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(54) **Reconfigurable electric switch**

Rekonfigurierbarer elektrischer Schalter

Commutateur électrique reconfigurable

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Description

Object of the Invention

[0001] The present invention belongs to the field of electric switches and/or circuit breakers, particularly suitable for extinguishing the electric arc occurring when opening and closing the contacts thereof.

[0002] More specifically, an object of the present invention is to provide a current breaker switch, which allows quickly and effectively extinguishing electric arcs occurring in an electric circuit during the cutting off and closing operations thereof, all in a smaller volume.

[0003] Another object of the invention is to provide a reconfigurable current switch, such that the internal contacts of the switch are connected in series during the transitory process to cut off current or to connect current in order to cut off the current at several points and to facilitate extinguishing the arc, and those same contacts are connected in parallel during the permanent current conducting state of the switch in order to divide the current into several branches and to thus reduce the temperature of the conductive material.

[0004] The switch of the invention is particularly applicable to cutting off high power direct current, where it is more difficult to extinguish the electric arc than in alternating current.

Background of the Invention

[0005] Today it is known that electric arcs occurring in electric circuits can cause many problems because the heat energy produced during an electric arc is highly destructive. Some of these problems are: deterioration of the material of the switch, malfunctions and/or total or partial destruction of electric installations, including damage to people due to burns or another type of injuries.

[0006] The problems with extinguishing the electric arc is particularly noticeable in direct current cut-off where, unlike alternating current, there is no zero-crossing, so an arc occurred which must be eliminated as quickly as possible by means of deionizing the medium and increasing dielectric strength.

[0007] Several techniques are known today for extinguishing the electric arc occurring when opening and closing the contacts of a current switch or circuit breaker. The common objective of all these techniques is to achieve that the energy dissipated in heat of the electric arc is the smallest amount possible, with the objective of this being nil. To that end, the critical variable on which to act is time control, trying to get the speed in putting out the electric arc to be the quickest possible.

[0008] To achieve said objective, various techniques are known, among which the following must be pointed out:

a) increase in the separation distance between the fixed and moving contacts of the electrical switch,

which entails a larger volume of air between them, and therefore, a larger switch size.

- Speed increase in trip devices
- Radial cut-off
- Serially connecting simultaneous contacts

b) increase in the length or "lengthening" of the electric arc for one and the same time instant

- Arcing chambers
- Magnetic and pneumatic blow-out

c) cooling the electric arc using auxiliary means to reduce harmful heat effects, such as for example using sulfur hexafluoride SF₆ under pressure.

d) acting on the dielectric strength of the medium to prevent re-igniting the arc by the influence of the electric field due to potential differences.

[0009] However, even though there are electric breaker switches today that combine some of the techniques discussed above: arcing chamber with magnetic or pneumatic blow-out, radial instead of linear separation of contacts, etc., said switches today still have not satisfactorily solved their primary task of extinguishing the electric arc because the extinguishing time is still too high and the material still deteriorates, especially in very demanding applications such as high-power direct current cut-off.

[0010] Furthermore, the techniques known for extinguishing the arc generally entail an increase in the volume of switches due to the necessary volume of air between the contacts.

[0011] The operation of switch cut-off mechanisms usually entails some type of impact between parts which, in the long-term, cause the material to deteriorate by wear which can lead to destruction of the switch.

[0012] Patent US-3120585A refers to a rotary switch with replaceable contact sets, and having a insulator rotor shaft 18 carrying a first and second series of moving contact members arranged in linear spaced array, such as when the rotor is turned, the moving contacts engage the respective stationary contacts. The rotor does not move linearly along an axis.

[0013] Patent US-4841833A refers to a switch for An electromagnetic projectile launcher, wherein a firing switch which alternately opens and closes to repeatedly commutate current from a high current supply to a pair of projectile launching rails. A rotor having a transverse conducting element is rotated within and moved axially along a cylindrical stator.

[0014] Patent application EP-1267373A1 refers to a power control apparatus.

[0015] Patent application EP-0741399A1 refers to a gas-dielectric high-tension interrupter of the arc-puffer type

Description of the Invention

[0016] The present invention solves the drawbacks discussed above, providing a current breaker switch that simultaneously and synergistically integrates several arc extinguishing techniques, quickly and effectively breaking the electric arc in a smaller space and in one and the same time instant.

[0017] Therefore, a first aspect of the invention relates to an electric current breaker switch, comprising at least one pair of fixed contacts and one moving contact movable between a closed position of the switch in which it establishes electrical continuity with the fixed contacts, and an open position in which it cuts off current circulation.

[0018] The linear switch further comprises a rotor made of an insulating material that is movable defining a movement at least with a linear component with respect to an axis, such that at least one pair of moving contacts are assembled in the rotor and configured such that they have two ends accessible through two different points on the outer surface of the rotor. On the other hand, connection means external to the rotor are arranged and configured for connecting the moving contacts in series or in parallel, specifically in series in the transition process of the switch, and in parallel in the permanent conducting state.

[0019] Those connection means can consist of a first and a second pair of soleplates (or brush) placed adjacent to one another and arranged for being contacted by a first end of the moving contacts.

[0020] The moving contacts and the soleplates are relatively placed with respect to one another and/or configured such that as the rotor moves, in a first axial position of the rotor, precisely in the state transition of the switch from cut-off to conduction or vice versa, the moving contacts are connected to one another in series through the soleplates in order to cut off the current at several points or close the switch at several points, to thus reduce the intensity of the arc and facilitate extinguishing it.

[0021] Furthermore, in a second axial position of the rotor the moving contacts of the rotor are connected to one another in parallel through the soleplates in order to divide the current circulation into several branches and to thus reduce the temperature generated in the conductive material.

[0022] The current switch object of the invention is therefore reconfigurable because the internal contacts of the switch are connected in series during the transitory current cut-off process, and those same contacts are connected in parallel during the permanent current conducting state of the switch.

[0023] The movement of the rotor to produce the series-parallel-series connection of the moving contacts is a combination of a rotational movement and a linear movement with respect to the axis of the rotor. To that end, in a preferred embodiment, the rotor is movable in a helicoidal manner, which includes a component having

a rotational movement and simultaneously a component having a linear movement. In another preferred embodiment, the rotor is movable in a sequence of two movements, a first rotational movement alone and second linear movement alone, both with respect to the same axis.

[0024] The moving contacts rotate integrally with the rotor, so they are movable following a helicoidal movement about an axis passing through the center of the moving contacts, or alternatively with the sequential movement mentioned above. The helicoidal movement of the moving contact with respect to the fixed contacts is a combination of radial movement together with longitudinal movement of the moving contact, which has the effect of achieving a longer separation length between contacts (lengthening the electric arc) for extinguishing the arc quickly and in a smaller space.

[0025] The invention thereby successfully lengthens the electric arc in helicoidal form without requiring a larger volume of air, which means that for one and the same rated cut-off current, the switch can be smaller compared to a switch of the state of the art.

[0026] As a result of the helicoidal movement, the tangential speed of the cut-off point increases depending on the turning radius, thus increasing the cut-off speed in a simple manner, without the need for complex mechanisms and with a smaller number of parts, so manufacturing the switch is very simple.

[0027] The reconfigurable switch of the invention allows connecting the moving contacts thereof in series to promote current cut-off upon connection, and connecting them in parallel in a stable situation of the switch once the current cut-off function ends.

[0028] If the moving contacts remain connected in series when there is electric current circulating through the switch, the moving contacts would generate more heat than if they are in parallel, whereby the switch would heat up considerably and have energy losses. However, when connecting the moving contacts in parallel, the switch heats up less so there are fewer energy losses, and it further allows the same switch to work with more thermal allowance. For example, it is necessary today to oversize copper contacts in the heating portion so that they heat up less in order to meet UL standards for the North American market.

[0029] However, with the reconfigurable switch of this invention, it has been proven that heating is reduced by 50% with the same contacts currently used when they are connected in parallel. Therefore, the switch of the present invention with a simple structure is capable of connecting the same internal contacts one way to perform more critical work, i.e., cutting off or opening an electric current with the occurrence of an electric arc, and of connecting them in another more optimal way for when the current cut-off function has ended.

[0030] To overcome those drawbacks, the solution adopted today by manufacturers is to build larger switches.

[0031] However, with the switch of the invention the

linear forward movement of the moving contacts, with or without simultaneous rotation, is used to perform the series-parallel transition in a very simple and economical manner.

Description of the Drawings

[0032] To complement the description being made and for the purpose of aiding to better understand the features of the invention according to a preferred practical embodiment thereof, a set of drawings is attached as an integral part of said description in which the following has been depicted with an illustrative and nonlimiting character:

Figure 1 shows an exploded view of an embodiment of a helicoidal movement breaker switch according to the invention, in which in addition to the switch function, a series-parallel connection of the moving contacts is implemented.

Figure 2 shows perspective views of the embodiment of Figure 1, where Figure 2a is a view of a rotor according to the invention provided with ventilation fins, Figure 2b is a view of said rotor in the electrical cut-off position; and Figure 2c is a view of said rotor in the electrically closed or electrical continuity position of the switch.

Figure 3 shows a movement sequence of the moving contacts of the embodiment of Figures 1 and 2 for changing the connection of the moving contacts and fixed contacts from a series connection to a parallel connection with helicoidal movement of the rotor. Figures 3d and 3h are perspective views, and the remaining drawings show side elevational views. The rotor and stator are not depicted in the figure to better view the movement of the moving contacts. The movement sequence is as follows:

Figure 3a: switch Off, moving contact position 0°.

Figure 3b: switch Off, moving contact position 20°.

Figures 3c and 3d: switch On, moving contact position 30°.

Figure 3e: switch On, moving contact position 45°.

Figure 3f: switch On, moving contact position 60°, the transition in the connection occurs, the contacts go from being connected in series to being connected in parallel.

Figures 3g and 3h: switch On, moving contact position 90°.

The sequence of drawings shows the movement of the contacts for going from the cut-off (Off) position of the switch to the electrically closed (On) position, where the moving contacts move from left to right in

the figure. The reverse transition, i.e., going from On to Off, is identical but follows the reverse order of the drawings, i.e., from (g) to (a), the moving contacts moving in such case from right to left in the figure. The arrows indicate the path of the electric current in the On position.

Figure 4 shows a schematic depiction of an alternative embodiment in which the helicoidal rotation of the rotor is performed by means of an external body outside the casing, in which the rotor is threaded. The view consists of a side elevational section view. Figure 5 is a depiction similar to that of Figure 3 but of a preferred embodiment in which the rotor, instead of moving in helicoidal movement, moves with two types of related movements, first with a rotational movement in one and the same plane with respect to an axis, and then with a linear movement on that same axis. In Figure 5, Figures 5a, 5d, and 5g are side elevational views, Figures 5b, 5e and 5h are front elevational views, and Figures 5c, 5f and 5i are perspective views. The movement sequence is as follows:

Figures 5a, 5b and 5c: switch Off, moving contact position 0° (horizontal).

Figures 5d, 5e and 5f: switch On, moving contact position 90° (vertical), moving contacts have rotated 90° in one and the same plane with respect to the preceding position, contacts connected in series, Figures 5g, 5h and 5i: switch On, moving contact position 90°, but axially moved to the right with respect to the preceding position, and the contacts being connected in parallel.

Preferred Embodiment of the Invention

[0033] Figure 1 shows an embodiment of an electric switch (1) according to the invention comprising a stator (11) including a casing (7,7') made of an insulating material intended for being assembled in a fixed position of an electric installation, for example in a switchboard box, and can be formed by two halves (7,7') coupled to one another. The stator (11) internally forms a generally cylindrically-shaped chamber (3) in which a rotor (2) made of an insulating material is housed, and such that the rotor (2) is suitable for moving axially inside said chamber and with respect to its axis of revolution (X). In the embodiment of Figure 1, the rotor moves axially while at the same time it rotates with respect to axis (X), whereby it performs a helicoidal movement with respect to said axis (X).

[0034] A pair of fixed contacts (4,4') are assembled in said casing (7,7') and have respective contact surfaces (6,6') arranged for being contacted by a moving contact (9), for which they are curved in correspondence with the curvature of the outer surface of the rotor (2). The rotor (2) in turn incorporates at least one moving contact (9) which rotates integrally with the rotor and therefore also

defines a helicoidal movement about the axis "X".

[0035] The fixed contacts (4,4') and the moving contact (9) are arranged for coming into contact in the closed position of the switch (1) (Figure 2c), whereas in the electrical cut-off position of the switch (Figures 1 and 2b), they do not allow current circulation. The fixed contacts (4,4') are arranged in a diametrically opposed manner with respect to the axis of revolution (X) of the rotor (2).

[0036] To cause the helicoidal movement of the rotor (2) with respect to its axis of revolution (X) inside the chamber (3), the stator and the rotor are configured forming a complementary threaded coupling therebetween. Specifically, in the embodiment of Figure 1, that threaded coupling consists of one or more channels (44) with a helicoidal trajectory existing on the inner surface of the stator (11), and a pair of metal balls (39,39') coupled in diametrically opposed points of the rotor (2) and sliding through said channels. Particularly, the balls are arranged in a cylindrical sector (43) formed in said rotor (2), such that the rotor forms a type of bearing.

[0037] The rotor (2) is operated by conventional external means, for example a connecting rod (17) coupled with a lug (18) projecting from the rotor, which is in turn operated by any suitable mechanism. Said operating means cause the movement of the rotor in one direction or the other, i.e., reciprocally, along the axis (X) between a closed position and an electrical cut-off position of the switch.

[0038] The person skilled in the art will understand that other configurations are possible for obtaining said threaded or screw configuration between rotor and stator for the purpose of causing the helicoidal movement of the rotor. For example, alternatively, the helicoidal rotation of the rotor (2) is performed by means of external threading means outside the casing, specifically by means of an external body (29) outside the casing as shown in Figure 5, such that an elongation (2') of the rotor (2) is housed inside that body (29) and rotates about it by means of a threaded coupling (30) formed in a complementary manner in both elements (29, 2'). In this embodiment of Figure 5, the friction between the rotor (2) and the casing (7) is minimum since the rotor rests primarily on the body (29), so contact would only exist between the moving contacts and the casing or fixed contacts (not depicted in that drawing). The prolongation (2') of the rotor (2) consists of a body axially coupled at an end of the rotor (2) outside the chamber (3) of the casing (7,7'). The rotor (2) is operated by external means acting on one of its free ends (37). The external body (29) is fixed, for example, it can be fixed to the casing (7) itself or to another fixed element of the switch.

[0039] To enhance the arc extinguishing effect, in addition to increasing the length of the arc at each cut-off point, the switch of the invention can incorporate the electric arc breaking by means of the serial connection of contacts. To that end, as shown in Figure 1, the switch includes two or more moving contacts (9) assembled in the rotor in the same position (same angular position with

respect to the axis) but at a different axial position. One or more soleplates (19,19', 42,42') made of a conductive material are assembled in the stator (11) outside the rotor, and are arranged such that in the electrically closed position of the switch, they connect the moving contacts (9) between the fixed contacts (4,4') in series as is shown more clearly in Figure 3b, in which the arrows indicate the electric current circulation direction. The arc is thus split at several cut-off points, so it is easier to extinguish.

[0040] A pair of metal connection terminals (22,22') in the form of a plate serve to electrically connect the switch with an external circuit, and are arranged in opposite portions of the casing (7,7') and electrically connected with the fixed contacts (4,4') with which they are in contact.

[0041] On the other hand, the rotor (2) has a closed front end (37) and an open rear end (38) providing access to the inner hollow portion of the rotor, such that a suction valve (24) can be coupled to that open end. The valve (24) is assembled in a fixed position in the rear portion of the casing (7,7'), and has projections (26) to prevent rotation. The valve (24) is configured for being inserted into the rotor when the rotor moves towards said valve in its end position, in the movement to cut off power. As the rotor moves back, it is uncoupled from the valve (24) and causes suction inside the rotor, suctioning the electric arc. To allow that suction, the rotor has through holes arranged on the edges of the moving contacts.

[0042] In the electrically closed position of the switch, the closure valve (24) does not seal the rotor, as seen in Figure 2b, so it allows air to circulate towards the inside thereof. The suction valve (24) is cylindrical-shaped and made of a rigid or flexible elastic insulating material.

[0043] The rotor (2) has at least one through conduit (40) communicating the inside of the rotor with the outside, which performs the function of a chimney in the closed position of the switch through natural ventilation, such that the hot air circulates towards the soleplates and is released through the gaps and clearances between the output terminals. In the cut-off process, the same through conduit (40) is used to release the gases drawn in by the valve (24) through the holes of the moving contacts, providing direct output aligned with the windows of the stator (14 and 14').

[0044] In the situation of Figure 1, the switch is in the electrically open position, so the three moving contacts (9,9',9'') are not connected with the soleplates (19,19', 42,42') and current circulation is prevented. To close the switch, the rotor (2) is rotated clockwise as seen in Figure 2b, for example, whereby the rotor moves axially defining a helicoidal trajectory, such that the moving contacts (9,9',9'') move in a helicoidal movement in the same direction, until they contact the soleplates (19,19', 42,42'), at which time the three moving contacts are connected to one another in series through the soleplates, forming a circuit connecting the fixed contacts (4,4'), so the switch is closed to allow current circulation, as described below with greater detail in relation to the drawing.

[0045] In the reverse process, to go from the closed or

electrical continuity position to the open position, the rotor would be rotated with helicoidal movement counter-clockwise from the position of Figure 3g until the rotor reaches the position of Figure 3a again

[0046] Ventilation windows (14,14') existing in the stator allow viewing the position of the moving contacts (9,9',9'') inside the rotor such that the state of the switch can be visually inspected, which can be useful, for example, for an operator performing maintenance tasks.

[0047] The configuration and arrangement of the fixed and moving contacts of this embodiment is best seen in Figure 2. The rotor (2) is partially hollow and has three groups of moving contacts (9,9',9''), each group formed by two or more metal plates (5,5') that are superimposed and in electrical contact, which are generally rectangular-shaped and housed inside the rotor, such that they rotate integrally with the helicoidal movement of the rotor. The ends of the plates (5,5') slightly project through holes (8) of the rotor (2) located at diametrically opposed points thereof. The ends of the plates (5,5') are curved (in the form of an arc of circumference) in correspondence with the curvature of the curved surfaces (34,34'), being flush with same. The position of the three groups of moving contacts (9,9',9'') in the rotor is the same as seen in Figure 5b, but at a different axial level with respect to the axis (X).

[0048] On the other hand, in this embodiment, the switch incorporates as fixed contacts an upper pair of soleplates (19,42) assembled in an upper fixed position of the stator (11) (in the normal use position of the switch), and a lower pair of soleplates (19',42') assembled in a lower fixed position of the stator (11). Both the upper pair of soleplates (19,42) and the lower pair of soleplates (19',42') are aligned according to the longitudinal span of the rotor (2) and are adjacent to in pairs. Alternatively, more than two groups of adjacent soleplates and three or more moving contacts can be arranged on each side of the rotor depending on the current cut-off needs.

[0049] To assure electric insulation between those adjacent soleplates, there is an insulating plate located between the two conductor plates of each pair, specifically a first insulating plate (41) placed between the two upper conductor plates (12,42), and a second insulating plate (41') between the two lower conductor plates (12',42').

[0050] The soleplates (19,42,19',42') are permanently pressed against the groups of moving contacts (9,9',9'') or the rotor (2) by elastic means, in this case by means of a pair of upper springs (23) and a pair of lower springs (23').

[0051] The switch incorporates a pair of fixed contacts, specifically an upper fixed contact (4) in electrical contact with only the soleplate (42) and a lower fixed contact (4') in electrical contact with only the soleplate (19') as seen more clearly in Figure 3a. The soleplates (19,42') are not connected to another element of the switch and serve for connecting the moving contacts (9,9',9'') to one another.

[0052] The rotor (2) incorporates ventilation fins (32,32') which rotate integrally therewith and serve to

move the air around the rotor inside the chamber (3) and expel it out through the ventilation windows (14,14') of the stator (11) for the purpose of improving the reduction of the switch temperature. The ventilation fins (32,32') preferably extend along the rotor according to a line parallel to the axis (x). As seen in Figure 2, the rotor (2) has two bevels consisting of two planar surfaces (33,33') parallel to one another arranged on diametrically opposed sides of the rotor with respect to its axis (x), and two curved surfaces (34,34') with the curvature of an arc of circumference arranged on diametrically opposed sides of the rotor with respect to its axis (x). Alternatively, the rotor can be a complete cylinder.

[0053] The fins (32,32') project from said planar surfaces (33,33') and further have the additional advantage of increasing the outline of the rotor and therefore increasing the leakage path of the electric arc, so the electric insulation is improved, complying with the most demanding regulations concerning insulation, and all this in a smaller space. To further increase the leakage path of the electric arc, the rotor (2) incorporates respective channels (35,36') extending along same.

[0054] The moving contacts (9) project in both curved surfaces (34,34') and have ends with the same curvature.

[0055] With the structure and elements described above, the electrical switch functionality as well as the series-parallel-series connection of the moving contacts is obtained in the manner described below in relation to the sequence of drawings of Figure 3.

[0056] The three groups of moving contacts (9,9',9'') rotate simultaneously with the rotor (2) defining a helicoidal movement with respect to the axis of rotation (X) of the rotor, so while moving longitudinally in the direction of the axis (X) (from left to right in the figure), they rotate with respect to that axis. In the position of Figure 3a, the moving contacts (9,9',9'') are at an angle of 0° in the horizontal position, in an open position (no electrical connection) of the switch. In a subsequent instant when they have rotated 20°, Figure 3b, the ends of the moving contacts have approached the pairs of upper and lower conductor soleplates (19,42, 19',42'), but there still is no electrical connection.

[0057] In a subsequent instant when the moving contacts (9,9',9'') have rotated 30°, Figures 3c and 3d, the ends of the moving contacts (9,9',9'') come into contact, respectively, with the upper and lower conductor soleplates (19,42, 19',42') electrical conduction being started as indicated by the arrows of Figure 3c, and such that the three groups of moving contacts (9,9',9'') are connected in series by means of the soleplates (19,42, 19',42') so the electric current would circulate as indicated by the arrows. Therefore when the electric arc occurs, it is split at several cut-off points, specifically at six cut-off points corresponding to the number of ends of the three groups of moving contacts (9,9',9''), so it is easier to put the arc out.

[0058] Specifically, a first end of the first group of moving contacts (9) is in contact with the soleplate (19'), and

a second end of that same contact is in contact with the soleplate (19). A first end of the second group of moving contacts (9') is in contact with the soleplate (42'), and a second end of that same contact is in contact with the soleplate (19). A first end of the third group of moving contacts (9'') is in contact with the soleplate (42'), and a second end of the same contact is in contact with the soleplate (42).

[0059] The rotor (2) continues to rotate in the same direction, so the moving contacts (9,9',9'') move forward sliding respectively over the soleplates (19,42, 19',42'), reaching a rotation position of 45° (Figure 3e), in which the moving contacts continue to be connected in series, but where the upper end of the second group of moving contacts (9') is very close to the soleplate (42).

[0060] When the moving contacts reach the rotation position of 60° (Figure 3f), the upper end of the second group of moving contacts (9') comes into contact with the soleplate (42) and remains in contact with the soleplate (19), whereby the three groups of moving contacts (9,9',9'') are now connected in parallel, as shown by the arrows of that figure. In the position of Figures 3g and 3h, the moving contacts have rotated 90° and are in a vertical position, in which they remain stable until performing an operation to open the switch, and the reverse movement sequence is initiated.

[0061] It can be seen that the series-parallel and parallel-series connection change is obtained given the dimension of the moving contacts (9,9',9'') and soleplates (19,42,19',42') as well as the relative position between them, taking into account the helicoidal movement of the moving contacts (9,9',9'').

[0062] In the series-parallel transition, the first group of moving contacts (9) is always connected between the soleplates (19,19'), and the third group of contacts (9'') is always connected between the soleplates (42,42'). It is only necessary for the second group of moving contacts (9') to change the connection and to go from being connected between the soleplates (19,42') to being connected between the soleplates (19,42) and the soleplate (42').

[0063] Figure 5 depicts an alternative embodiment of the movement of the rotor and moving contacts to cause the series-parallel-series connection, which instead of being helicoidal such as in the case of the preceding drawings, is a sequence of movements with a first rotational movement about an axis of rotation followed by a second linear movement along that same axis. Both embodiments have in common the fact that the series-parallel-series reconfiguration of the moving contacts is performed by means of a linear movement of those contacts, together with rotation in the case of helicoidal movement, and without rotation in the case of the embodiment of Figure 5.

[0064] The process of reconfiguring the connection of the moving contacts of this embodiment is identical to that described above in relation to Figure 3. In Figures 5a, 5b and 5c, the moving contacts (9,9',9'') are in a hor-

izontal position and there is no current circulation. To close the switch, the moving contacts are rotated about the axis (X) by means of the rotor (not depicted) clockwise and in one and the same plane, i.e., without axial movement, until the moving contacts reach a vertical position and contact with the soleplates (19,42,19',42'), being connected to one another in series and allowing current circulation.

[0065] Then, keeping the moving contacts in the position of Figure 5e, the rotor is linearly moved on the axis X, sliding the ends of the moving contacts over the soleplates, until the moving contacts are connected to one another in parallel, as seen in Figure 5g and its enlarged detail.

[0066] The current cut-off process would be the reverse, i.e., moving the rotor from the position of Figure 5g to Figure 5a.

[0067] To produce this sequential movement of the moving contacts, the switch incorporates or has associated therewith operating means, such as a control or push button which, by means of a suitable manual or automatic mechanism, performs the two movements of the rotor described above. The person skilled in the art is familiar with the mechanisms for operating such switches, so he said person would know how to implement those operating means.

[0068] One of the advantages of the invention is that as a result of the current cut-off being performed without having any impact between parts, materials different from those used today can be used. Therefore in a preferred embodiment of the invention, the rotor (2) is made of glass, which provides the additional advantage of that material being an excellent insulating material with high dielectric strength, and it is highly resistant to deterioration caused by the electric arc, compared with plastic insulating materials conventionally used in the state of the art, which in turn significantly prolong the service life of the switch. Alternatively, the rotor can also be made of porcelain, obtaining the same advantages discussed above with respect to glass.

[0069] In view of these figures it can be seen that the switch developed in this invention is capable of achieving in one and the same instant and with a single movement at least three effects, namely:

- greater separation between contacts in the cut-off process as a result of the sum of the radial and axial movement of the helicoidal movement of the moving contacts,
- connecting contacts in series to increase the cut-off power,
- and optionally, the possibility of producing the suction of the arc towards the inside of the rotor.
- Another advantageous effect is that the parallel connection of the moving contacts in the permanent conducting state improves the thermal performance of the switch and aids in overcoming the regulations. Furthermore, another very significant advantage of

the parallel connection is that since there a lower internal temperature, it allows less environmental ionization, which favors a quicker arc cut-off, so it is another synergistic factor to favor extinguishing the arc. If the inside has a higher temperature (e.g., if all the contacts are connected in series generating heat), it helps maintain the arc for a longer period of time or to leap more easily.

[0070] The particular structure of the switch allows it to be smaller because it is not necessary to have air chambers between contacts, being able to reach a size reduction of about 50% with respect to a conventional switch for the same cut-off power.

[0071] The operation of the switch does not entail the abrupt impact between any of its parts, which increases the service life of the switch and increases its reliability.

[0072] The embodiment depicted in the drawings corresponds to a one-pole, i.e., single-pole, switch. However, for the person skilled in the art it is clear that the same depicted structure can easily be adapted to implement a multiple pole switch.

[0073] The various embodiments and alternatives described herein can be combined with one another, without departing from the scope of the appended claims.

Claims

1. Electric switch (1) comprising: at least one pair of fixed contacts (4,4') and at least one moving contact (9) movable between a closed position of the switch in which it establishes electrical continuity with the fixed contacts (4,4'), and an open position in which current circulation is prevented,

characterized in that it further comprises:

a rotor (2) made of an insulating material and having an outer surface and an axis (X), wherein the rotor (2) is axially movable about its axis (X), at least two moving contacts (9,9',9'') assembled in the rotor (2), wherein each. moving contact (9,9',9'') has two ends and it is configured such a first end is accessible through a first area on the outer surface of the rotor (2), and a second end is accessible through a second area on the outer surface of the rotor (2), and where the moving contacts (9,9',9'') are placed in the rotor (2) at a different axial position with respect to the axis (X) of the rotor (2), at least a first pair of conductor soleplates (19,19',42,42') arranged adjacent to one another and aligned according to the longitudinal span of the rotor (2), and arranged for being contacted by a first end of the moving contacts (9,9',9''), and where one of these conductor soleplates (19,19',42,42') is connected with a first fixed contact (4,4') of the switch,

at least a second pair of conductor soleplates (19,19',42,42') arranged adjacent to one another and aligned according to the longitudinal span of the rotor (2), and arranged for being contacted by a second end of the moving contacts (9,9',9''), and where one of these conductors soleplates (19,19',42,42') is connected with a second fixed contact (4,4') of the switch (1), where the moving contacts (9,9',9'') and the soleplates (19,19',42,42') are relatively placed with respect to one another such that, as the rotor (2) moves axially, in a first axial position of the rotor (2), the moving contacts (9,9',9'') are connected to one another in series through the soleplates (19,19',42,42'), and in a second axial position of the rotor, the moving contacts (9,9',9'') of the rotor (2) are connected to one another in parallel through the soleplates (19,19',42,42').

2. Switch according to claim 1, where the rotor (2) is movable defining a helicoidal movement with respect to an axis of rotation (X).
3. Switch according to claim 1, where the rotor is movable in a sequence of two movements, a first rotational movement about an axis of rotation (X), followed by a second linear movement along that same axis.
4. Switch according to any of the preceding claims, where the moving contacts (9,9',9'') are placed in the rotor (2) in the same angular position with respect to the axis (X) of the rotor (2).
5. Switch according to any of the preceding claims, where the moving contacts (9,9',9'') have ends accessible through diametrically opposed areas on the outer surface of the rotor (2).
6. Switch according to any of the preceding claims, where the first and the second pair of soleplates (19,19',42,42') are facing one another on diametrically opposed sides of the rotor (2).
7. Switch according to any of the preceding claims, where at least one of the moving contacts (9,9',9'') is formed by two or more superimposed conductor plates (5,5') in direct contact with each other.
8. Switch according to any of the preceding claims, further comprising a stator (11) including a casing (7,7') made of an insulating material, where said fixed contacts and the soleplates are assembled in said stator (11), and where the rotor (2) is housed inside the stator (11).
9. Switch according to any of the preceding claims,

where the stator (11) and the rotor (2) are configured to form a complementary threaded coupling therebetween to cause the helicoidal movement of the rotor (2) and reciprocally between a closed position and an electrical cut-off position of the switch (1).

10. Switch according to any of the preceding claims 1 to 8, incorporating an external body (29) outside the casing (7,7'), and in that the rotor (2) has a portion housed inside that external body (29) and rotates about it by means of a threaded coupling formed in a complementary manner in both elements (29,2) to cause the helicoidal movement of the rotor (2), and reciprocally between a closed position and an electrical cut-off position of the switch (1).
11. Switch according to any of the preceding claims, where the stator (11) has a cylindrical chamber (3) in which the rotor (2) is housed, wherein the rotor (2) is at least partially hollow, and wherein the stator (11) and the rotor (2) have ventilation windows (14,14') placed such that they are superimposed in the electrically open position of the switch, defining a ventilation channel communicating the inside of the rotor (2) with the outside of the stator (11).
12. Switch according to any of the preceding claims, where the rotor (2) has a through hole communicating the inside of the rotor with the outside, and in that it has suction means for suctioning the electric arc towards the inside of the rotor (2) with the movement thereof.
13. Switch according to claim 12, where the rotor (2) has an open end and said suction means comprise at least one closure valve arranged for closing the open end of the rotor, and configured for sliding inside the rotor (2) in a tight manner to cause suctioning inside the rotor (2).
14. Switch according to any of the preceding claims, where the rotor (2) is made of glass or porcelain.
15. Switch according to any of the preceding claims, where the rotor (2) forms two planar surfaces parallel to one another arranged on diametrically opposed sides of the rotor with respect to its axis (X), and in that it incorporates a cylindrical sector whereby it is supported and slides with respect to the stator (11).

Patentansprüche

1. Elektrischer Schalter (1) mit:

mindestens einem Paar feststehender Kontakte (4, 4') und mindestens einem bewegbaren Kontakt (9), der zwischen einer geschlossenen Po-

sition des Schalters, in welcher er eine elektrische Kontinuität mit den feststehenden Kontakten (4, 4') herstellt, und einer offenen Position bewegbar ist, in welcher die Stromzirkulation verhindert ist,

dadurch gekennzeichnet, dass er ferner aufweist:

einen Rotor (2), der aus einem isolierenden Material besteht und eine Außenfläche und eine Achse (X) aufweist, wobei der Rotor (2) axial um seine Achse (X) bewegbar ist, mindestens zwei bewegbare Kontakte (9, 9', 9''), die in den Rotor (2) eingebaut sind, wobei jeder bewegbare Kontakt (9, 9', 9'') zwei Enden aufweist und derart ausgebildet ist, dass ein erstes Ende über einen ersten Bereich auf der Außenfläche des Rotors (2) zugänglich ist und ein zweites Ende über einen zweiten Bereich auf der Außenfläche des Rotors (2) zugänglich ist, und wobei die bewegbaren Kontakte (9, 9', 9'') in dem Rotor (2) an unterschiedlichen axialen Positionen in Bezug auf die Achse (X) des Rotors (2) angeordnet sind, mindestens ein erstes Paar Leiter-Grundplatten (19, 19', 42, 42'), die einander benachbart angeordnet sind und entsprechend der Längserstreckung des Rotors (2) ausgerichtet sind, und welche zum Kontakt mit einem zweiten Ende der bewegbaren Kontakte (9, 9', 9'') angeordnet sind, und wobei eine dieser Leiter-Grundplatten (19, 19', 42, 42') mit einem zweiten feststehenden Kontakt (4, 4') des Schalters (1) verbunden ist, wobei die bewegbaren Kontakte (9, 9', 9'') und die Grundplatten (19, 19', 42, 42') in Bezug zueinander derart relativ angeordnet sind, dass während der axialen Bewegung des Rotors (2) die bewegbaren Kontakte (9, 9', 9'') in einer ersten axialen Position des Rotors (2) über die Grundplatten (19, 19', 42, 42') miteinander in Reihe verbunden sind, und die bewegbaren Kontakte (9, 9', 9'') des Rotors (2) in einer zweiten axialen Position des Rotors über die Grundplatten (19, 19', 42, 42') parallel miteinander verbunden sind.

2. Schalter nach Anspruch 1, bei welchem der Rotor (2) in einer schraubenlinienförmigen Bewegung in Bezug auf die Drehachse (X) bewegbar ist.
3. Schalter nach Anspruch 1, bei welchem der Rotor in einer Abfolge von zwei Bewegungen bewegbar ist, nämlich einer ersten Drehbewegung um die Drehachse (X), auf die eine zweite, lineare Bewegung

entlang derselben Achse folgt.

4. Schalter nach einem der vorhergehenden Ansprüche, bei welchem die bewegbaren Kontakte (9, 9', 9'') in dem Rotor (2) an derselben Winkelposition in Bezug zu der Achse (X) des Rotors (2) angeordnet sind. 5
5. Schalter nach einem der vorhergehenden Ansprüche, bei welchem die bewegbaren Kontakte (9, 9', 9'') Enden aufweisen, die über diametral gegenüberliegende Bereiche auf der Außenfläche des Rotors (2) zugänglich sind. 10
6. Schalter nach einem der vorhergehenden Ansprüche, bei welchem das erste und das zweite Paar von Grundplatten (19, 19', 42, 42') einander auf diametral gegenüberliegenden Seiten des Rotors (2) zugewandt sind. 15
7. Schalter nach einem der vorhergehenden Ansprüche, bei welchem mindestens einer der bewegbaren Kontakte (9, 9', 9'') durch zwei oder mehr in direktem Kontakt miteinander befindliche übereinanderliegende Leiterplatten (5, 5') gebildet ist. 20
8. Schalter nach einem der vorhergehenden Ansprüche, ferner mit einem Stator (11) mit einem aus einem Isoliermaterial bestehenden Gehäuse (7, 7'), wobei die feststehenden Kontakte und die Grundplatten in dem Stator (11) eingebaut sind, und wobei der Rotor (2) in dem Stator (11) aufgenommen ist. 30
9. Schalter nach einem der vorhergehenden Ansprüche, bei welchem der Stator (11) und der Rotor (2) dazu ausgebildet sind, zwischen einander eine komplementäre Gewindekopplung zu bilden, um die schraubenlinienförmige Bewegung des Rotors (2) und die Hin- und Herbewegung zwischen einer geschlossenen Position und einer Stromsperrposition des Schalters (1) zu bewirken. 35
10. Schalter nach einem der vorhergehenden Ansprüche 1 bis 8, mit einem äußeren Körper (29) außerhalb des Gehäuses (7, 7'), und wobei der Rotor (2) einen Bereich aufweist, der in diesem äußeren Körper (29) aufgenommen ist und um diesen mittels einer Gewindekopplung in beiden Elementen (29, 2) in komplementärer Weise dreht, um die die schraubenlinienförmige Bewegung des Rotors (2) und die Hin- und Herbewegung zwischen einer geschlossenen Position und einer Stromsperrposition des Schalters (1) zu bewirken. 40
11. Schalter nach einem der vorhergehenden Ansprüche, bei welchem der Stator (11) eine zylindrische Kammer (3) aufweist, in welcher der Rotor (2) aufgenommen ist, wobei der Rotor (2) zumindest teil- 50

weise hohl ist, und wobei der Stator (11) und der Rotor (2) Lüftungsfenster (14, 14') aufweisen, die derart angeordnet sind, dass sie einander in der elektrisch offenen Position des Schalters überlagern, wobei sie einen Lüftungskanal bilden, der das Innere des Rotors (2) mit dem Äußeren des Stators (11) verbindet.

12. Schalter nach einem der vorhergehenden Ansprüche, bei welchem der Rotor (2) ein Durchgangsloch aufweist, das das Innere des Rotors mit dem Äußeren verbindet, und wobei er Saugeinrichtungen zum Saugen des Lichtbogens mit der Bewegung des Rotors in Richtung des Inneren des Rotors (2) aufweist. 10
13. Schalter nach Anspruch 12, bei welchem der Rotor (2) ein offenes Ende aufweist, und die Saugeinrichtung mindestens ein Schließventil aufweist, das zum Schließen des offenen Endes des Rotors angeordnet ist und dazu ausgebildet ist, in dem Rotor (2) dicht zu gleiten, um ein Ansaugen in den Rotor (2) zu bewirken. 15
14. Schalter nach einem der vorhergehenden Ansprüche, bei welchem der Rotor (2) aus Glas oder Porzellan besteht. 20
15. Schalter nach einem der vorhergehenden Ansprüche, bei welchem der Rotor (2) zwei zueinander parallele planare Flächen bildet, die in Bezug auf die Achse (X) des Rotors auf diametral gegenüberliegenden Seiten des Rotors angeordnet sind, und wobei er einen zylindrischen Abschnitt aufweist, mittels welchem er gestützt ist und in Bezug auf den Stator (11) gleitet. 25

Revendications

1. Commutateur électrique (1) comprenant : au moins une paire de contacts fixes (4, 4') et au moins un contact mobile (9) mobile entre une position fermée du commutateur dans laquelle il établit la continuité électrique avec les contacts fixes (4, 4') et une position ouverte dans laquelle la circulation du courant est empêchée, 40

caractérisé en ce qu'il comprend en outre :

un rotor (2) réalisé avec un matériau isolant et ayant une surface externe et un axe (X), dans lequel le rotor (2) est axialement mobile autour de son axe (X),
au moins deux contacts mobiles (9, 9', 9'') assemblés dans le rotor (2), dans lequel chaque contact mobile (9, 9', 9'') a deux extrémités et il est configuré de sorte qu'une première extrémité est accessible par une première zone sur la surface externe du rotor (2), et qu'une seconde 50

- extrémité est accessible par une seconde zone sur la surface externe du rotor (2), et dans lequel les contacts mobiles (9, 9', 9'') sont placés dans le rotor (2) dans une position axiale différente par rapport à l'axe (X) du rotor (2),
- au moins une première paire de semelles conductrices (19, 19', 42, 42') agencées de manière adjacente entre elles et alignées selon l'envergure longitudinale du rotor (2) et agencées pour être contactées par une première extrémité des contacts mobiles (9, 9', 9'') et dans lequel l'une de ces semelles conductrices (19, 19', 42, 42') est raccordée avec un premier contact fixe (4, 4') du commutateur,
- au moins une seconde paire de semelles conductrices (19, 19', 42, 42') agencées de manière adjacente entre elles et alignées selon l'envergure longitudinale du rotor (2), et agencées pour être contactées par une seconde extrémité des contacts mobiles (9, 9', 9'') et dans lequel l'une de ces semelles conductrices (19, 19', 42, 42') est raccordée avec un second contact fixe (4, 4'') du commutateur (1),
- dans lequel les contacts mobiles (9, 9', 9'') et les semelles (19, 19', 42, 42') sont placés relativement les uns par rapport aux autres de sorte que, lorsque le rotor (2) se déplace de manière axiale, dans une première position axiale du rotor (2), les contacts mobiles (9, 9', 9'') sont raccordés entre eux en série par le biais des semelles (19, 19', 42, 42') et dans une seconde position axiale du rotor, les contacts mobiles (9, 9', 9'') du rotor (2) sont raccordés entre eux en parallèle par le biais des semelles (19, 19', 42, 42').
2. Commutateur selon la revendication 1, dans lequel le rotor (2) est mobile, définissant un mouvement hélicoïdal par rapport à un axe de rotation (X).
 3. Commutateur selon la revendication 1, dans lequel le rotor est mobile dans une séquence de deux mouvements, un premier mouvement de rotation autour d'un axe de rotation (X), suivi par un second mouvement linéaire le long de ce même axe.
 4. Commutateur selon l'une quelconque des revendications précédentes, dans lequel les contacts mobiles (9, 9', 9'') sont placés dans le rotor (2) dans la même position angulaire par rapport à l'axe (X) du rotor (2).
 5. Commutateur selon l'une quelconque des revendications précédentes, dans lequel les contacts mobiles (9, 9', 9'') ont des extrémités accessibles par des zones diamétralement opposées sur la surface externe du rotor (2).
 6. Commutateur selon l'une quelconque des revendications précédentes, dans lequel la première et la seconde paire de semelles (19, 19', 42, 42') se font face sur des côtés diamétralement opposés du rotor (2).
 7. Commutateur selon l'une quelconque des revendications précédentes, dans lequel au moins l'un des contacts mobiles (9, 9', 9'') est formé par deux plaques conductrices (5, 5') superposées ou plus, en contact direct entre elles.
 8. Commutateur selon l'une quelconque des revendications précédentes, comprenant en outre un stator (11) comprenant un boîtier (7, 7') réalisé avec un matériau isolant, dans lequel lesdits contacts fixes et les semelles sont assemblés dans ledit stator (11) et dans lequel le rotor (2) est logé à l'intérieur du stator (11).
 9. Commutateur selon l'une quelconque des revendications précédentes, dans lequel le stator (11) et le rotor (2) sont configurés pour former un couplage fileté de manière complémentaire entre eux pour provoquer le mouvement hélicoïdal du rotor (2) et réciproquement entre une position fermée et une position électrique arrêtée du commutateur (1).
 10. Commutateur selon l'une quelconque des revendications 1 à 8, incorporant un corps externe (29) à l'intérieur du boîtier (7, 7') et en ce que le rotor (2) a une partie logée à l'intérieur de ce corps externe (29) et tourne autour de ce dernier au moyen d'un couplage fileté formé d'une manière complémentaire dans les deux éléments (29, 2) pour provoquer le mouvement hélicoïdal du rotor (2) et réciproquement entre une position fermée et une position électrique arrêtée du commutateur (1).
 11. Commutateur selon l'une quelconque des revendications précédentes, dans lequel le stator (11) a une chambre cylindrique (3) dans laquelle le rotor (2) est logé, dans lequel le rotor (2) est au moins partiellement creux, et dans lequel le stator (11) et le rotor (2) ont des fenêtres de ventilation (14, 14') placées de sorte qu'elles sont superposées dans une position électriquement ouverte du commutateur, définissant un canal de ventilation faisant communiquer l'intérieur du rotor (2) avec l'extérieur du stator (11).
 12. Commutateur selon l'une quelconque des revendications précédentes, dans lequel le rotor (2) a un trou débouchant faisant communiquer l'intérieur du rotor avec l'extérieur, et en ce qu'il a des moyens d'aspiration pour aspirer l'arc électrique vers l'intérieur du rotor (2) avec son mouvement.
 13. Commutateur selon la revendication 12, dans lequel

le rotor (2) a une extrémité ouverte et lesdits moyens d'aspiration comprennent au moins une valve de fermeture agencée pour fermer l'extrémité ouverte du rotor, et configurée pour coulisser à l'intérieur du rotor (2) d'une manière étanche afin de provoquer l'aspiration à l'intérieur du rotor (2). 5

14. Commutateur selon l'une quelconque des revendications précédentes, dans lequel le rotor (2) est réalisé à partir de verre ou de porcelaine. 10

15. Commutateur selon l'une quelconque des revendications précédentes, dans lequel le rotor (2) forme deux surfaces planes parallèles entre elles, agencées sur les côtés diamétralement opposés du rotor par rapport à son axe (X), et en ce qu'il comprend un secteur cylindrique, moyennant quoi il est supporté et coulisse par rapport au stator (11). 15

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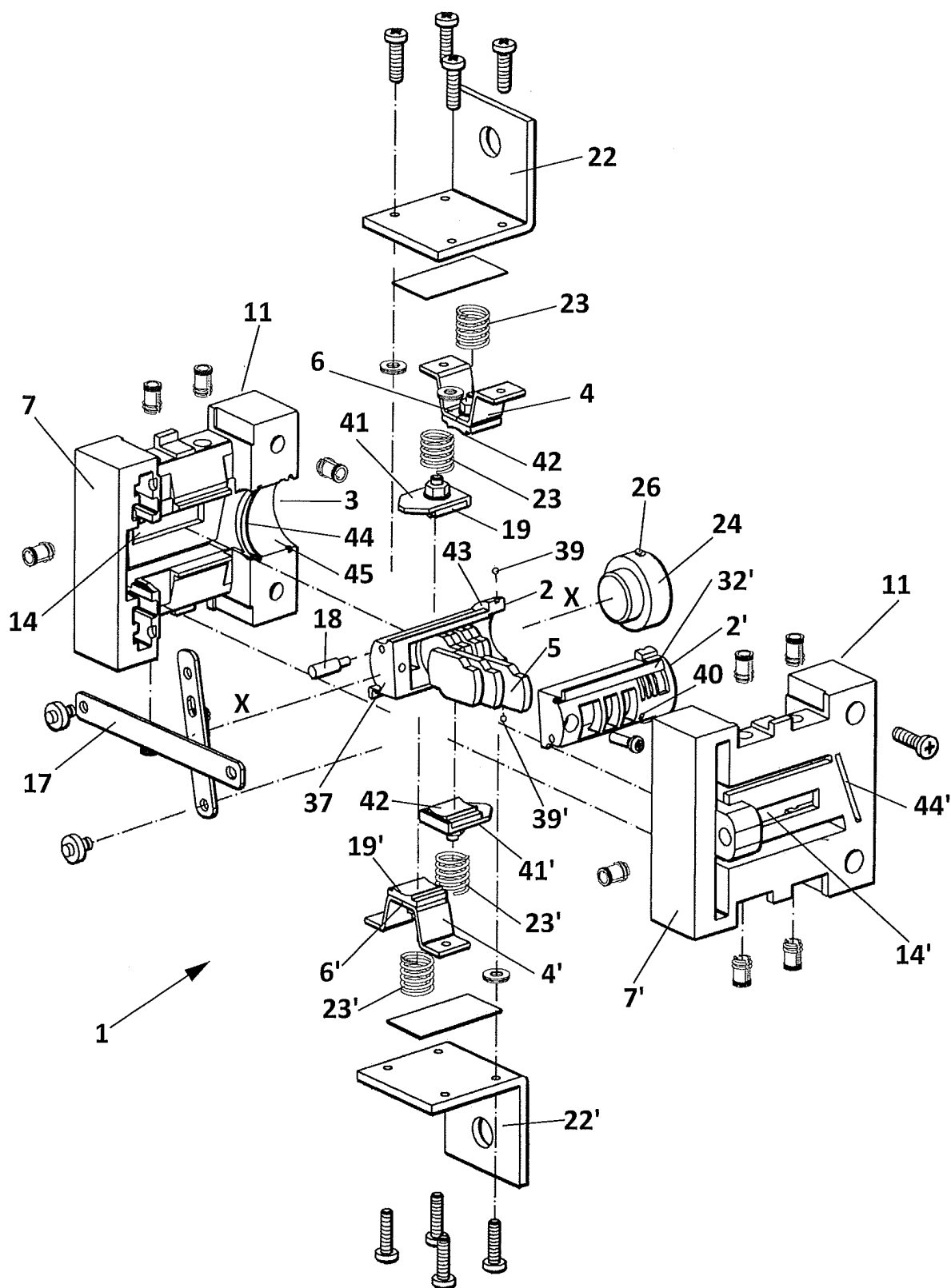


FIG. 1

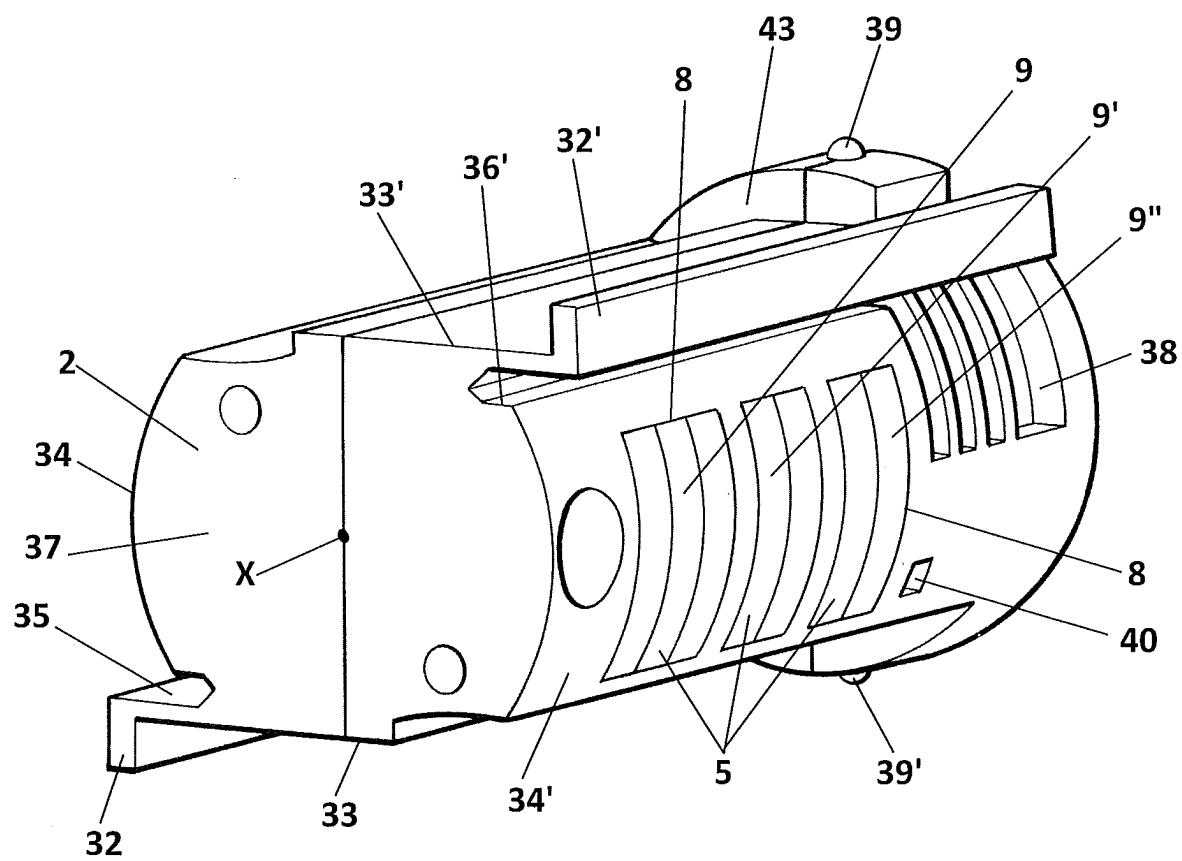


FIG. 2a

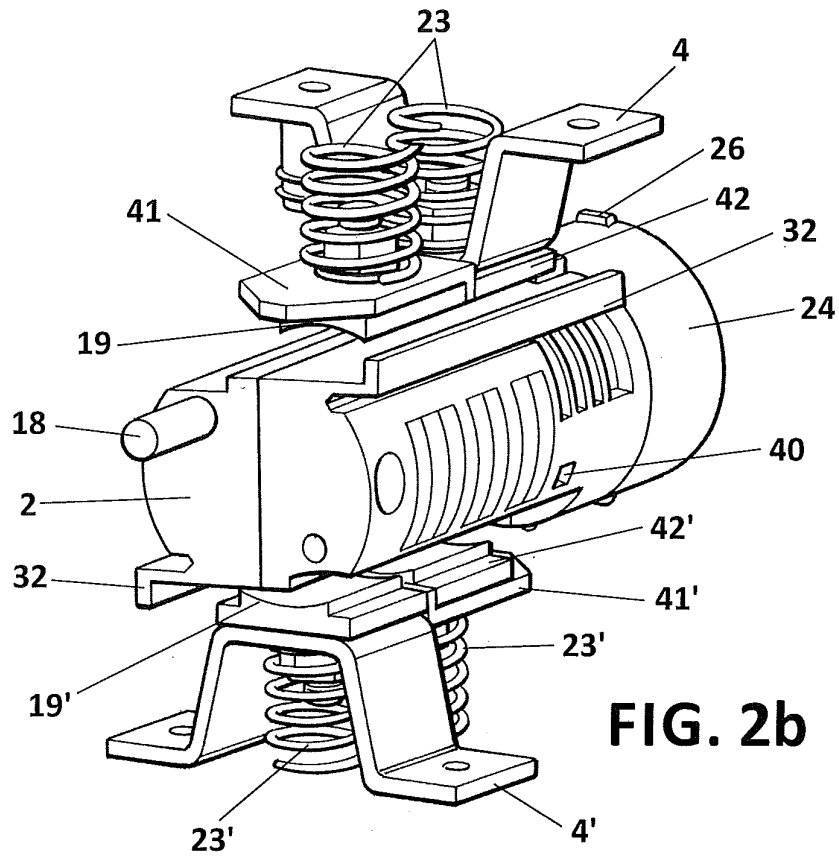


FIG. 2b

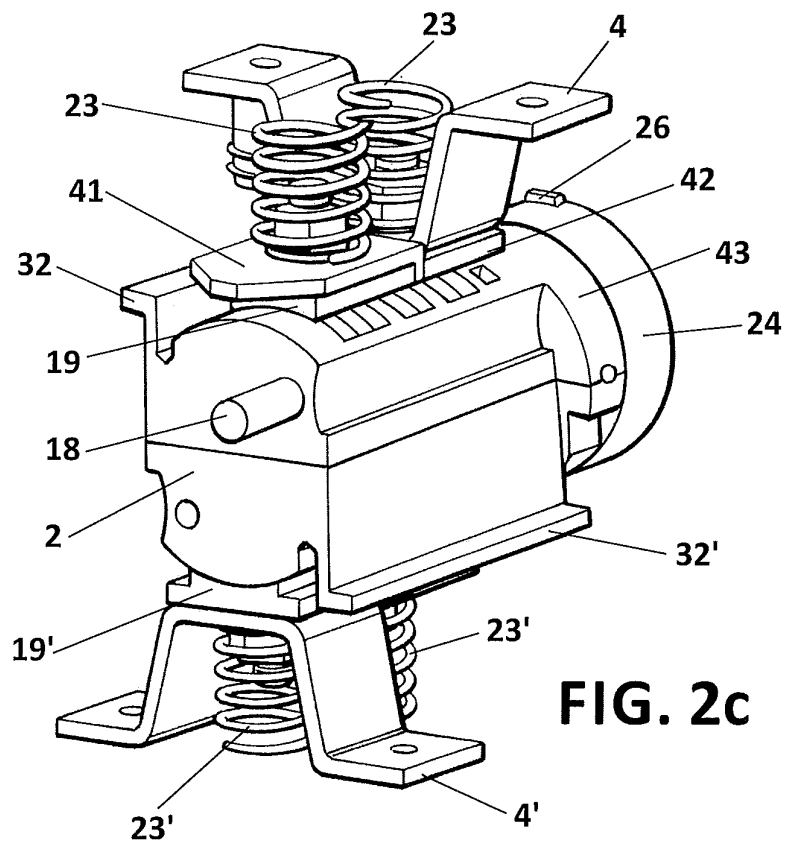
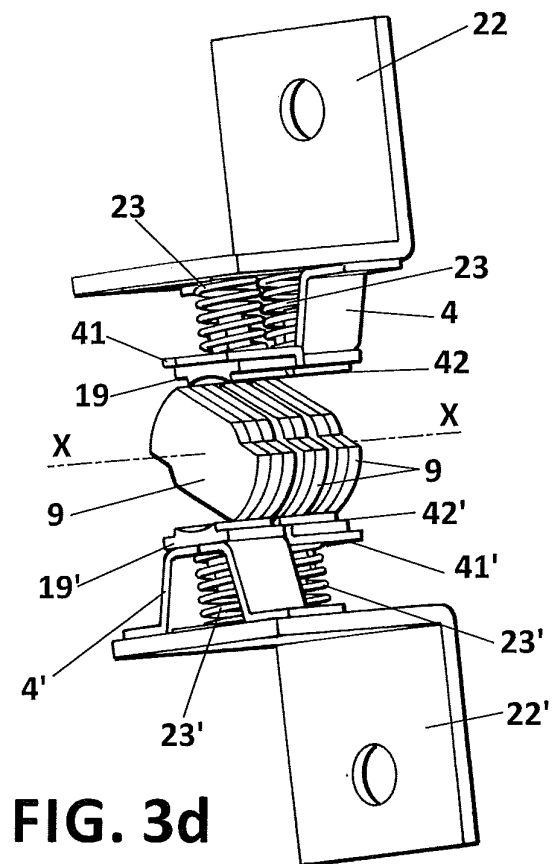
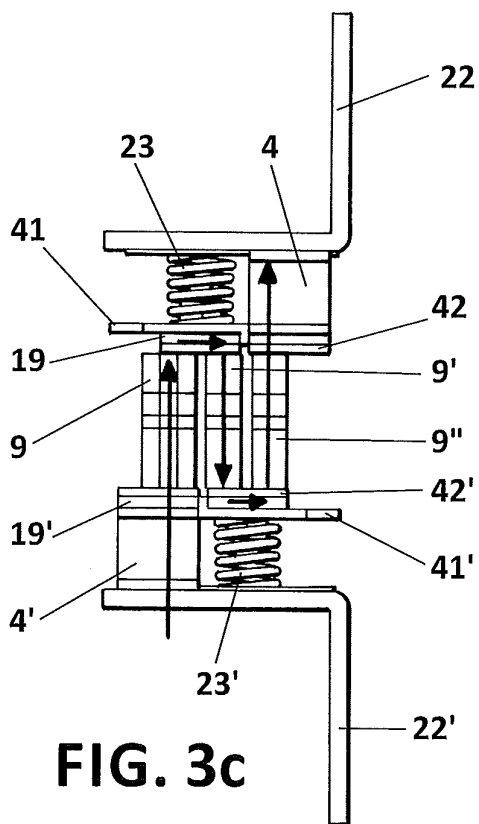
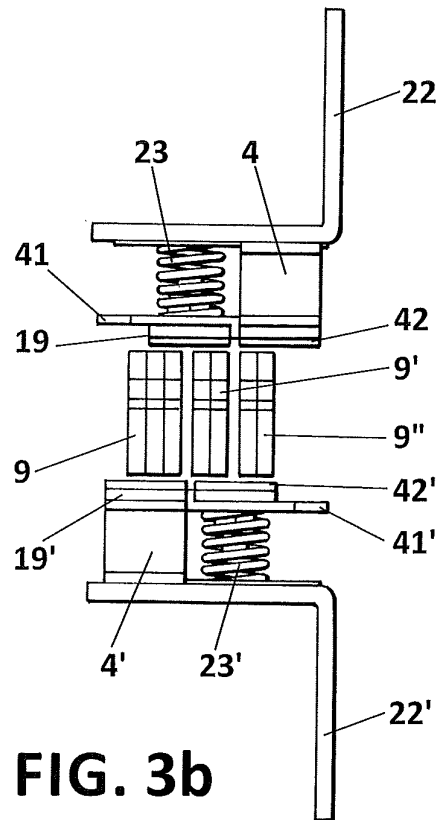
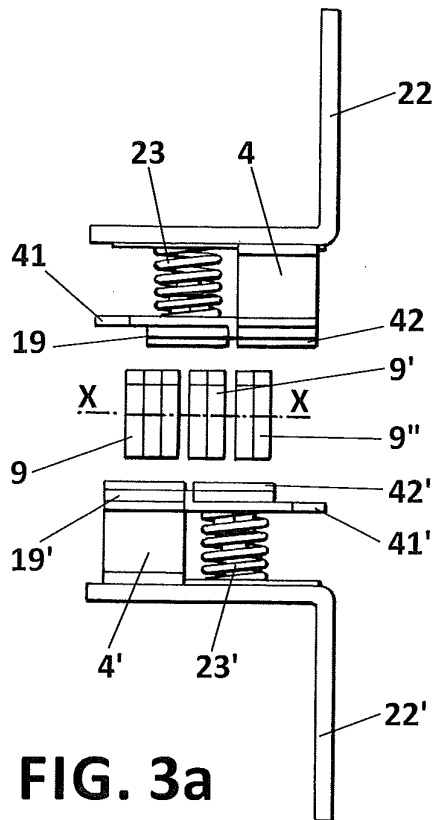
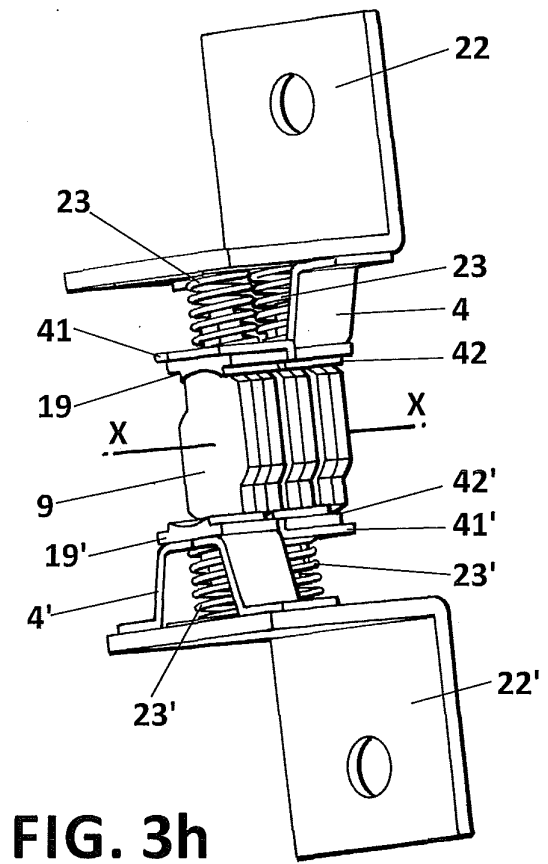
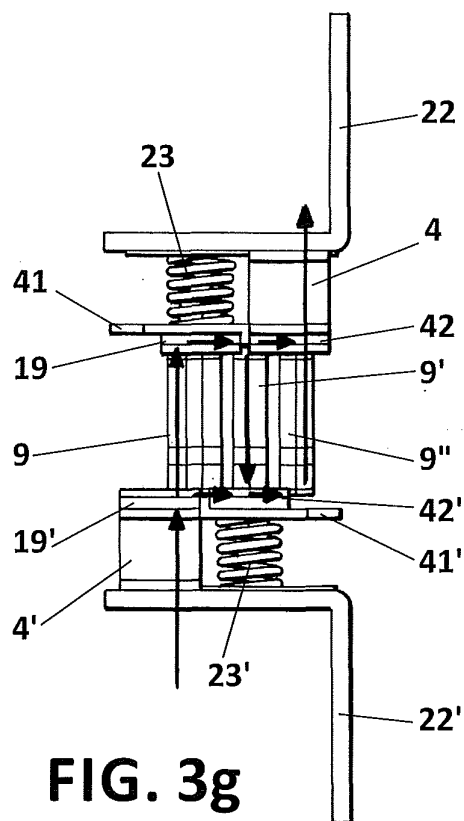
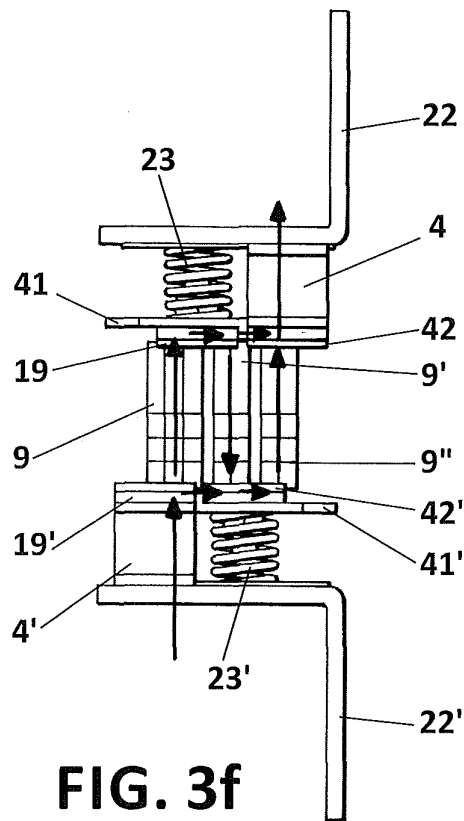
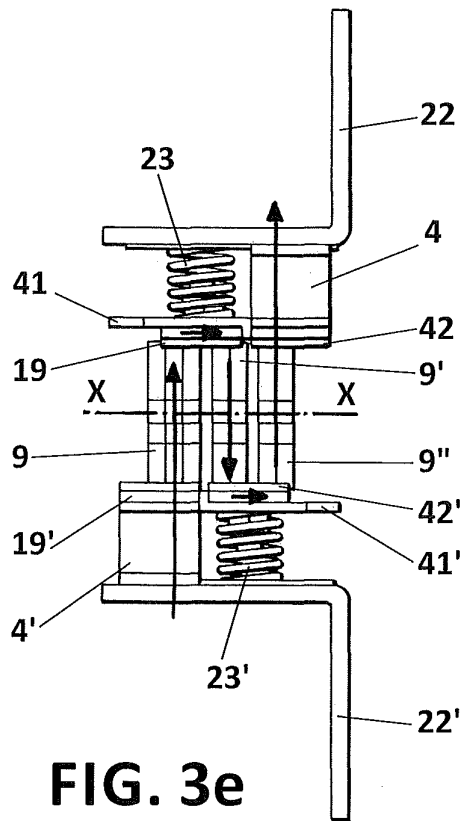


FIG. 2c





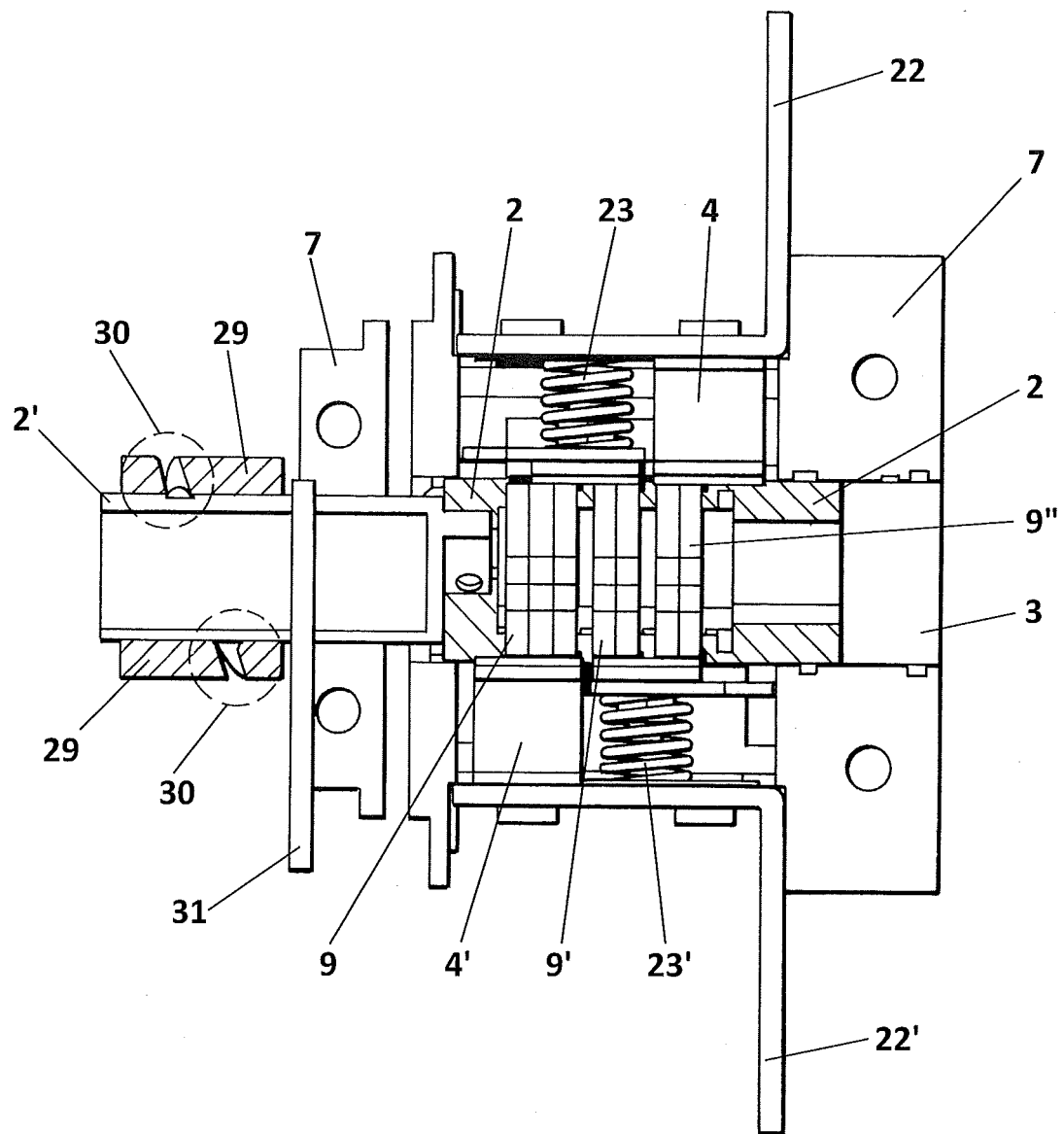


FIG. 4

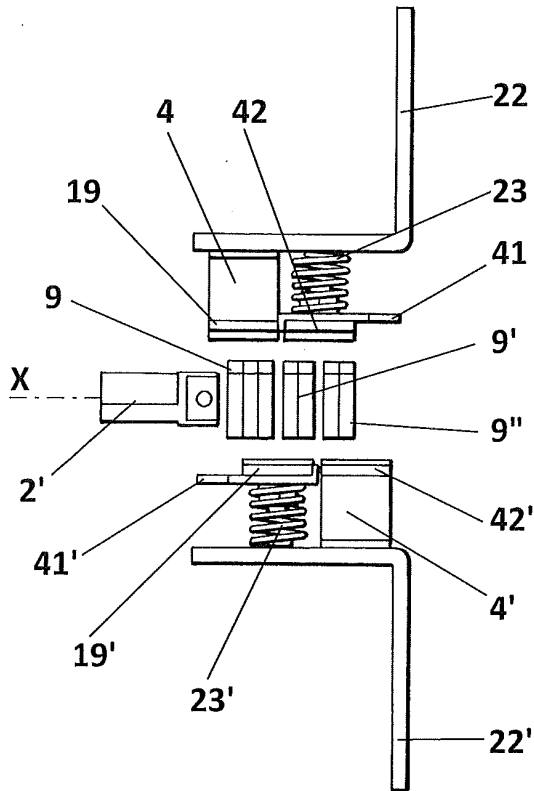


FIG. 5a

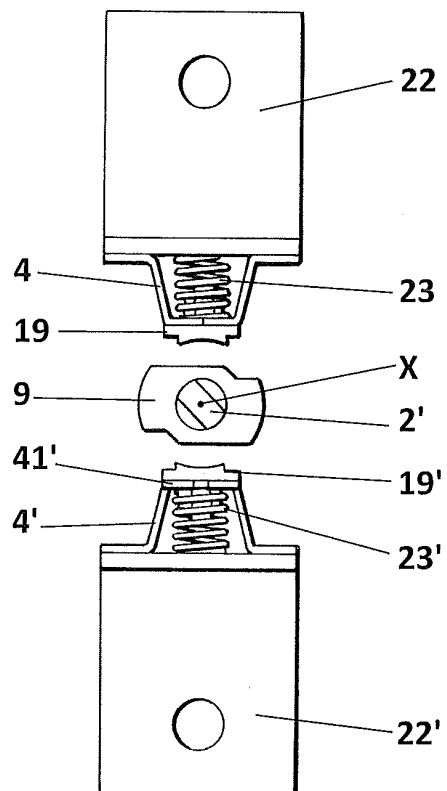


FIG. 5b

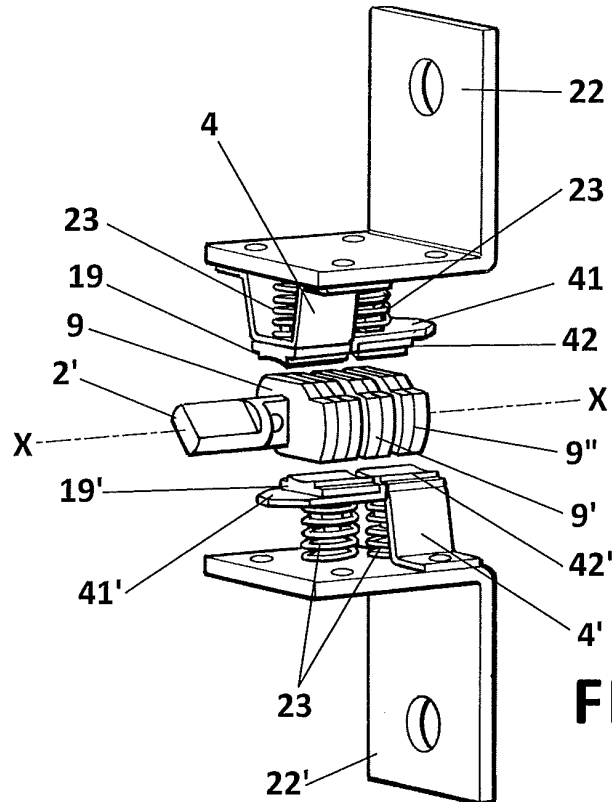


FIG. 5c

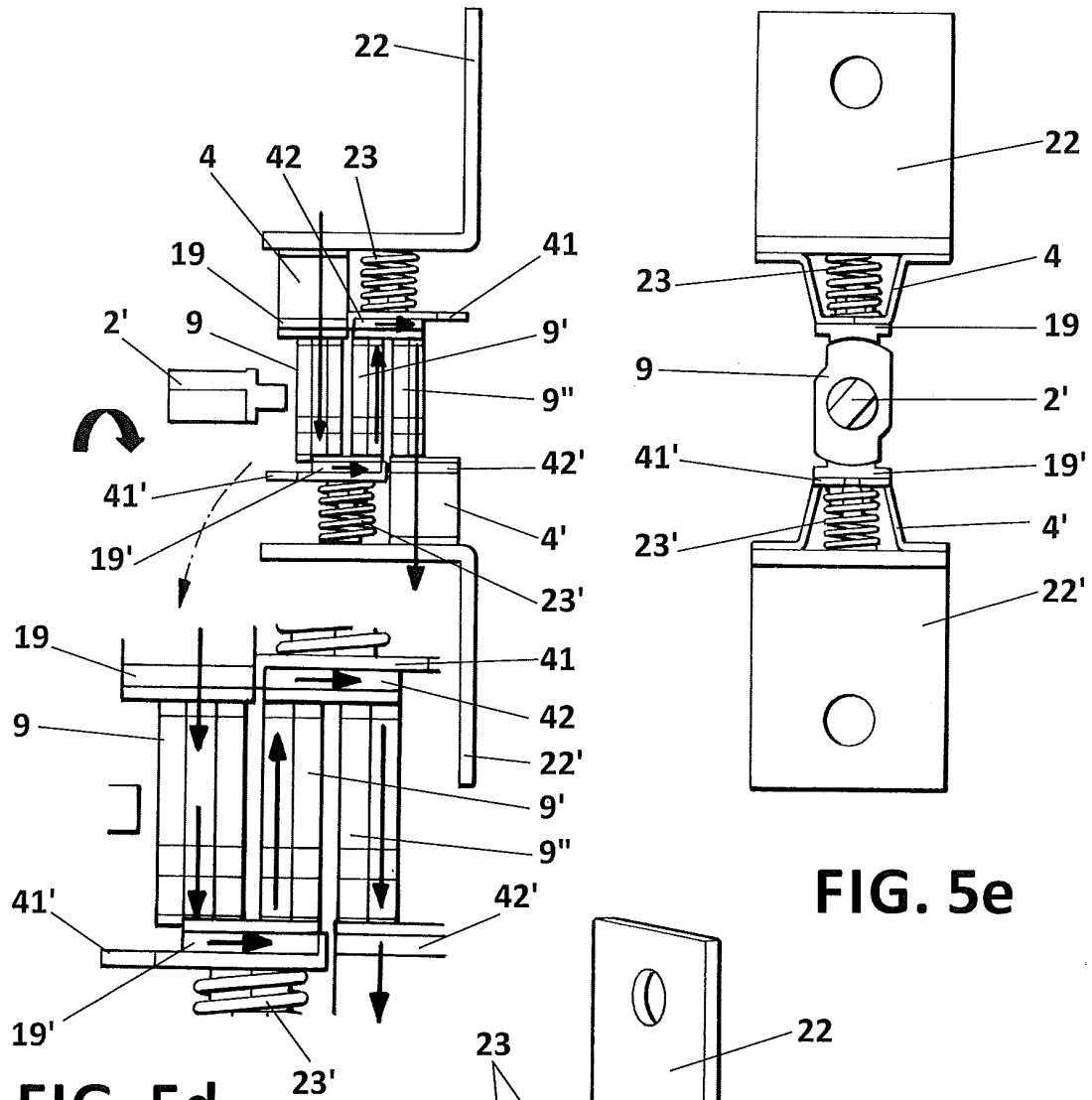


FIG. 5e

FIG. 5d

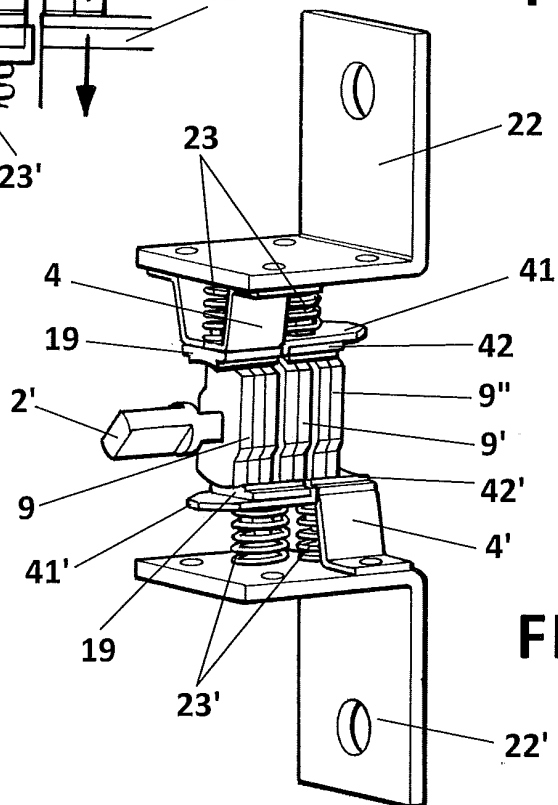


FIG. 5f

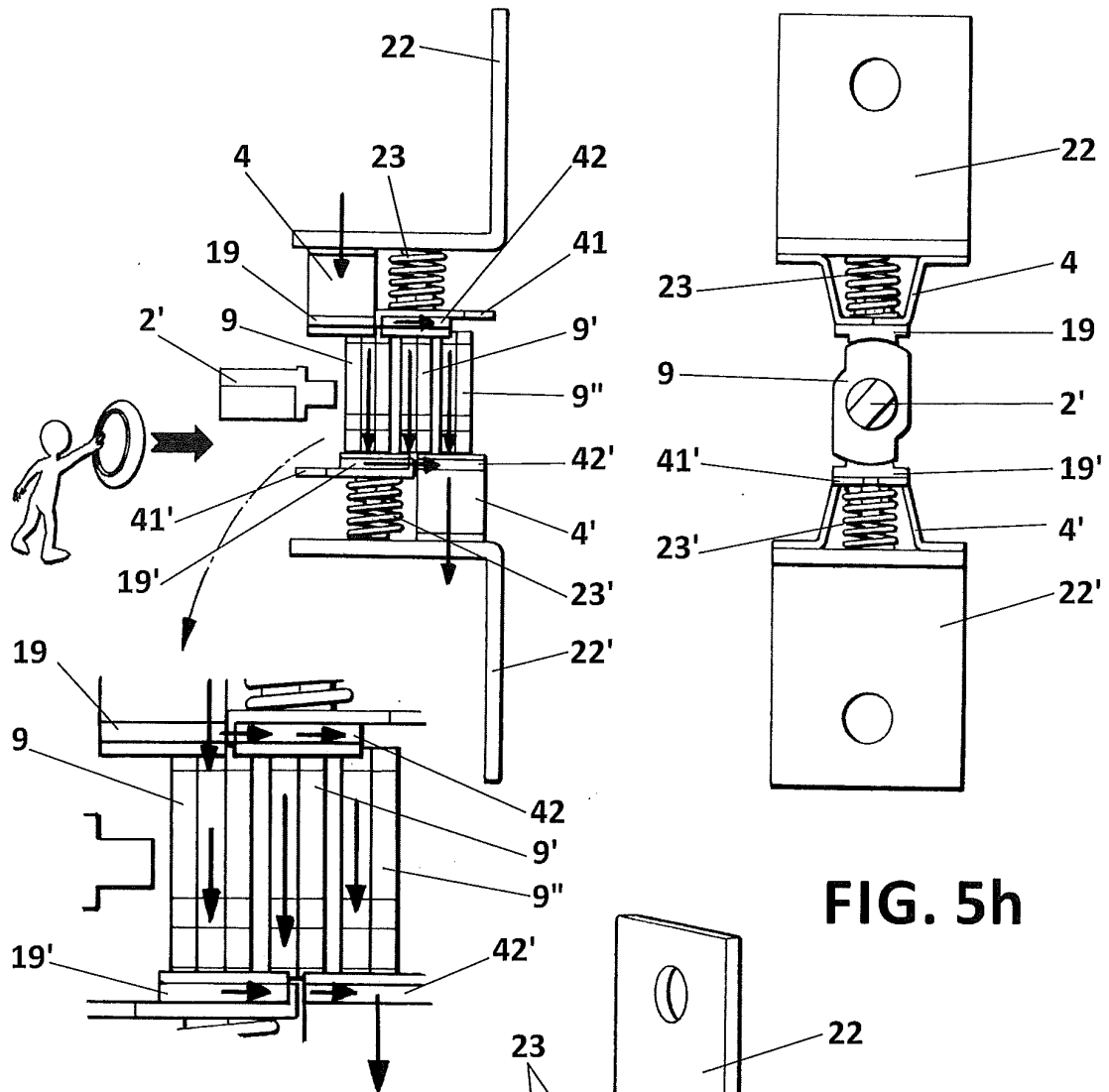


FIG. 5h

FIG. 5g

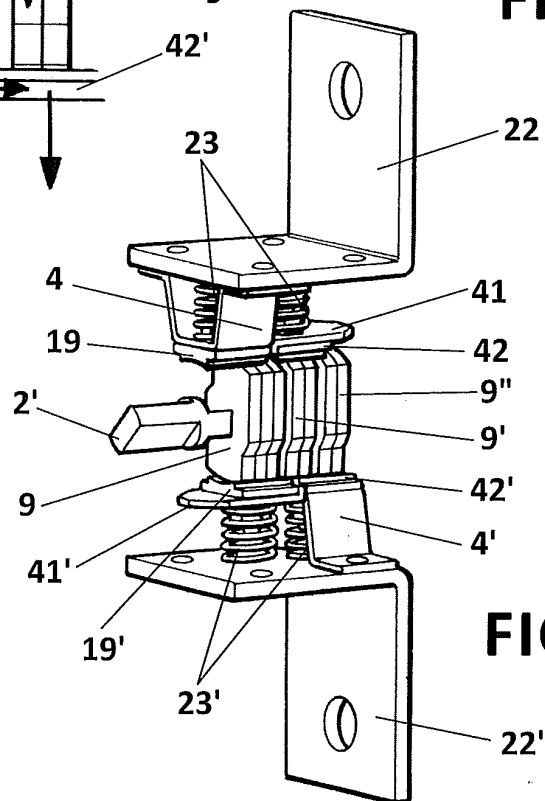


FIG. 5i

REFERENCES CITED IN THE DESCRIPTION

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