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(54) PARALLEL BREAKING LOAD SWITCH AND MEDIUM-VOLTAGE SWITCHGEAR WITH SAME

(57) Present disclosure relates to a parallel breaking load switch, which includes: - a stationary contact; - a moving contact, wherein the moving contact is configured to be capable of rotating around a pivot axis among a closed position, a commutation position and a breaking position; - a vacuum interrupter, wherein the stationary contact is electrically connected with a fixed switch contact in the vacuum interrupter; and - a cam assembly, wherein the cam assembly is provided with a small contact capable of rotating around the pivot axis; wherein a moving end of a movable switch contact can be guided and operatively connected to the cam assembly, and a travel of the linear movement is not less than 7 mm. Thus, a relatively long breaking distance can be realized, and technical requirements such as over-travel can be set flexibly. Present disclosure also relates to a medium-voltage switchgear with the parallel breaking load switch.

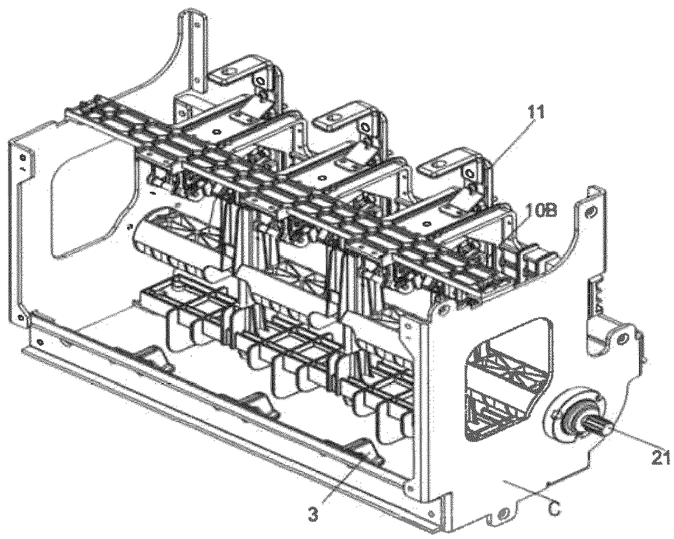

Fig. 1

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Description

Technical Field

[0001] Present disclosure relates to a parallel breaking load switch, which is particularly suitable for breaking a power line of a medium-voltage electrical system and includes a breaking load switch with a vacuum interrupter. The term "medium voltage" (MT) is used in an ordinary meaning, i.e. to indicate a voltage of more than 1 000 volts but not more than 52,000 volts in alternating current and more than 1500 volts but not more than 75,000 volts in direct current. Present disclosure also relates to a medium-voltage switchgear with the parallel breaking load switch.

Background Art

[0002] It is known that circuit breakers and disconnect switches in medium-voltage or high-voltage power lines or power cables usually include boxes in which switch contacts re arranged so as to move between a position of contact with each other corresponding to closure of the power line and a position of separation from each other corresponding to disconnection of the power line. These boxes are filled with a dielectric fluid; the switch contacts are immersed in the dielectric fluid, and the dielectric fluid assists in disconnecting current by extinguishing arc that may remain after the switch contacts are separated from each other. A lot of different fluids (such as air, oil, nitrogen, etc.) were proposed in the past, but sulfur hexafluoride (SF6) is commonly used now, which has good dielectric characteristics and is therefore very suitable for the purpose. Even so, the use of the gas is limited because of its weakness, namely toxicity and corrosiveness of its decomposition products and contribution to the greenhouse effect. Therefore, there is a demand for the use of vacuum interrupters that are also used in some disconnect switches, switch contacts are internal elements of these switch boxes, and the vacuum interrupters are the most effective in extinguishing arc current; however, without further improvement, the use of vacuum interrupters in the existing circuit breakers cannot be considered because of the cost, because the vacuum interrupter in these circuit breakers are too bulky from the perspective of materials and dimensions; and the materials and dimensions capable of meeting different electrical and dielectric requirement must be used, such as the ability of withstanding the lightning shocks.

[0003] In order to solve the above defects, it is particularly known from the Chinese invention patent with Publication No. CN102623234A that the vacuum interrupter is arranged in a bypass circuit parallel to a main circuit of a main switch including one phase of the electrical equipment. In the structure, no current passes through the vacuum interrupter during normal operation, that is, when the main switch is closed and thus the current passes through the main circuit. During the operation of disconnecting the main switch, a movable portion of the main switch closes the parallel bypass circuit containing the vacuum interrupter before the current in the main circuit is interrupted. The current is then interrupted in the main circuit, so that all the current then passes through the vacuum interrupter. When the disconnecting stroke is continued, the movable portion of the main switch disconnects the contact of the vacuum interrupter, and the current is cut off. Therefore, the generation of arcs in the main switch is avoided, because at the moment of cutting off the current, the current only passes through the vacuum interrupter. Because there is current passing through the vacuum interrupter only during a transient phase of the cut-off current, the vacuum interrupter can be simplified and be smaller in size than the vacuum interrupters normally intended to be arranged in series with the main switch.

[0004] However, in the vacuum interrupter, the disconnection of the vacuum interrupter is only caused by the main switch in the disconnection stroke. Therefore, the relative arrangement of the vacuum interrupter and the main switch is limited. Furthermore, the kinematic connection between the vacuum interrupter and the main switch needs to be very precise. In view of the number of elements involved in the assembly, the dimensional tolerances of each element of the kinematic connection sequence must be tight.

[0005] Therefore, there is a technical need in the related technical field to allow lower accuracy, longer breaking distance, and flexible setting of over-travel, etc. in the formation of the movable portion that contributes to the disconnection of the vacuum interrupter in a simple and reliable manner.

Summary of the Invention

[0006] Therefore, a task of present disclosure is to provide a parallel breaking load switch to overcome the defects in the prior art.

[0007] According to an aspect of present disclosure, provided is a parallel breaking load switch, which is suitable for breaking a power line of a medium-voltage electrical system, and includes: a stationary contact including a first end connected to the power line and a second end opposite to the first end; a moving contact, wherein the moving contact is configured to be capable of rotating around a pivot axis among a closed position, a commutation position and a breaking position, the moving contact is connected to the second end of the stationary contact at the closed position and electrically communicated with the stationary contact, and the moving contact is disconnected from the stationary contact when rotating around the pivot axis to the breaking position; a vacuum interrupter with a fixed switch contact and a movable switch contact arranged therein, wherein the stationary contact is electrically connected with the fixed switch contact; and a cam assembly, wherein the cam assembly is provided with a small contact capable of rotating around the rotating axis, the small contact is provided with an electric conductor that can be electrically connected with the moving contact so as to be electrically connected with the vacuum interrupter in response to the rotation of the moving contact round the pivot axis; wherein a moving end of the movable switch contact is aligned along the axis of the vacuum interrupter and is capable of making linear movement between an off position and an on position, the moving end of the movable switch contact can be guided and operatively connected to the cam assembly, and a travel of the linear movement is not less than 7 mm; at the closed position, the moving contact is in contact with the stationary contact and is spaced apart from the small contact, the movable switch contact is at the on position in contact with the fixed switch contact, and the current can flow through the stationary contact to the moving contact; the moving contact rotates around the pivot axis in a first rotating direction from the closed position to the commutation position, and during the rotation, the moving contact is in contact with the small contact, so that the electrical current can flow through the stationary contact and the vacuum interrupter to the moving contact via the small contact; and moreover, the moving contact further rotates around the pivot axis in the first rotating direction from the commutation position to the breaking position, wherein the moving contact drives the small contact to rotate around the rotating axis and actuates the cam assembly, so that the moving end of the movable switch contact moves linearly from the on position to the off position along the axis of the vacuum interrupter to separate the movable switch contact from the fixed switch contact of the vacuum interrupter.

[0008] According to the parallel breaking load switch of present disclosure, the technical demand of lower precision, longer breaking distance and capability of flexibly setting over-travel can be allowed in a simple and reliable manner when the moving part contributing to the disconnection of the vacuum interrupter. Moreover, the parallel breaking load switch according to present disclosure needs fewer components and less cost and has good reliability.

[0009] In some embodiments, as a preferred aspect, the cam assembly includes a cam frame, wherein the small contact is pivotally connected to the cam frame, and the cam frame is provided with a leading groove for leading the moving end of the movable switch contact to move linearly between the off position and the on position; a cam pivotally connected to the cam frame, wherein the cam is provided with an abutting pin operatively connected with the small contact and a guiding groove for sandwiching the moving end of the movable switch contact; wherein the small contact can drive the cam to pivot together around the rotating axis, so that the moving end of the movable switch contact moves linearly between the off position and the on position via the leading groove and the guiding groove.

[0010] In some embodiments, as a preferred aspect, the small contact is designed as an elongated piece, which includes a first end pivoted to the cam frame and a second end being opposite to the first end, wherein the second end is provided with an elastic sheet capable of elastically abutting the moving contact. Thus, the design ensures the continuity of the current and can realize a simple bypass circuit.

[0011] In some embodiments, as a preferred aspect, the parallel breaking load switch further includes an insulation bracket constructed as an integral piece and includes a horizontal portion for fixedly installing the cam frame and the vacuum interrupter and a vertical portion for fixedly installing the stationary contact. Thus, the design ensures the transmission accuracy and can effectively reduce assembling errors.

[0012] In some embodiments, as a preferred aspect, the cam assembly further includes a torsional spring fixedly installed to the cam frame, wherein a supporting leg of the torsional spring operatively abuts the cam to pivot along with the cam relative to the cam frame to accumulate elastic potential energy, and to subsequently release the elastic potential energy so as to return the cam to an initial position.

[0013] In some embodiments, as a preferred aspect, the moving contact includes a pair of spaced contact pieces, wherein one end of the contact piece is provided with a spherical portion protruded outwards and operatively connected to an actuator so as to be actuated to rotate around the pivot axis among the closed position, the commutation position and the breaking position, and the other end of the contact piece is provided with an abutting portion that is protruded outwards and forms surface contact with the second end of the stationary contact.

[0014] In some embodiments, as a preferred aspect, the parallel breaking load switch further includes a voltage equalizing ring arranged adjacent to the spherical portion of the contact piece and used for equalizing an electric field of the current flowing through the moving contact, and a semicircular shielding cover arranged adjacent to the abutting portion of the contact piece in a spaced manner and used for preventing partial discharge.

[0015] In some embodiments, as a preferred aspect, the small contact is made of an insulation material, and the second end is provided with an insulation material layer at one side opposite to the contact piece.

[0016] In some embodiments, as a preferred aspect, the parallel breaking load switch further includes a grounding contact located at one side of the moving contact and capable of being electrically coupled to a grounding conductor, wherein the grounding contact is designed generally in a U shape and includes a first end coupled to the grounding conductor, a second end opposite to the first end and a hollow portion located between the first end and the second end, and the second end is provided with a pair of contact feet matched with the moving contact.

[0017] According to another aspect of present disclosure, a medium-voltage switchgear is further provided, which includes a shell filled with insulation gas and the parallel breaking load switch arranged in the shell.

[0018] Some of other features and advantages of present disclosure may be obvious to those skilled in the art after reading the description, and the other part may be described in the following detailed embodiments in combination with the accompanying drawings.

Brief Description of the Drawings

[0019] Embodiments of present disclosure are described in detail in combination with the accompanying drawings.

Figure 1 is a front view of a medium-voltage switchgear with a parallel breaking load switch according to present disclosure;
Figure 2 is a side view of a medium-voltage switchgear with a parallel breaking load switch according to present disclosure;
Figure 3 is a front view of a medium-voltage switchgear with a parallel breaking load switch according to present disclosure;
Figure 4 is a top view of a medium-voltage switchgear with a parallel breaking load switch according to present disclosure;
Figures 5-6 are a perspective view and a side view of a main circuit of a parallel breaking load switch according to present disclosure, wherein a moving contact is removed;
Figure 7 is a side view of a moving contact of a parallel breaking load switch according to present disclosure;
Figure 8 is a perspective view of a parallel breaking load switch according to present disclosure, wherein some components of the medium-voltage switchgear are removed to better show the details;
Figure 9 is a side view of a parallel breaking load switch according to present disclosure, wherein some components of the medium-voltage switchgear are removed to better show the details;
Figures 10-12 are views of different perspectives of a parallel breaking load switch according to present disclosure, wherein some components of the medium-voltage switchgear are removed to better show the details.

Description of numerals in the drawings:

[0020]

100, parallel breaking load switch; C, shell; 1, stationary contact; 11, first end;
12, second end; 10, insulation bracket; 10A, vertical portion; 10B, horizontal portion;
2, moving contact; 21, actuator; 22, surface contact; 23, shielding part;
24, voltage equalizing ring; 25, wiring terminal; 3, grounding contact; 3 1, contact foot;
4, vacuum interrupter; 41, fixed end; 42, moving end; 5, cam frame;
51, leading groove; 52, pivot point; 53, lead holder; 6, electric conductor; 7, small contact; 71, elastic sheet; 72, bottom end; 73, copper sheet; 8, cam;
81, guiding groove; 82, abutting pin;
9, torsional spring; A1, rotating axis; A2, pivot axis

Detailed Description of the Invention

[0021] Referring to the accompanying drawings, schematic solutions of a parallel breaking load switch and a medium-voltage switchgear with same disclosed by present disclosure are described in detail. Although the provided accompanying drawings are used for showing some embodiments of present disclosure, the accompanying drawings are unnecessary to be drawn according to dimensions of a specific embodiment; and moreover, some features can be enlarged, removed or sectioned locally to better illustrate and explain the content of present disclosure. Positions of some components in the accompanying drawings can be adjusted without affecting the technical effect according to actual needs. The phrase "in the accompanying drawings" or similar terms appearing in the description need not refer to all of the accompanying drawings or examples. Some directional terms for describing the accompanying drawings hereinafter such as "internal", "external", "upper", "lower" and the like may be understood to have the normal meanings and to refer to those directions involved in a normal view of the accompanying drawings. Unless otherwise specified, the directional terms in the description basically refer to the conventional direction understood by those skilled in the art.

[0022] The terms "first", "the first one", "second", "the second one" and similar terms used in present disclosure do not indicate any order, quantity or importance, but are used to distinguish one component from other components in present disclosure.

[0023] In order to make the purpose, structure, features and functions of present disclosure further understood, details are described below in combination with embodiments.

[0024] As shown in Figures 1-4 of present disclosure, a medium-voltage switchgear according to present disclosure is particularly suitable for being connected into a medium-voltage circuit as a load breaking switch. Therefore, the medium-voltage switchgear is used to provide a breaking function and a circuit cutoff function at a specified circuit state (a nominal or overload state), and particularly to make a load-side portion of the circuit to be grounded.

[0025] As shown in Figure 1, in an embodiment of the present utility mode, the medium-voltage switchgear belongs to a multi-phase (e.g. three-phase) type, and includes a plurality of (e.g. three) electrodes. Further, the medium-voltage switchgear includes a shell C preferably made of an insulation material, and the insulation shell C beneficially defines an internal space capable of accommodating the electrodes. As shown in Figure 1, the insulation shell C has an elongated shape (for example, generally a cuboid shape) extending along a main longitudinal axis. The plurality of electrodes are arranged side by side along a corresponding horizontal plane perpendicular to the main longitudinal axis of the medium-voltage switchgear. The internal space of the medium-voltage switchgear is filled with pressurized dry air with low environment impact or another insulation gas (such as a mixture of oxygen, nitrogen, carbon dioxide and/or fluorinated gases).

[0026] As shown in Figure 1, each electrode is electrically connected to a power line of the medium-voltage electrical system and is correspondingly broken by a parallel breaking load switch of present disclosure, wherein the parallel breaking load switch 100 includes a stationary contact 1 which includes a first end 11 connected to the power line and a second end 12 opposite to the first end, the first end 11 is protruded out of the upper side of the insulation shell C and provided with a connector connected with an external power line, and the second end 12 is a flaky piece arranged inside the insulation shell C and protruded inwards. Those skilled in the art can also know that the stationary contact 1 can be realized according to other solutions of a known type (for example, configured according to a plurality of blades including a plurality of fixed contact pieces), which is not described in detail here for brevity.

[0027] The parallel breaking load switch 100 further includes a moving contact 2 which is at least partially made of a conductive material, and can be electrically connected to the power line of the electrical system via a wiring terminal 25 located at the lower end. As shown in Figure 1 and Figure 3, the moving contact 2 can pivot reciprocally around a corresponding pivot axis A2 generally parallel to the main longitudinal axis of the medium-voltage switchgear. Specifically, the moving contact 2 can rotate in a first rotating direction away from the second end 12 of the stationary contact 1 and toward a grounding contact 3 or a second rotating direction, and tire second rotating direction is opposite to the first rotating direction and is directed away from the grounding contact 3 and towards the second end 12 of the stationary contact 1. As may be better explained below, the moving contact 2 moves in the first rotating direction during the breaking operation and commutation operation of the medium-voltage switchgear and moves in the second rotating direction during the closing operation or reconnection of the switchgear. Thus, the moving contact 2 can move reciprocally around the pivot axis A2, so that the moving contact 2 can be electrically connected to the second end 12 of the stationary contact 1 or separated from the second end 12 of the stationary contact 1, or can be electrically connected to the grounding contact 3 or separated from the grounding contact 3.

[0028] As a preferred aspect, the moving contact 2 can be formed by a pair of spaced contact pieces that are made of a conductive material. Each contact piece has an end that is hinged to the corresponding wiring terminal 25 at the pivot axis A2 and forms an opposite free end electrically coupled with the second end 12 of the stationary contact 1. Further, in order to realize the rotation of the moving contact 2 around the pivot axis A2, the medium-voltage switchgear includes an actuator 21, and the actuator 21 provides an appropriate actuating force to actuate the moving contact 2 (Figure 1). The actuator 21 here can be, for example, a mechanical actuator, an electric motor or a solenoid actuator.

[0029] As a preferred aspect, as shown in Figure 11, one end of the contact piece of the moving contact 2 is provided with a spherical portion protruded outwards and operatively connected to the actuator 21 so as to be actuated to rotate around the pivot axis A2 among the closed position, the commutation position and the breaking position that are described in detail below, and the other end of the contact piece of the moving contact 2 is provided with an abutting portion 22 protruded outwards and capable of forming surface contact with the second end 12 of the stationary contact 1. By means of the added abutting portion 22, a contact area between the moving contact 2 and the stationary contact 1 can be increased obviously, thereby improving the passing capacity of the current, so that ablation and fusion welding are unlikely to occur when the breaking operation is performed by means of the moving contact 2. At the same time, since the lower portion of the moving contact 2 is designed in a spherical surface, the friction or resistance of the pivot movement can be reduced, thereby meeting the requirements of temperature-rise test. More preferably, as shown in Figures 10-11, the moving contact 2 is also provided with a voltage equalizing ring 24 arranged adjacent to the spherical portion of the contact piece and used to equalize an electric field of electrical current flowing through the moving contact and a semicircular shielding cover 23 arranged adjacent to the abutting portion of the contact piece at an interval and used for preventing partial discharge, which are helpful to prevent the partial discharge during the normal operation of the medium-voltage electrical equipment and equalize the electric field inside the electrical equipment, and beneficial to improving the operation reliability and service life of the medium-voltage electrical equipment.

[0030] Further, the medium-voltage electrical equipment can also include a grounding contact 3 located at one side of the moving contact 2 and capable of being electrically coupled to a grounding conductor, wherein the grounding contact 3 is designed generally in a U shape and includes a first end coupled to a grounding conductor, a second end opposite to the first end and a hollow portion located between the first end and the second end, and the second end is provided with a pair of contact feet 31 (referring to Figures 8-10) matched with the moving contact. In present disclosure, since the grounding contact 3 is designed in a U shape, those skilled in the art may know that two sides of an electrodynamic force are opposite in direction according to a right-hand rule, and most of electrodynamic force acting on the moving contact 3 can be counteracted, so that the grounding closing test is more stable and more reliable.

[0031] Subsequently, Figures 5- 6 show more details of the parallel breaking load switch 100 below according to present disclosure. Specifically, the parallel breaking load switch 100 also includes a vacuum interrupter 4, which is provided with a fixed switch contact and a movable switch contact, and the stationary contact 1 is electrically connected with the fixed switch contact. The vacuum interrupter 4 as an example here includes the paired fixed switch contact and movable switch contact, wherein the fixed switch contact can be electrically connected with the first end 11 of the stationary contact 1, and the vacuum interrupter 4 is fixedly connected to the stationary contact 1. At the same time, the movable switch contact is driven by a moving end 42 extending from the shell of the vacuum interrupter 4. In this structure, no electrical current passes through the vacuum interrupter 4 during the normal operation, that is, when the moving contact 2 and the stationary contact 1 are closed to enable the current to pass through a main circuit. During the operation of disconnecting the moving contact 2 and the stationary contact 1, a movable portion of the moving contact 2 switches on a parallel bypass circuit including the vacuum interrupter before the electrical current in the main circuit is interrupted. The current is then interrupted in the main circuit, so that all the current then passes through the vacuum interrupter. When the disconnecting operation is continued, the movable portion of the main circuit disconnects the contact of the vacuum interrupter, and the current is cut off. Therefore, the generation of arcs in the main circuit is avoided, because at the moment of cutting off the current, the current only passes through the vacuum interrupter. The structure of the vacuum interrupter 4 is known, for example, the vacuum interrupter can be a VI-8 vacuum interrupter commercially available from Eaton Company, and its structure is not described in detail here for the sake of brevity.

[0032] Since the medium-voltage electrical equipment according to present disclosure does not use sulfur hexafluoride (SF6) gas as an insulation medium, but uses other gases with poorer insulation properties, higher requirements are imposed on the breaking distance of the arc interrupter and the kinematic connection between components of the load switch, and further description is made below in combination with the accompanying drawings.

[0033] As shown in Figures 5-6, the parallel breaking load switch 100 includes a cam assembly, wherein the cam assembly is provided with a small contact 7 capable of rotating around a rotating axis A1, and the small contact 7 is provided with an electric conductor 6 capable of being electrically connected with the moving contact 2 so as to be electrically connected with the vacuum interrupter 4 in response to the rotation of the moving contact 2 around the pivot axis A2. Preferably, the cam assembly includes a cam frame 5, wherein the small contact 7 is pivotally connected to the cam frame 5 via, for example, a pivot point 52 of a pivot pin, the cam frame 5 is provided with a leading groove 51 for leading the moving end 42 of the movable switch contact to move linearly between an off position and an on position; the cam assembly also includes a cam 8 capable of being pivotally connected to the cam frame 5, the cam 8 is designed generally in a semilunar shape and also pivotally pivoted to the pivot point 52 by means of the pivot pin, the cam 8 is provided with an abutting pin 82 operatively connected with the small contact 7 and a guiding groove 81 sandwiching the moving end 42 of the movable switch contact; therefore, when the small contact 7 drives the cam 8 to pivot together around the rotating axis A1, the moving end 42 of the movable switch contact can move linearly between the off position and the on position via the leading groove 81 and the guiding groove 51; and the moving end 42 of the movable switch contact is aligned with the axis of the vacuum interrupter 4, and the stroke of linear movement is not less than 7 mm.

[0034] Those skilled in the art can know that the cam assembly described above realizes the breaking of the vacuum interrupter 4 in a manner of rotating the small contact 7 that can be used as a lever. The whole process is consisting of following transmissions, i.e. rotation pair realized by the moving contact 2, the lever realized by the small contact 7, the movement synthesis of the guiding groove 81 and the leading groove 51. A contact angle of the moving contact 2 and the breaking stroke of the vacuum interrupter 4 can be controlled not to be less than 7 mm, and can over-travel can also be set by lengths of the guiding groove 81 in the cam 8 and the leading groove 51 in the cam frame 5 and interaction thereof and the length of the arm of force of the small contact 7. As a preferred aspect, in order to ensure that the vacuum interrupter 4 is electrically switched on at an initial position, the cam assembly further includes a torsional spring 9 fixedly installed to the cam frame 5, wherein a supporting leg of the torsional spring 9 operatively abuts the cam 8 so as to pivot along with the cam 8 relative to the cam frame 5 to accumulate elastic potential energy, and subsequently to release the elastic potential energy to return the cam 8 to the initial position; and thus, when the cam 8 rotates clockwise or counterclockwise, the cam can be reset rapidly under the action of the torsional spring 9.

[0035] As a preferred aspect, as shown in Figure 7 and Figure 9, the small contact 7 is designed as an elongated piece, which includes a first end pivoted to the cam frame 5 and a second end opposite to the first end, wherein the second end is provided with an elastic sheet 71 elastically abutting the moving contact 2; the elastic sheet 71 is designed to expand outwards here and located at the top of the second end of the small contact 7; and when the moving contact 2 performs the breaking operation around the pivot axis A2, the elastic sheet 71 can be snapped into the inner sides of two contact pieces of the moving contact 2. The design ensures the continuity of the eletrical current. A copper sheet 73 electrically communicated with the electric conductor 6 is also arranged below the elastic sheet 71; the moving contact 2 may contact the copper sheet 73 when continuing the action; the current is transferred to the vacuum interrupter 4 through the copper sheet 73 and the electric conductor 6; and the above design can realize a simple bypass circuit. In order to prevent the moving contact 2 from switching on the bypass circuit when pivoting to the closed position in the opposite direction, the small contact 7 is preferably made of insulation material and the second end of the small contact is provided with an insulation material layer on the side opposite to the elastic sheet 71.

[0036] In order to fixedly install the cam assembly to the medium-voltage switchgear, as shown in Figures 5-6, the parallel breaking load switch 100 also includes an insulation bracket 10 constructed as an integral piece and includes a horizontal portion 10B for fixedly installing the cam frame 5 and the vacuum interrupter 4 and a vertical portion 10A for fixedly installing the stationary contact 1; and the insulation bracket 10 is injection molded by high-strength PC material, and three phases are installed in a same plane. After the vacuum interrupter 4 and the stationary contact 1 are installed, the cam assembly and the stationary contact 1 can be installed on the same insulation bracket 10, so that the transmission precision can be ensured, and the assembling errors can be reduced effectively. Further, the horizontal portion 10B of the insulation bracket 10 can also be fixedly provided with a lead holder 53, wherein as best shown in Figure 6, the lead holder 53 is provided with a horizontal installation section installed to the plane below the horizontal portion 10B and an arc section for leading the electric conductor 6, thereby presenting a mirrored "5" shape in a cross section. As best shown in Figure 10, a groove for embedding the electric conductor 6 is arranged in the arc section, at the installed state, and the electric conductor moves in an arc path defined by the groove in the arc section, which effectively prevents the electric conductor 6 from being broken due to repeated bending, affecting the reliability and service life of the whole parallel breaking load switch 100.

[0037] According to present disclosure, the parallel breaking load switch 100 can execute different types of operations, and each of the operations corresponds to given change in the operation state. Specifically, as shown in Figure 8, the moving contact 2 is located on the closed position, the vacuum interrupter 4 then is located on a default closed position, that is, the fixed switch contact and the movable switch contact are closed. When the moving contact 2 is located at the closed position, the moving contact 2 is kept in close contact with the second end 12 of the stationary contact 1 by means of the abutting portion 22, the current can flow from the first end of the stationary contact 1 to the stationary contact and further flows through the moving contact 2 to reach the wiring terminal 25, and the parallel breaking load switch 100 can be considered to be in closed configuration.

[0038] Then, as the actuator 21 is activated, the moving contact 2 begins to rotate around the pivot axis A2 and contacts the second end of the stationary contact 1 and the cam assembly (specifically the small contact 7 in the cam assembly) connected with the vacuum interrupter 4 at a certain rotation point, thus forming a commutation point, wherein since the fixed switch contact and the movable switch contact of the vacuum interrupter 4 are closed, a bypass current circuit from the first end 11 of the stationary contact 1 to the moving contact 2 directly through the vacuum interrupter 4 and the electric conductor 6 is thus formed. At the time, the parallel breaking load switch 100 is considered to be in the commutation configuration.

[0039] Subsequently, the moving contact 2 continues to rotate around the pivot axis A2 under the action of the actuator 21 and thus is separated from the second end 12 of the stationary contact 1 but kept in electric contact with the small contact 7; and moreover, the fixed switch contact and the movable switch contact of the vacuum interrupter 4 still contact each other, so that the current flows to the vacuum interrupter 4 only from the first end 11 of the stationary contact 1 and then flows to the moving contact 2 through the vacuum interrupter 4. Then the moving contact 2 keeps rotating, and during the rotation of the moving contact, the small contact 7 continues to rotate correspondingly, the cam 8 is then driven by the abutting pin 82 to rotate together relative to the cam frame 5 with the pivot point 52 as the rotating axis A1, and consequently, with the rotation of the cam assembly, the moving end 42 of the movable switch contact accommodated in the leading groove 51 and the guiding groove 81 of the cam assembly moves linearly along the axis of the vacuum interrupter 4 from the on position to the off position so as to separate the movable switch contact from the fixed switch contact of the vacuum interrupter 4, and the stroke of the linear movement is not less than 7 mm. The result is that the contact of the vacuum interrupter 4 is already broken to cut off the current. Finally, the moving contact 2 continues to rotate and passes through the small contact 7, the small contact 7 is then reset under the action of the torsional spring 9 and drives the vacuum interrupter 4 to be returned to the default closed configuration; however, the moving contact 2 is already separated from the small contact 7 and the first end 12 of the stationary contact 1; therefore, the parallel breaking load switch 100 is already in the breaking configuration; and as the moving contact rotates to contact the grounding contact 3 and is stopped by the grounding contact, the parallel breaking load switch 100 is then in the grounding configuration.

[0040] Those skilled in the art can understand that by actuating the moving contact 2 to rotate around the pivot axis A2 in an opposite direction through the actuator 21, the parallel breaking load switch 100 can be changed from grounding configuration to closed configuration; moreover, a current path is formed between the second end 11 of the stationary contact 1 and the moving contact 2; and moreover, the vacuum interrupter 4 is configured in a state that the contact is closed, and there is no current flowing through the vacuum interrupter. Thereafter, the parallel breaking load switch 100 is prepared for another breaking operation. Since the opposite side of the small contact 7 is designed to be insulated, the moving contact 2 is prevented from switching on the bypass circuit when pivoting to the closed position in an opposite direction.

[0041] It should be understood that although this description is described according to various embodiments, each embodiment does not include only one independent technical solution. The description of the description is only for the sake of clarity. Those skilled in the art should take the description as a whole, and the technical solutions in each embodiment can be combined appropriately to form other embodiments that can be understood by those skilled in the art.

[0042] The above is only illustrative implementations of present disclosure, and is not intended to limit the scope of present disclosure. Any equivalent changes, modifications and combinations made by any person skilled in the art without departing from the concept and principles of present disclosure shall belong to the scope of protection of present disclosure.

Claims

1. A parallel breaking load switch suitable for breaking a power line of a medium-voltage electrical system, comprising:

   - a stationary contact, comprising a first end connected to the power line and a second end opposite to the first end;
   - a moving contact, wherein the moving contact is configured to be capable of rotating around a pivot axis among a closed position, a commutation position and a breaking position, the moving contact is connected to the second end of the stationary contact at the closed position and electrically communicated with the stationary contact, and the moving contact is disconnected from the stationary contact when rotating around the pivot axis to the breaking position;
   - a vacuum interrupter with a fixed switch contact and a movable switch contact arranged therein, wherein the stationary contact is electrically connected with the fixed switch contact; **characterizing in that** further comprising:
   - a cam assembly, wherein the cam assembly is provided with a small contact capable of rotating around the rotating axis, the small contact is provided with an electric conductor that is capable of being electrically connected with the moving contact so as to be electrically connected with the vacuum interrupter in response to the rotation of the moving contact round the pivot axis;

   wherein a moving end of the movable switch contact is aligned along the axis of the vacuum interrupter and is capable of making linear movement between an off position and an on position, the moving end of the movable switch contact is capable of being guided and operatively connected to the cam assembly, and a travel of the linear movement is not less than 7 mm;

   at the closed position, the moving contact is in contact with the stationary contact and is spaced apart from the small contact, the movable switch contact is at the on position in contact with the fixed switch contact, and electrical current is capable of flowing through the stationary contact to the moving contact;

   wherein the moving contact rotates around the pivot axis in a first rotating direction from the closed position to the commutation position, and during the rotation, the moving contact is in contact the small contact, so that the electrical current is capable of flowing through the stationary contact and the vacuum interrupter to the moving contact via the small contact; and

   wherein the moving contact further rotates around the pivot axis in the first rotating direction from the commutation position to the breaking position; wherein the moving contact drives the small contact to rotate around the rotating axis and actuates the cam assembly, so that the moving end of the movable switch contact moves linearly from the on position to the off position along the axis of the vacuum interrupter to separate the movable switch contact from the fixed switch contact of the vacuum interrupter.

2. The parallel breaking load switch according to claim 1, wherein the cam assembly comprises:

   - a cam frame, wherein the small contact is pivotally connected to the cam frame, and the cam frame is provided with a leading groove for leading the moving end of the movable switch contact to move linearly between the off position and the on position;
   - a cam pivotally connected to the cam frame, wherein the cam is provided with an abutting pin operatively connected with the small contact and a guiding groove for sandwiching the moving end of the movable switch contact;

wherein the small contact is capable of driving the cam to pivot together around the rotating axis, so that the moving end of the movable switch contact moves linearly between the off position and the on position via the leading groove and the guiding groove.

3. The parallel breaking load switch according to claim 2, wherein the small contact is designed as an elongated piece comprising a first end pivoted to the cam frame and a second end being opposite to the first end, wherein the second end is provided with an elastic sheet capable of elastically abutting the moving contact.

4. The parallel breaking load switch according to claim 2, further comprising an insulation bracket constructed as an integral piece and comprising a horizontal portion for fixedly installing the cam frame and the vacuum interrupter and a vertical portion for fixedly installing the stationary contact.

5. The parallel breaking load switch according to claim 2, wherein the cam assembly further comprises a torsional spring fixedly installed to the cam frame, wherein a supporting leg of the torsional spring operatively abuts the cam to pivot along with the cam relative to the cam frame to accumulate elastic potential energy, and to subsequently release the elastic potential energy so as to return the cam to an initial position.

6. The parallel breaking load switch according to claim 1, wherein the moving contact comprises a pair of spaced contact pieces, wherein one end of the contact piece is provided with a spherical portion protruded outwards and operatively connected to an actuator so as to be actuated to rotate around the pivot axis among the closed position, the commutation position and the breaking position, and the other end of the contact piece is provided with an abutting portion that is protruded outwards and forms surface contact with the second end of the stationary contact.

7. The parallel breaking load switch according to claim 6, further comprising a voltage equalizing ring arranged adjacent to the spherical portion of the contact piece and used for equalizing an electric field of the current flowing through the moving contact, and a semicircular shielding cover arranged adjacent to the abutting portion of the contact piece in a spaced manner and used for preventing partial discharge.

8. The parallel breaking load switch according to claim 3, wherein the small contact is made of an insulation material, and the second end is provided with an insulation material layer at one side opposite to the contact piece.

9. The parallel breaking load switch according to claim 1, further comprising a grounding contact located at one side of the moving contact and capable of being electrically coupled to a grounding conductor, wherein the grounding contact is designed generally in a U shape and comprises a first end coupled to the grounding conductor, a second end opposite to the first end and a hollow portion located between the first end and the second end, wherein the second end is provided with a pair of contact feet matched with the moving contact.

10. The parallel breaking load switch according to claim 1, further comprising a lead holder connected below the horizontal portion of the insulation bracket, wherein the lead holder is provided with an arc section for leading an electric conductor, and a groove for embedding the electric conductor is arranged in the arc section.

11. A medium-voltage switchgear, comprising a shell filled with insulation gas and the parallel breaking load switch arranged in the shell, wherein the parallel breaking load switch is the parallel breaking load switch according to one of claims 1-10.

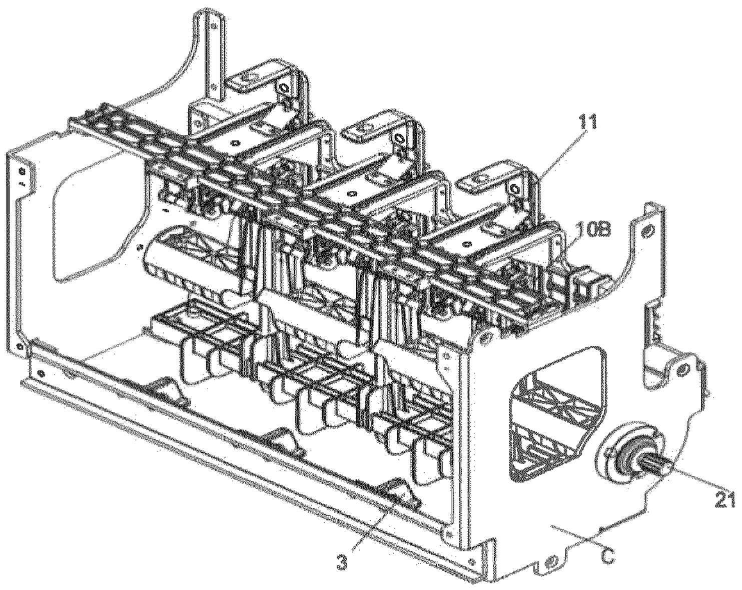

Fig. 1

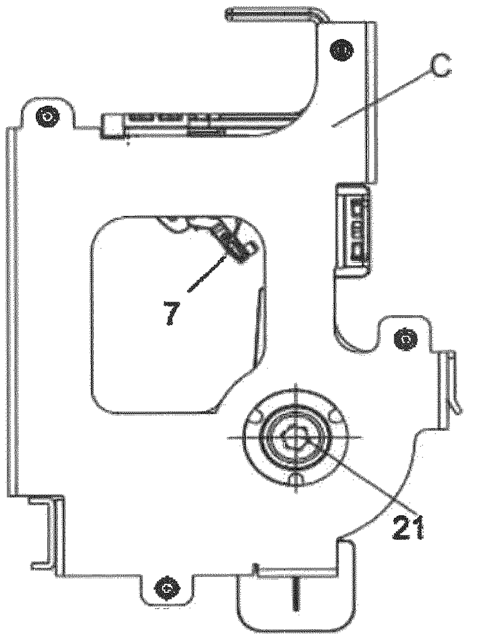

Fig. 2

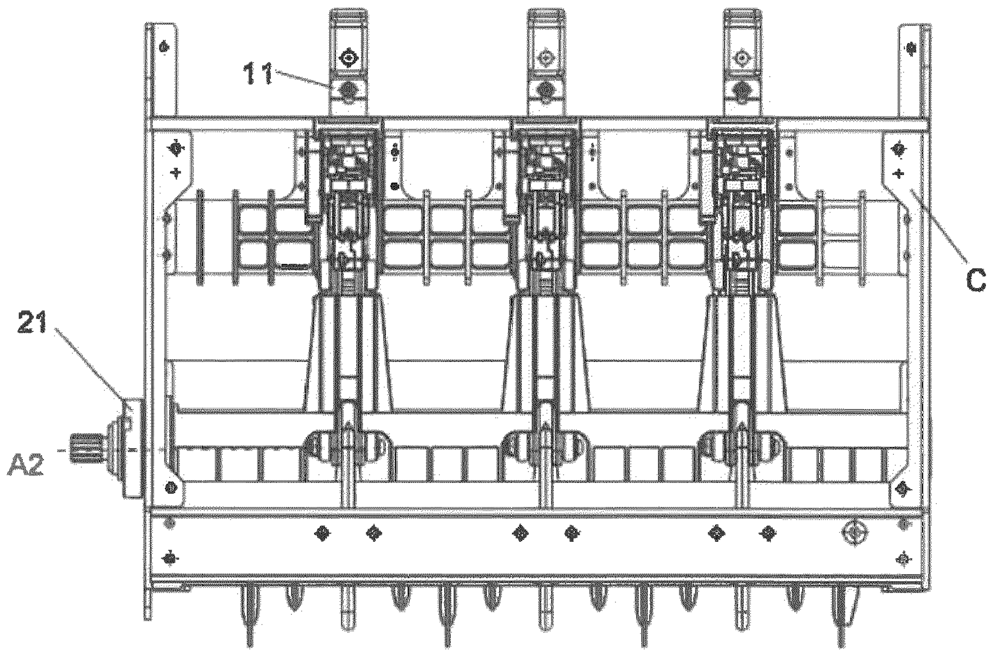

Fig. 3

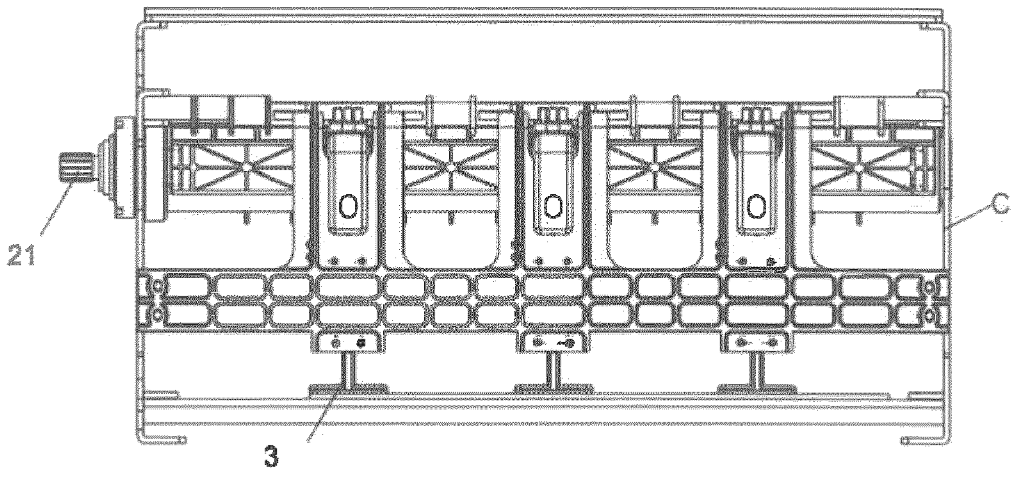

Fig. 4

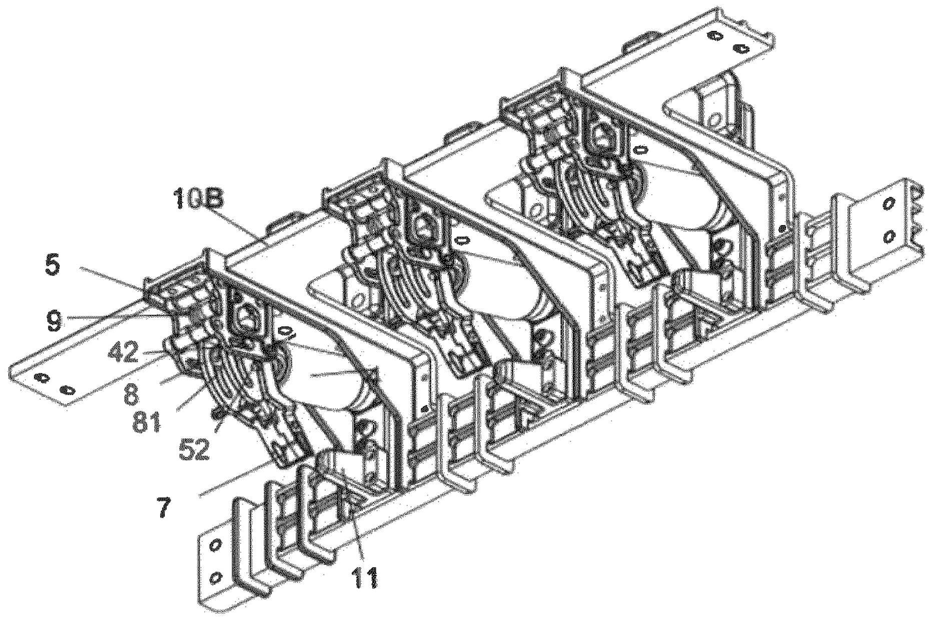
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Fig. 5

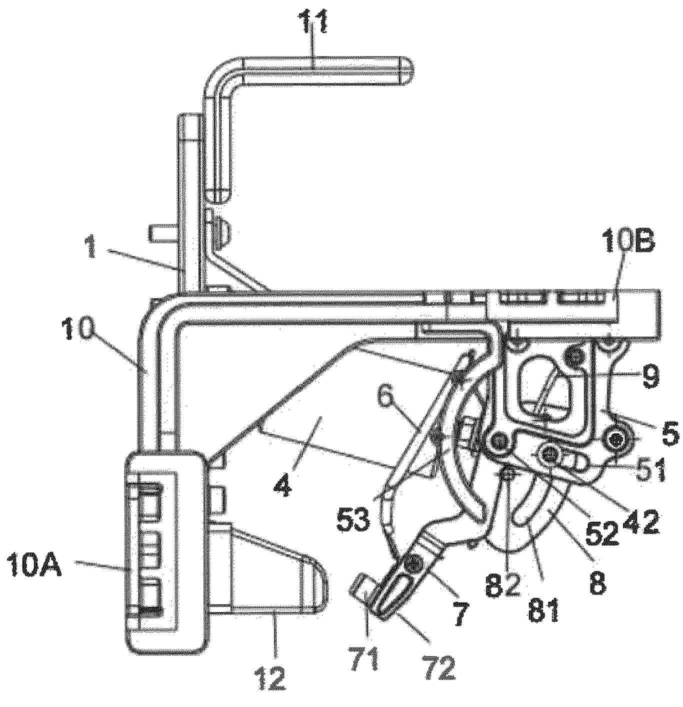
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Fig. 6

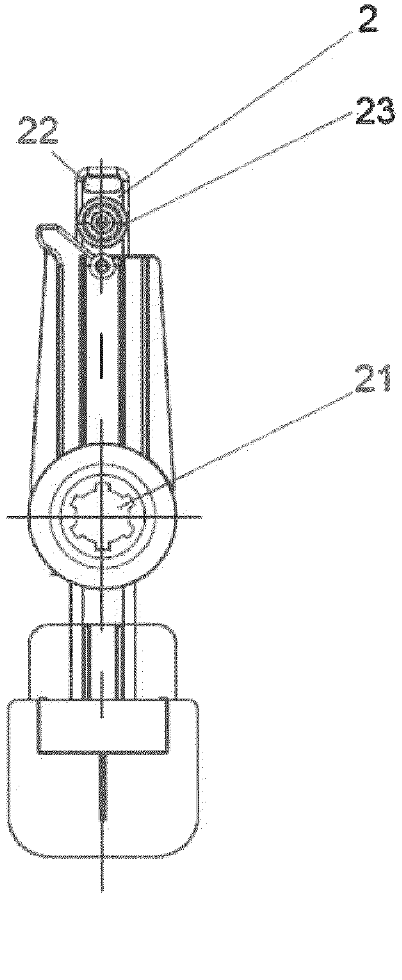

Fig. 7

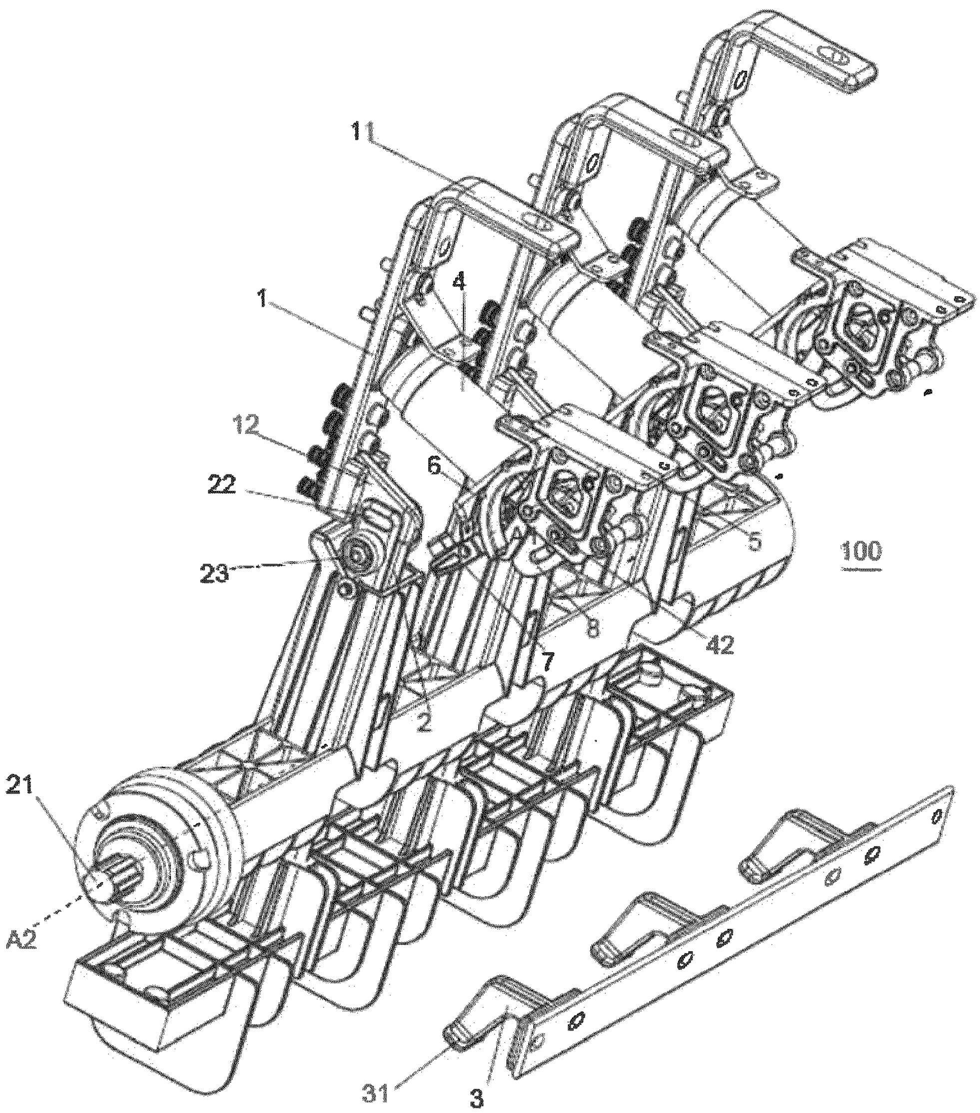

Fig. 8

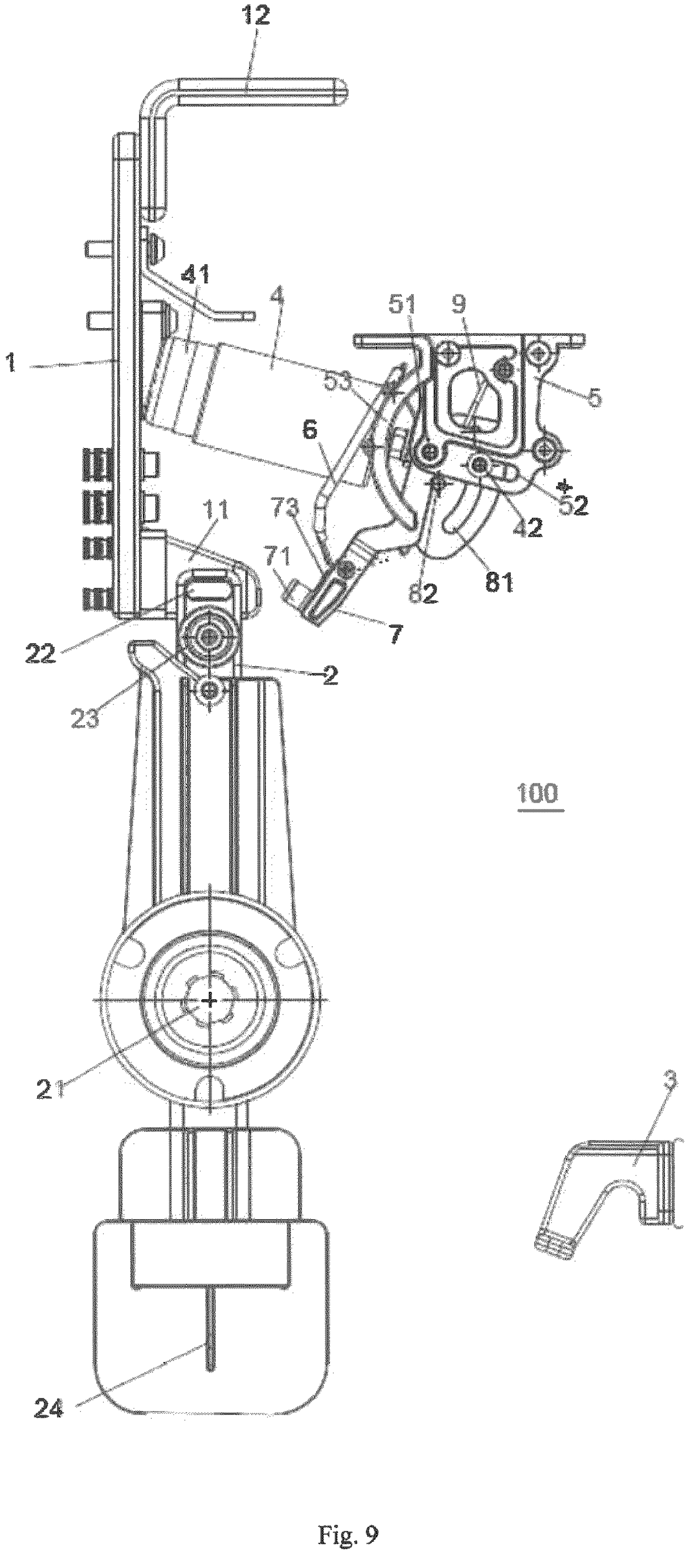

Fig. 9

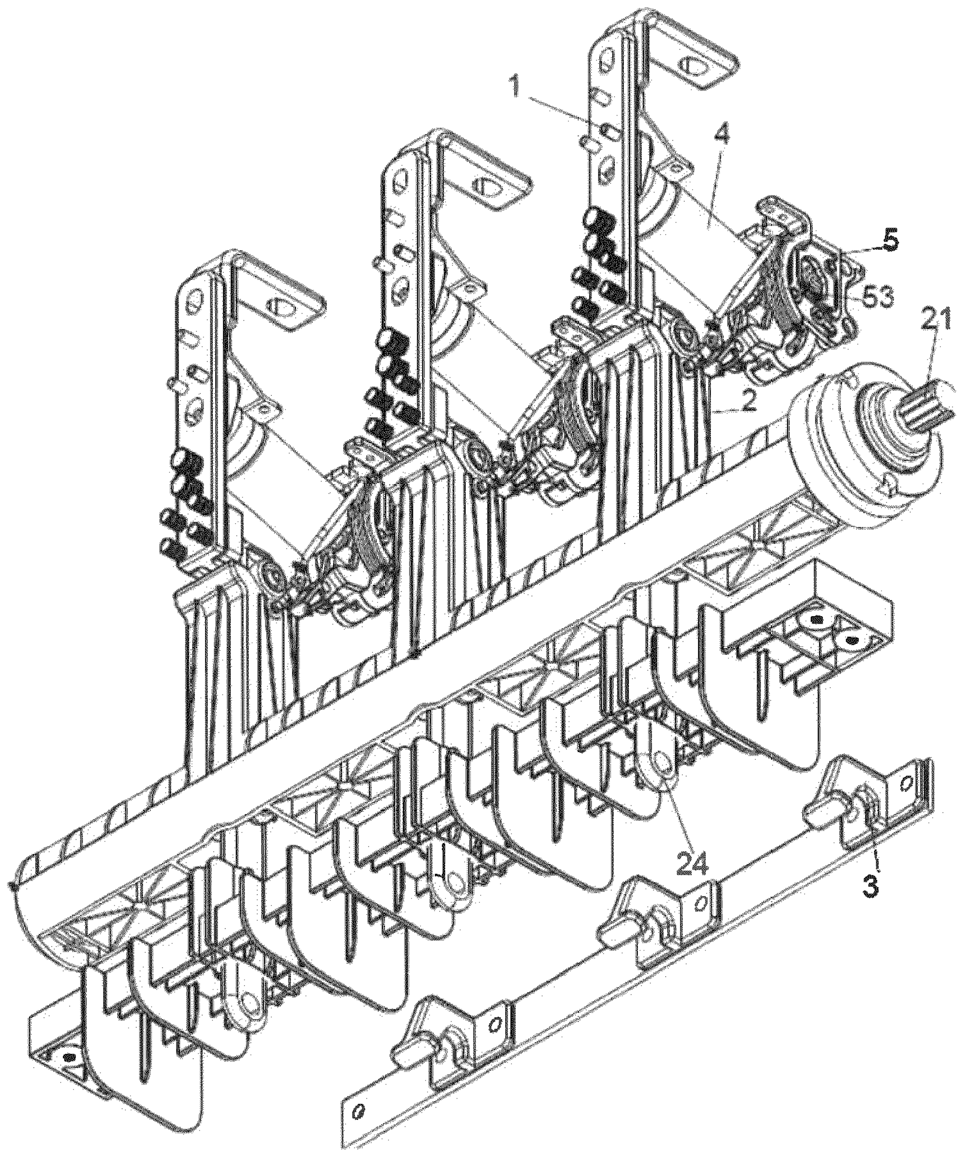

Fig. 10

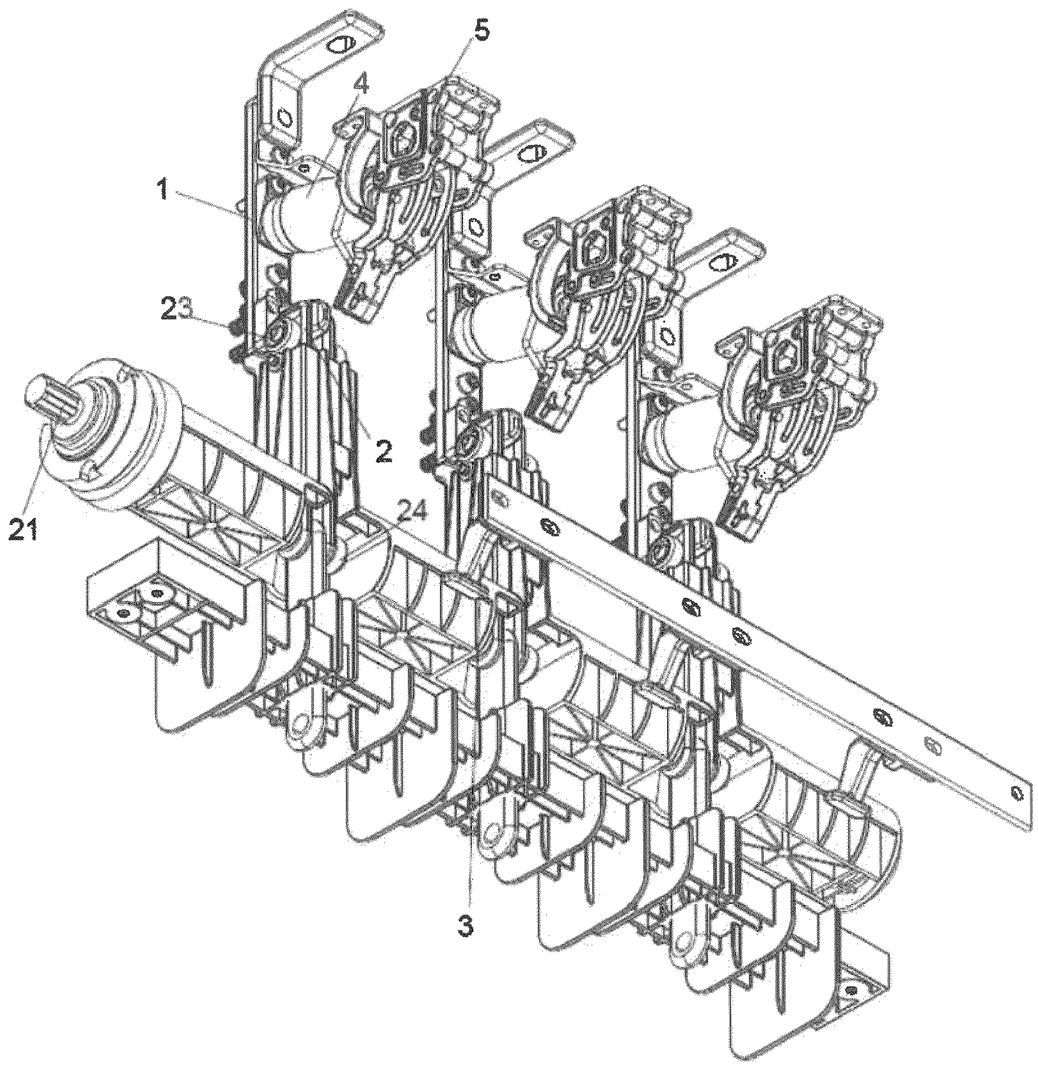

Fig. 11

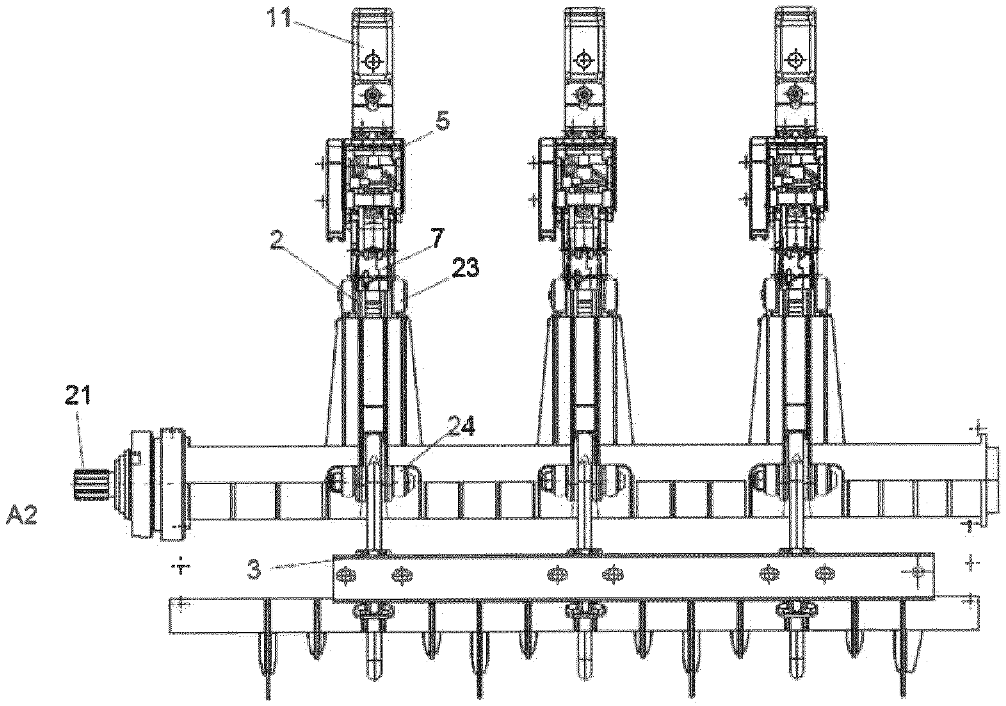

Fig. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 3100

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			H01H H02G H02B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	9 October 2024	Simonini, Stefano

CATEGORY OF CITED DOCUMENTS

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