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(54) **SINGLE-PHASE DIVERTER SWITCH FOR COLUMN-TYPE ON-LOAD TAP CHANGER**

(57) A single-phase diverter switch (100) for a column-type on-load tap changer comprises an insulating carrier plate (150) having a first carrier section (151) substantially semicircular in cross-section, and having a second carrier section (152) substantially semicircular in cross-section and abutting the first carrier section (151); an interrupter arrangement disposed on the first carrier section (151) of the insulating carrier plate (150), the interrupter arrangement including a first main interrupter (110), a second main interrupter (111) and a transition phase interrupter (112); and a disconnecter arrangement disposed on the second carrier section (152) of the insulating carrier plate (150), the disconnecter arrangement including a first disconnecter (120) electrically connected to the first main vacuum interrupter (110) and a second disconnecter (121) electrically connected to the second main vacuum interrupter (111). Respective connection states of the interrupter arrangement and of the disconnecter arrangement are controllable according to a predetermined switching sequence.

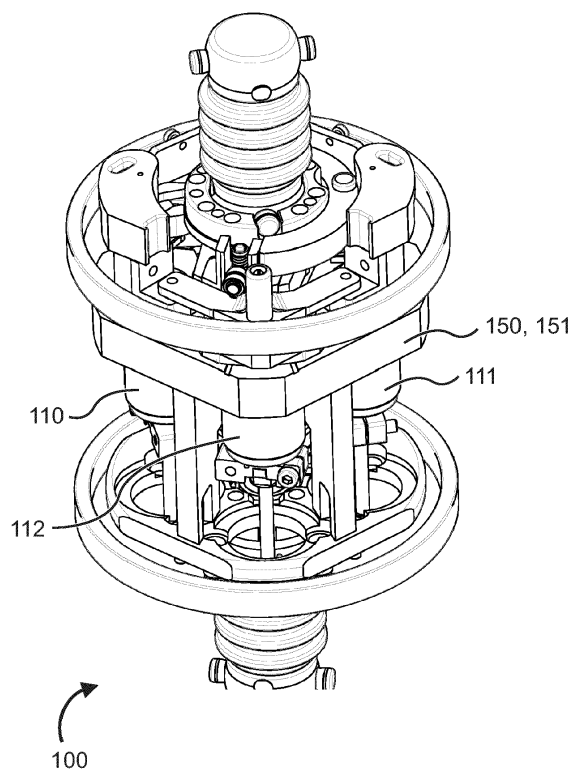


Fig. 1

Description

TECHNICAL FIELD

[0001] The disclosure relates to a single-phase diverter switch for an on-load tap changer of the column type.

BACKGROUND ART

[0002] An on-load tap changer is part of a power transformer and used to switch a tapping of the transformer to regulate an output high voltage when the power transformer is in full operation, i.e. in an on-load condition. With the use of an on-load tap changer, the output power, or power supply, need not be interrupted, resulting in a substantially continuous supply of output power even when the output voltage has to be regulated. The tap changer includes a set of fixed contacts, each fixed contact being connectable to a number of taps of a regulating winding of the power transformer. By selecting the taps to be connected or disconnected as needed, the output voltage of the transformer can be regulated.

[0003] A tap changer of the diverter type comprises a diverter switch. An electrical connection of a respective fixed contact and an external contact is established by the tap changer through intermediation of the diverter switch. A conventional diverter switch is known in which the current nominally flows through a main branch. In a transition period during switching, the current is made to flow through a transition branch. Typically, the transition branch has a higher impedance, such as a higher resistance or a higher inductance.

[0004] When a tap change is performed, one tap is temporarily connected to the external contact via the transition branch, whereas the other tap is connected via the main branch. Then, the new tap is connected to the external contact via the main branch. Subsequently, the transition branch is disconnected.

[0005] Such a transition operation requires interrupters for switching from the main branch to the transition branch, and vice versa. While vacuum interrupters have a high current carrying capacity and a good switching performance, the step voltage to be switched with a vacuum interrupter is typically limited when a compact configuration is desired. In a column-type on-load tap changer, an accurate coordination is necessary between a selector unit of the tap changer and the diverter switch.

[0006] Hence, there is a desire for a single-phase diverter switch for an on-load tap changer that is compact and/or is suitable for switching at a comparatively high switchable voltage level, while coordination in switching is simplified.

DESCRIPTION OF THE INVENTION

[0007] According to an aspect, a single-phase diverter switch for a column-type on-load tap changer is provided. The diverter switch comprises an insulating carrier plate,

an interrupter arrangement, and a disconnecter arrangement. The insulating carrier plate includes a first carrier section that has a substantially semicircular cross-section. The insulating carrier plate further includes a second carrier section that has a substantially semicircular cross-section. The second carrier section abuts on the first carrier section. The interrupter arrangement is disposed on the first carrier section of the insulating carrier plate. The interrupter arrangement comprises a first main interrupter, a second main interrupter, and a transition phase interrupter. The disconnecter arrangement is disposed on the second carrier section of the insulating carrier plate. The disconnecter arrangement includes a first disconnecter that is electrically connected to the first main interrupter. The disconnecter arrangement further includes a second disconnecter that is electrically connected to the second main interrupter. The respective connection states of the interrupter arrangement and of the disconnecter arrangement are controllable according to a predetermined switching sequence.

[0008] The two main interrupters and the transition phase interrupter are mounted on the first carrier section that takes roughly have the area of a circle. In the other half the first and second disconnectors are mounted on the second carrier section. Thus, the main parts of the diverter switch have a comparatively compact configuration and do not require a very accurate coordination in the switching process. The first and second disconnectors help to realize a higher step voltage for disconnecting the branch that is currently not in use during nominal operation, i.e. either the branch through the first main interrupter or the branch through the second interrupter. Thus, the switchable voltage level is raised.

[0009] The insulating carrier plate need not be a continuous plate. In embodiments, for example, it is conceivable that the first carrier section is separate from the second carrier section. In this connection, typically, the first and second carrier sections are arranged substantially in the same plane of the single-phase diverter switch. Typically, the plane is substantially orthogonal to an axial direction of the diverter switch.

[0010] In further embodiments, any one of the first main interrupter, the second main interrupter and the transition phase interrupter is a vacuum-type, VI, interrupter. Typically, all of the first main interrupter, the second main interrupter and the transition phase interrupter are VI interrupters.

[0011] In further embodiments, the first disconnecter and the second disconnecter each comprise a movable carrying arm and a stationary contact body. The movable carrying arms move relative to the corresponding stationary contact bodies, thus contributing to a safe and simple switching operation.

[0012] In further embodiments, the diverter switch further comprises a central shaft, and the central shaft is configured to drive the first main interrupter, the second main interrupter and the transition phase interrupter. By means of one central shaft driving all of the first main

interrupter, the second main interrupter and the transition phase interrupter, the driving procedure for performing a switching operation is simplified, without any very accurate coordination required.

[0013] In embodiments relating to the central shaft configured to drive any one or more of the interrupters, the central shaft may comprise one or more cams. The cams are arranged to act on the first main interrupter, the second main interrupter or the transition phase interrupter, respectively, such that the corresponding interrupter is driven. Acting on the interrupters, as used herein, may include that the cams actually engage with the respective interrupters.

[0014] In further embodiments, the diverter switch further comprises a central shaft, and the central shaft is configured to drive the first disconnecter and the second disconnecter. By means of one central shaft driving all of the disconnectors, the driving procedure for performing a switching operation is simplified, without any very accurate coordination required.

[0015] In embodiments relating to the central shaft configured to drive any one or more of the disconnectors, the central shaft may comprise one or more actuator pins. The actuator pins are arranged to act on the first or second disconnectors to drive the respective disconnecter. Acting on the disconnectors, as used herein, may include that the cams actually engage with the respective disconnectors.

[0016] In further embodiments, one central shaft is configured to drive the first main interrupter, the second main interrupter and the transition phase interrupter, as well as the first disconnecter and the second disconnecter. In this connection, the central shaft may comprise - e.g. on or in the vicinity of one end thereof - one or more cams that are arranged such that they act on the first main interrupter, the second main interrupter and the transition phase interrupter to drive the respective interrupter(s); and the central shaft may comprise - e.g. on or in the vicinity of the other end thereof - a plurality of actuator pins that are arranged to act on the first or second disconnectors to drive the respective disconnecter(s).

[0017] In embodiments, the diverter switch is configured to perform a switching according to the switching sequence, wherein the switching sequence comprises, in the stated order, driving an open one of the first and second main interrupters to the closed position, driving the transition phase interrupter to the closed position, driving the respective other one of the first and second main interrupters to the open position, and driving the transition phase interrupter to the open position.

[0018] For example, according to the embodiment, in an exemplary starting state in which the first main interrupter is closed and the second main interrupter is open, the current flows through the first main interrupter. To initiate the switching sequence, the second main interrupter is driven to the closed position. Then, the transition phase interrupter is driven to the closed position, such that the transition branch participates in the current trans-

mission. Subsequently, the first main interrupter is driven to the open position. In order to finish the transition sequence, the transition phase interrupter is driven to the open position. Thus, an exemplary finishing state is established, in which the first main interrupter is open and the second main interrupter is closed.

[0019] The respective first and second disconnectors may aid in keeping the switchable voltage level high. In further embodiments, the switching sequence further comprises driving an open one of the first and second disconnectors to the closed position, and driving the respective other one of the first and second disconnectors to the open position.

[0020] In the example given above, in which the switching is performed from the exemplary starting state to the exemplary finishing state, the first disconnecter is closed and the second disconnecter is open in the starting state. In the finishing state, the first disconnecter is opened and the second disconnecter is closed.

[0021] According to another aspect, an on-load tap changer is provided. The on-load tap changer comprises the single-phase diverter switch as described herein.

[0022] According to yet another aspect, a power transformer is provided. The power transformer includes an on-load tap changer. The on-load tap changer comprises the single-phase diverter switch as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] In the following, embodiments of the present disclosure will be described with reference to the drawings in which:

Fig. 1 is a schematic perspective view of a diverter switch according to an embodiment;

Fig. 2 is a schematic perspective view of elements of the diverter switch in the embodiment;

Fig. 3 is a schematic perspective view of the diverter switch in the embodiment, showing, among others, disconnectors;

Fig. 4 is a schematic perspective view of the diverter switch in the embodiment, showing, among others, a cam, a movable carrying arm on a central shaft, and a stationary contact body;

Fig. 5 is a schematic perspective view of the diverter switch in the embodiment, showing, among others, the movable carrying arm on the central shaft, and the stationary contact body; and

Fig. 6 is a sectional side view of the diverter switch in the embodiment.

DETAILED DESCRIPTION

[0024] An embodiment of the present disclosure will be described commonly with reference to the illustrations in Figs. 1 through 6. Fig. 1 shows a schematic perspective view of a diverter switch 100 according to an embodiment. Fig. 2 shows a schematic perspective view of elements (interrupters 110, 111, 112) of the diverter switch 100. Fig. 3 shows a schematic perspective view of the diverter switch 100 and shows, among others, disconnectors 120, 121. Fig. 4 shows a schematic perspective view of the diverter switch 100, and shows, among others, a cam 190, a movable carrying arm 122 on a central shaft 180, and a stationary contact body 123. Fig. 5 shows a schematic perspective view of the diverter switch 100, and shows, among others, the movable carrying arm 122 on the central shaft 180, and the stationary contact body 123. Fig. 6 shows a sectional side view of the diverter switch 100.

[0025] The diverter switch 100 is adapted to be used with an on-load tap changer of the column type; thus, the diverter switch 100 extends along a rotation axis thereof, roughly from top to bottom in the illustration according to Fig. 1. At the viewing angle of Fig. 1, a first carrier section 151 of an insulating carrier plate 150 is visible. The first carrier section 151 has a substantially semicircular cross section perpendicular to the rotation axis of the diverter switch 100. An interrupter arrangement formed of a first vacuum-type (VI) main interrupter 110, a second VI main interrupter 111 and a transition phase VI interrupter 112 is disposed, or mounted, on the first carrier section 151.

[0026] As apparent from Fig. 2, a second carrier section 152 of the insulating carrier plate 150 is visible. A first disconnector 120 is mounted on the second carrier section 152. Although not shown in Fig. 2, likewise, a second disconnector 121 is mounted on the second carrier section 152 in an area not illustrated here. The first disconnector 120 is electrically connected to the first main interrupter 110, and the second disconnector 121 is electrically connected to the second main interrupter 111, such that both the pair of first disconnector 120 and first main interrupter 110 on the one hand, and the pair of second disconnector 121 and second main interrupter 111 on the other hand participate in a diverter switching operation. The disconnectors 120, 121 are also shown in the illustration of Fig. 3.

[0027] The first carrier section 150 is substantially semicircular in cross-section. Likewise, the second carrier section 151 is substantially semicircular in cross-section. In the embodiment, the carrier sections 150, 151 abut on each other, are separate from one another and are arranged substantially in the same plane of the diverter switch 100 perpendicular to the rotation axis.

[0028] As apparent from the illustration in Figs. 4-6, a central shaft 180 penetrates through the diverter switch 100, having mounted thereon multiple actuator pins 170, 171, 172 that are arranged such that upon a rotation of the central shaft 180 and depending on the rotational

position thereof, they engage with the disconnectors 120, 121 to drive the respective disconnector 120, 121. The first disconnector 120 comprises a movable carrying arm 122 and a stationary contact body 123. Likewise, the second disconnector 121 comprises a movable carrying arm 124 and a stationary contact body 125. Upon the rotational movement of the central shaft 180, the movable carrying arms 122, 124 perform a pivoting movement to engage, when the rotational angle is correct, with the respective corresponding contact body 123, 125.

[0029] On the opposite side in the axial direction, mounted on another plate 160 (see Fig. 2; here, without limitation, a steel plate) is a driving system 115 for the interrupters 110, 111, 112. The plates 150, 160 are typically mechanically by means of insulation bars in order to ensure the mechanical stability of the phase. connected A cam 190 is mounted on the central shaft 180 that is arranged such that upon rotating the central shaft 180 and depending on the rotational position thereof, the cam 190 acts on the first main interrupter 110, the second main interrupter 111, or the transition phase interrupter 112 respectively, to actuate - or drive - the respective interrupter 110, 111, 112.

[0030] As such, the diverter switch 100 according to the embodiment comprises two main vacuum interrupters 110, 111 and one auxiliary, or transition phase, vacuum interrupter 112 that are mounted on the semicircular half formed by section 151 of the plate 150. In the other half there are placed the contact disconnectors 120, 121 that are driven by the central shaft 180 via an even number of pins 170, 171, 172 (a fourth one not shown in the drawings) that are fastened on the shaft 180. On another axial end of the shaft 180 there are mounted one or more cams 190 for controlling the interrupters' driving system 115. The interrupters' driving system 115 is mounted on carrying plate 160. The movable part of the contact disconnectors 120, 121 comprises the carrying arms 122, 124. The stationary part of the contact disconnectors 120, 121 comprises the stationary contact bodies 123, 125, e.g. a pair of contact clamps that are gripped by the movable elements on both sides.

[0031] The diverter switch 100 is configured such that by rotating the central shaft 180, a switching according to a switching sequence is carried out. In the switching sequence, an open one of the first main interrupter 110 and second main interrupter 111 is driven to the closed position. Then, the transition phase interrupter 112 is driven to the closed position. Then, the respective other one of the first main interrupter 110 and second main interrupter 111 is driven to the open position. Subsequently, the transition phase interrupter 112 is driven to the open position.

[0032] In addition to the interrupters 110, 111, 112, in the switching sequence, an open one of the first disconnector 120 and second disconnector 121 is driven to the closed position. Then, respective other one of the first disconnector 120 and second disconnector 121 is driven to the open position. Thus, the switching sequence is

completed.

[0033] It is noted that while the above description refers to specific embodiments, the skilled person will recognize that the features described therein may be combined as appropriate, and/or that one or more features thereof may be altered or omitted as appropriate, without departing from the gist of the present application whose scope is defined by the claims.

Claims

1. A single-phase diverter switch (100) for a column-type on-load tap changer, comprising:

an insulating carrier plate (150) having a first carrier section (151) substantially semicircular in cross-section, and having a second carrier section (152) substantially semicircular in cross-section and abutting the first carrier section (151);

an interrupter arrangement disposed on the first carrier section (151) of the insulating carrier plate (150), the interrupter arrangement including a first main interrupter (110), a second main interrupter (111) and a transition phase interrupter (112);

a disconnecter arrangement disposed on the second carrier section (152) of the insulating carrier plate (150), the disconnecter arrangement including a first disconnecter (120) electrically connected to the first main interrupter (110) and a second disconnecter (121) electrically connected to the second main interrupter (111), wherein respective connection states of the interrupter arrangement and of the disconnecter arrangement are controllable according to a predetermined switching sequence.

2. The single-phase diverter switch (100) according to claim 1, wherein the first carrier section (151) and the second carrier section (152) are separate from one another and arranged substantially in a same plane of the single-phase diverter switch (100).

3. The single-phase diverter switch according to any one of the preceding claims, wherein one or more of the first main interrupter (110), the second main interrupter (111) and the transition phase interrupter (112) is a vacuum-type (VI) interrupter.

4. The single-phase diverter switch according to any one of the preceding claims, wherein the first disconnecter (120) and the second disconnecter (121) each comprise a movable carrying arm (122, 124) and a stationary contact body (123, 125).

5. The single-phase diverter switch according to any

one of the preceding claims, further comprising a central shaft (180) configured to drive the first main interrupter (110), the second main interrupter (111) and the transition phase interrupter (112).

6. The single-phase diverter switch according to claim 4, the central shaft (180) comprising one or more cams (190) arranged to act on or to engage with the first main interrupter (110), the second main interrupter (111) or the transition phase interrupter (112) to drive the respective interrupter.

7. The single-phase diverter switch according to any one of claims 1-3, further comprising a central shaft (180) configured to drive the first disconnecter (120) and the second disconnecter (121).

8. The single-phase diverter switch according to claim 7, the central shaft (180) comprising a plurality of actuator pins (170, 171, 172) arranged to act on or to engage with the first or second disconnectors (120, 121) to drive the respective disconnecter.

9. The single-phase diverter switch according to any one of claims 1-3, further comprising a central shaft (180), wherein the central shaft (180) is configured to drive the first main interrupter (110), the second main interrupter (111) and the transition phase interrupter (112), and wherein the central shaft (180) is configured to drive the first disconnecter (120) and the second disconnecter (121).

10. The single-phase diverter switch according to claim 9, the central shaft (180) comprising one or more cams (190) arranged to act on or to engage with the first main interrupter (110), the second main interrupter (111) or the transition phase interrupter (112) to drive the respective interrupter, and the central shaft (180) comprising a plurality of actuator pins (170, 171, 172) arranged to act on or to engage with the first or second disconnectors (120, 121) to drive the respective disconnecter.

11. The single-phase diverter switch according to any one of the preceding claims, the single-phase diverter switch being configured to perform a switching according to the switching sequence, the switching sequence comprising in the stated order:

- i) driving an open one of the first and second main interrupters (110, 111) to the closed position;
- ii) driving the transition phase interrupter (112) to the closed position;
- iii) driving the respective other one of the first and second main interrupters (110, 111) to the open position;
- iv) driving the transition phase interrupter (112)

to the open position.

12. The single-phase diverter switch according to claim 11, the switching sequence further comprising driving an open one of the first and second disconnectors (120, 121) to the closed position, and driving the respective other one of the first and second disconnectors (120, 121) to the open position. 5
13. An on-load tap changer comprising the single-phase diverter switch according to any one of the preceding claims. 10
14. A power transformer including an on-load tap changer, the on-load tap changer comprising the single-phase diverter switch according to any one of claims 1-12. 15

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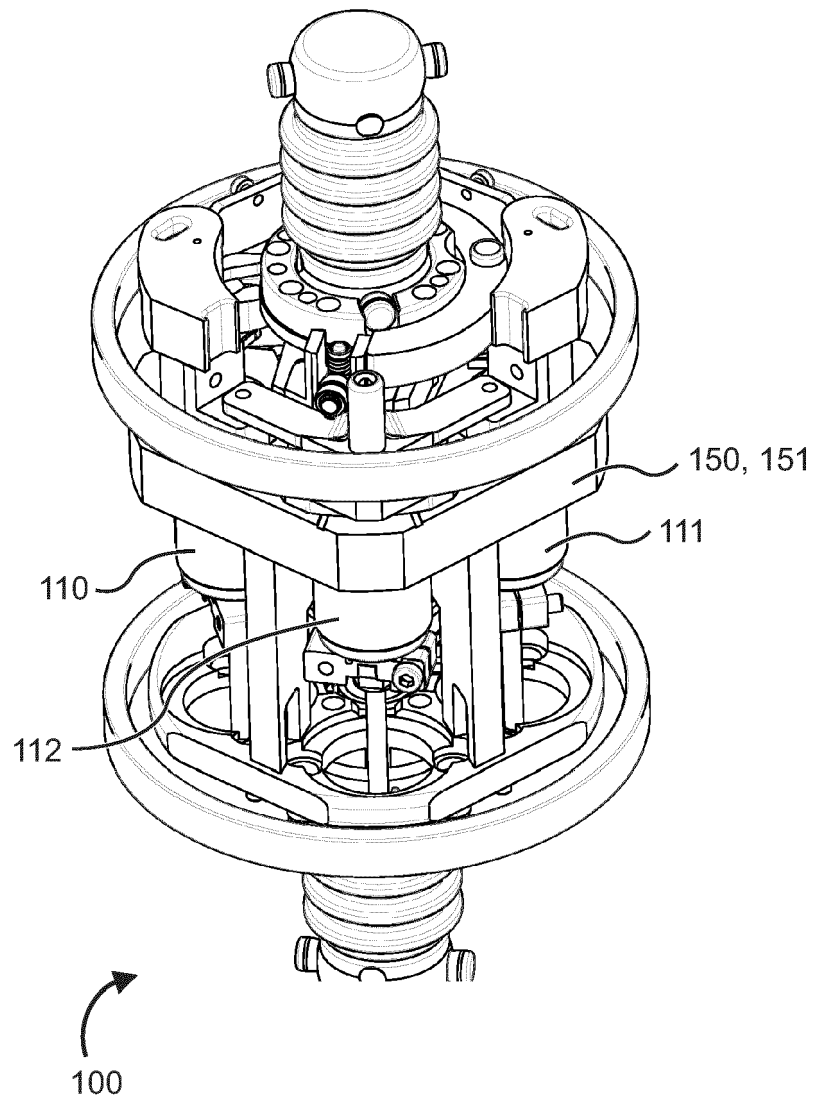


Fig. 1

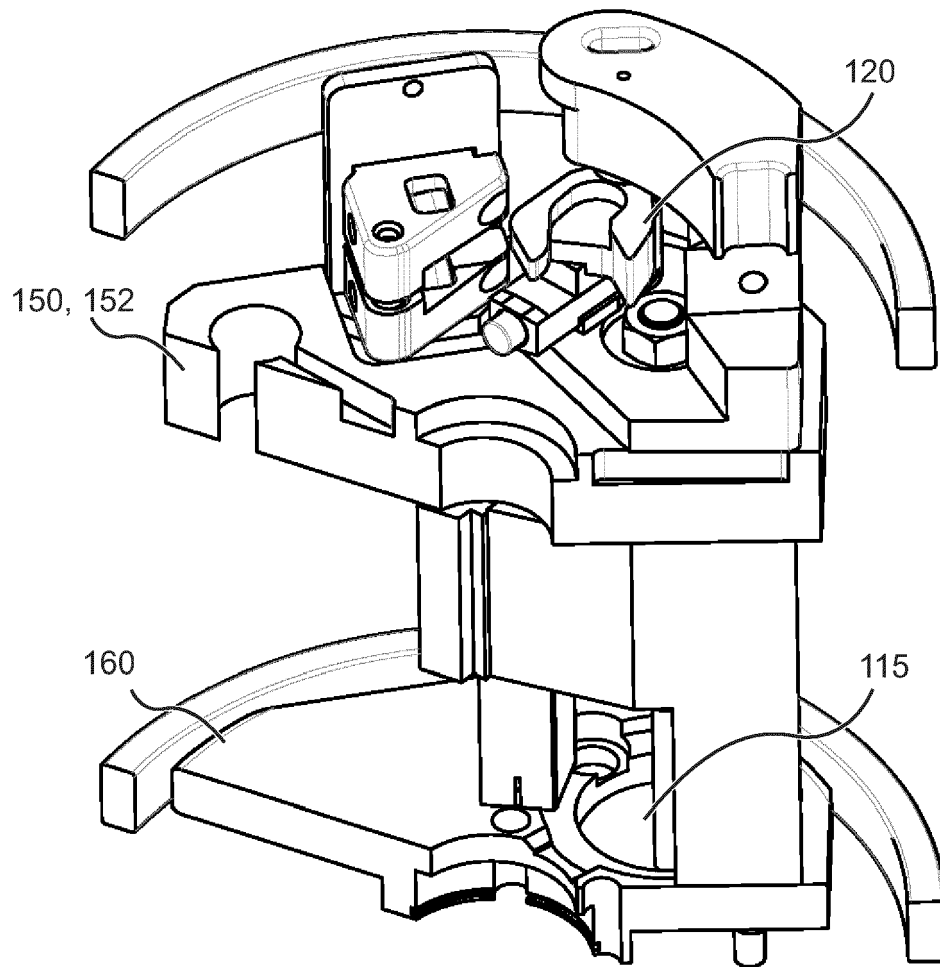


Fig. 2

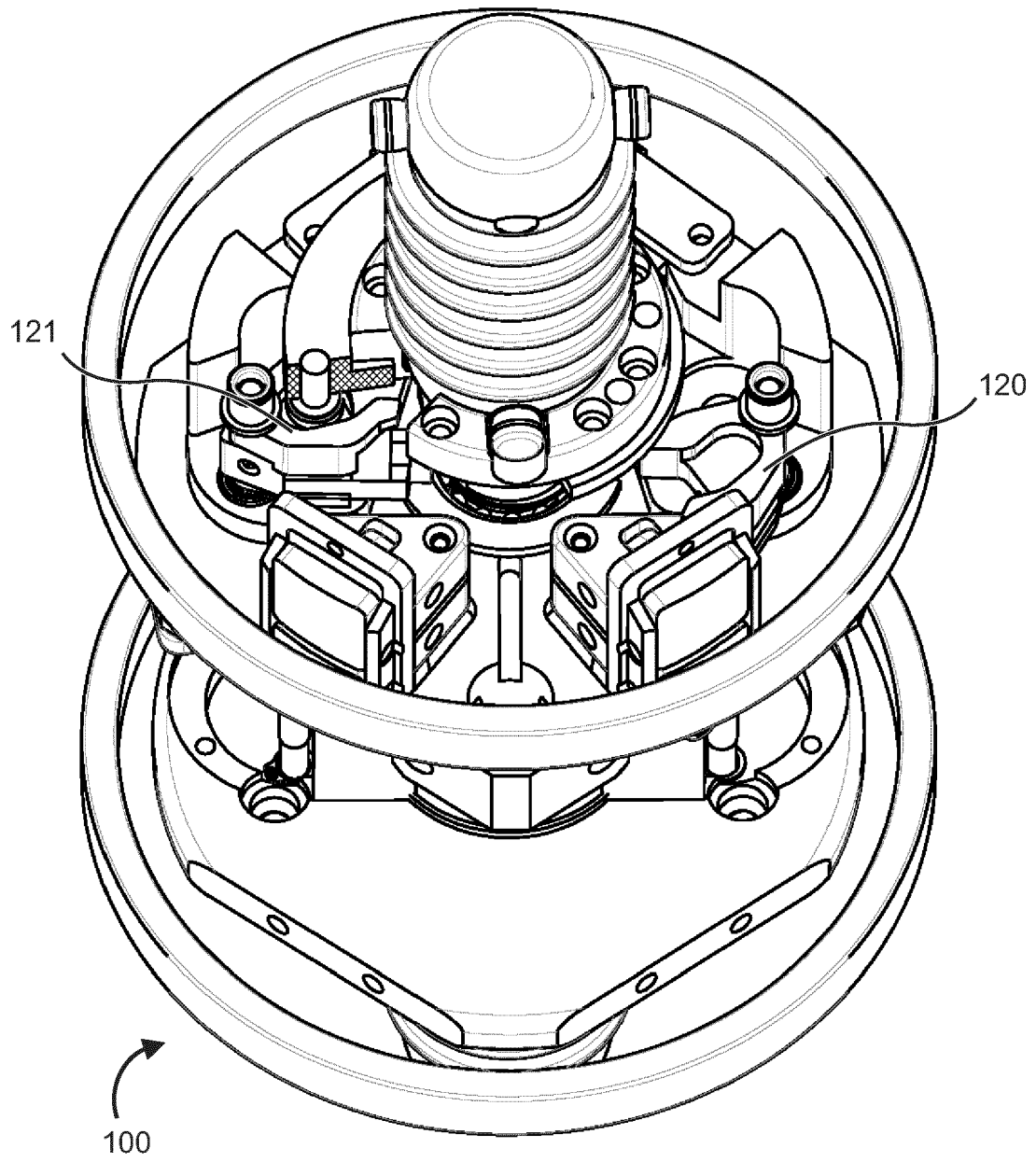


Fig. 3

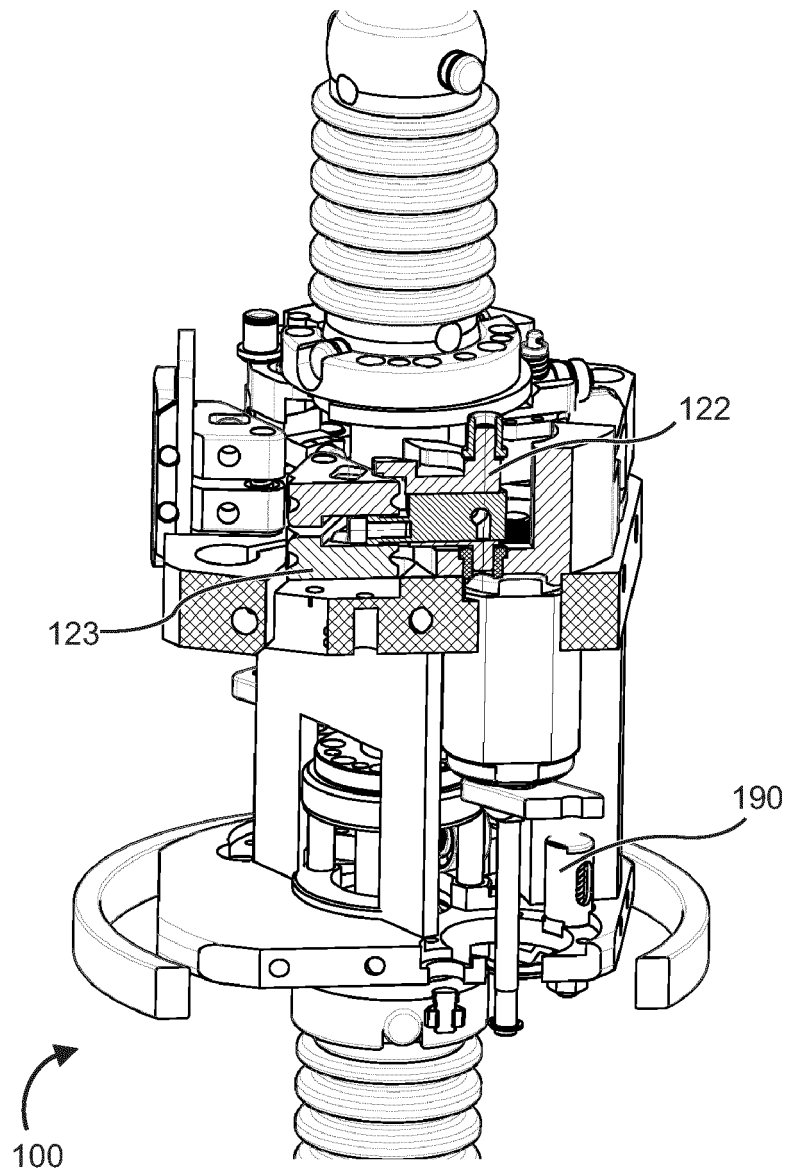


Fig. 4

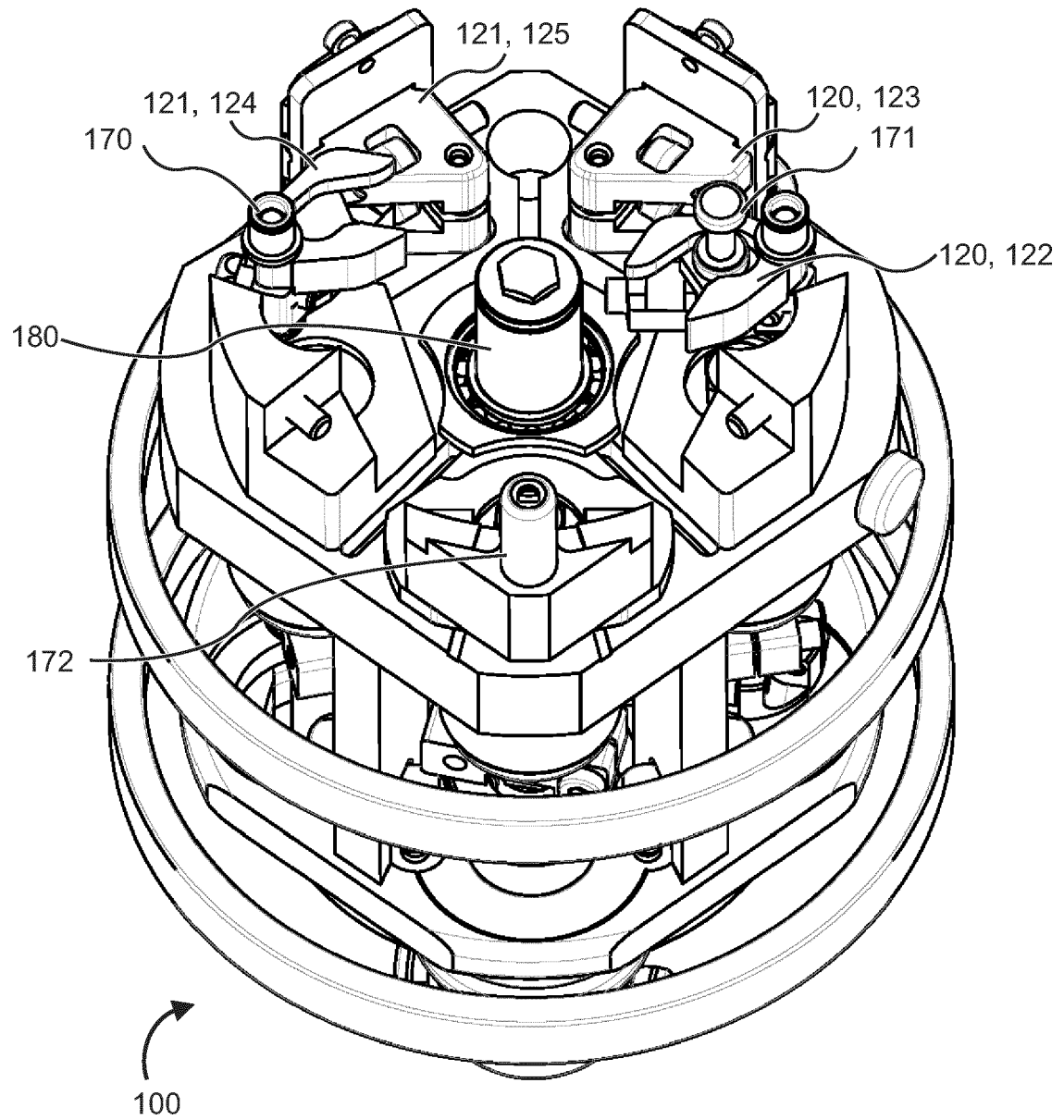


Fig. 5

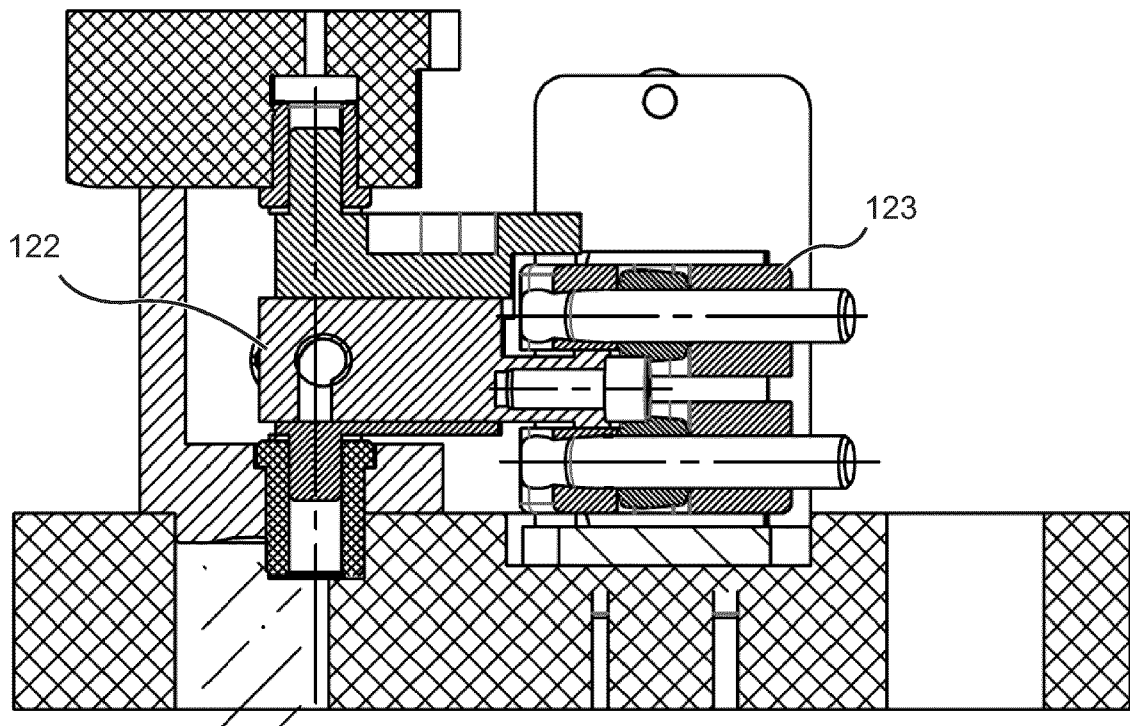


Fig. 6



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Application Number
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The present search report has been drawn up for all claims			
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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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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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