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(54) HELICOIDAL SWITCH

(57) The present invention relates to a current breaker switch which allows quickly, effectively and completely extinguishing electric arcs occurring in an electric circuit during circuit cut-off and closing operations, which makes it particularly applicable to cutting off direct current. The switch comprises at least one pair of fixed contacts (4,4') and a moving contact (9) assembled in a rotor (2) made of an insulating material, where the rotor (2) is suitable for moving, defining a helicoidal movement with respect to the fixed contacts. The switch achieves a solid cut-off of the current, because the insulating material of the rotor (2) is instantly placed between the two fixed contacts (4,4') in the same instant in which the power is cut off.

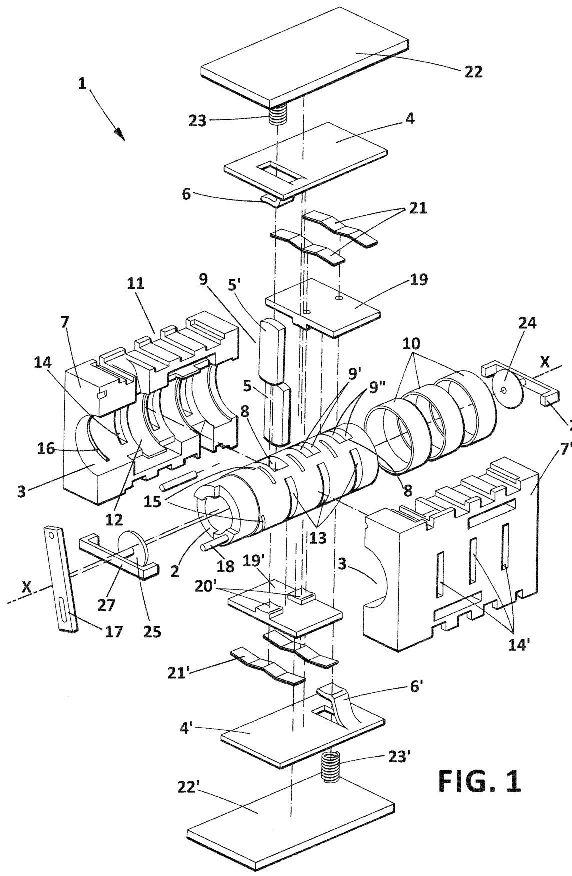

FIG. 1

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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] 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

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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 SF_6 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.

[0008] 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.

[0009] 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.

[0010] 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.

Description of the Invention

[0011] 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.

[0012] 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.

[0013] The moving contact is arranged between the fixed contacts, and it is movable following a helicoidal movement with respect to an axis. 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.

[0014] 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.

[0015] The switch preferably incorporates a rotor made of an insulating material, in which said at least one moving contact is assembled, where the rotor is movable with a helicoidal trajectory with respect to an axis of rotation, and therefore causes the helicoidal movement of the moving contact.

[0016] As a result of the helicoidal movement, the tangential speed of the cut-off point can be increased by simply increasing 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.

[0017] The rotor can be a cylindrical body or have a generically cylindrical shape which moves in a helicoidal manner with respect to its axis of revolution reciprocally, i.e., in both directions, to go from the closed position to the cut-off position and vice versa.

[0018] A pair of fixed contacts have a contact surface arranged for being contacted by a moving contact, and the rotor is configured such that in the open position of the switch, the insulating material of the rotor is in direct contact with the fixed contacts and covers most of the contact surface of the fixed contacts, so there is no air chamber around the moving contacts and the occurrence of the electric arc is reduced or made impossible.

[0019] This particularity has the effect that by means of the switch of the present invention, solid cut-off of the current is achieved, which means that due to the helicoidal trajectory of the rotor, in the electrical cut-off position of the switch (the current circulation is prevented), the insulating material of the rotor is instantly placed between the two moving contacts in the same instant in which the power is cut off, achieving the electric insulation of the cut-off points with the interposition of a solid insulating medium or material between the fixed and moving contacts, instead of the insulating medium being air, oil or another insulating liquid as known in the state of the art.

Description of the Drawings

[0020] 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 non-limiting character:

Figure 1 shows an exploded view of an embodiment of a helicoidal movement breaker switch according to the invention.

Figure 2 shows the embodiment of Figure 1 in the initial position of 0° of rotation of the rotor, corresponding to the electrically closed position of the switch (the passage of current is allowed), where Figure 2a is a front elevational view without the stator, Figure 2b is a profile view, Figure 2c is a perspective view, and Figure 2d is another perspective view with the stator coupled and partially sectioned.

Figure 3 shows a depiction similar to that of Figure 2, when the rotation of the rotor is about 45° with the rotation direction clockwise, corresponding to an electrical cut-off position.

Figure 4 shows a depiction similar to that of Figure 2, when the rotor has rotated 90° with respect to a vertical axis, and the separation between the moving contact and the fixed contacts is maximum.

Figure 5 shows a schematic depiction of an alternative embodiment to produce the helicoidal rotation of the rotor, which 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 6 shows an exploded view similar to that of Figure 1 of another preferred embodiment of the invention, in which in addition to the switch function, a series-parallel-series connection of the contacts is implemented.

Figure 7 shows perspective views of another embodiment of Figure 6, where Figure 7a is a view of a rotor provided with ventilation fins, Figure 7b is a view of said rotor in the electrical cut-off position; and Figure 7c is a view of said rotor in the electrically closed or electrical continuity position of the switch.

Figure 8 shows a movement sequence of the moving contacts of the embodiment of Figures 6 and 7 for changing the connection of the moving contacts and fixed contacts from a series connection to a parallel connection. Figures 8d and 8h 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 8a: switch Off, moving contact position 0°.

Figure 8b: switch Off, moving contact position 20°.

Figures 8c and 8d: switch On, moving contact position 30°.

Figure 8e: switch On, moving contact position 45°.

Figure 8f: 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 8g and 8h: switch On, moving contact position 90°.

[0021] 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.

Preferred Embodiment of the Invention

[0022] Figure 1 shows an embodiment of a helicoidal switch (1) for solid cut-off 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 fuse 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, defining a helicoidal movement inside said chamber and with respect to its axis of revolution (X).

[0023] A pair of fixed contacts (4,4') are assembled in said casing (7,7'), forming contact terminals (6,6') projecting in said chamber (3) and 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".

[0024] The rotor (2) is preferably at least partially hollow and has two transverse holes (8) located at diametrically opposed points thereof. To improve conduction, in this embodiment the moving contact (9) consists of one or more superimposed metal plates (5,5') in direct contact, and such that the two ends of the metal plates (5,5') project diametrically through said holes (8) of the rotor, being flush with its outer surface, for which purpose said ends are curved according to the curvature of the outer surface of the rotor.

[0025] The outer surface of the rotor (2) slides in permanent contact with the contact terminals (6,6') of the fixed contacts. 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 2), whereas in the electrical cut-off position of the switch (Figures 3 and 4), the fixed contacts (4,4') are in contact with the insulating material of the rotor (2). To that end, a portion of the rotor has a dimension coinciding with the separation distance of the fixed contacts (4,4'), which can be arranged in a diametrically opposed manner with respect to the axis of revolution (X) of the rotor (2).

[0026] Preferably, the switch further comprises at least one ring (10) made of an insulating material, assembled with rotational capacity inside the cylindrical chamber (3) of the stator (11), for which purpose the casing (7) has seatings (12) in the chamber (3) in which said rings are housed, and such that the inner surface of the rings is flush with the surface of the chamber (3). The diameter of the cylindrical chamber (3) coincides with or is slightly larger than the outer diameter of the rotor (2) to allow its sliding therein in a tight manner. The rotor (2) slides over said rings (10), which in turn are rotational with respect to the casing (7,7') such that the rings (10) act as bearings that facilitate the rotation of the rotor (2). For that purpose, the rings (10) can be made from an insulating material having low friction.

[0027] The insulating rings (10) perimetrically surrounding the rotor (2) furthermore serve to guide the rotor (2) in its helicoidal movement and to electrically insulate the moving contacts (9).

[0028] The stator (11) and the rotor (2) have ventilation windows, specifically the windows (13) of the rotor and the windows (14) of the stator, which are placed such that they are superimposed in the electrically closed position of the switch (as shown in Figure 2d), thus forming a ventilation channel communicating the inside of the rotor (2) with the outside of the stator (11), allowing ventilation of the switch and the exit of gases generated during current cut-off operations.

[0029] 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 case of Figure 1, the rotor has on its outer surface one or more channels (15) with a helicoidal trajectory, cooperating with ribs (16) existing inside the chamber (3) with a similar shape, such that said ribs are inserted in said channels and slide over them. The person skilled in the art will understand that other configurations are possible, such that the stator and the rotor are threaded to one another in a manner similar to a nut and screw, where the rotor would be the rotating screw with respect to the stator.

[0030] Alternatively, the helicoidal rotation of the rotor (2) is performed by means of rotor operating means outside the casing, specifically by means of an external body (29) outside the casing as shown in Figure 5, such that an extension (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. In this embodiment of Figure 5, friction between the rotor (2) and the casing (7) is minimal, because the rotor is mainly supported in the body (29), so there would only be contact between the moving contacts and the casing or fixed contacts (not depicted in that figure). The extension (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 external body (29) is fixed, for example it can be fixed to the actual casing (7) or to another fixed element of the switch.

[0031] The rotor (2) is driven 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 helicoidal 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.

[0032] To enhance the arc extinguishing effect, the switch of the invention can incorporate the electric arc breaking by means of the serial connection of contacts, together with the increase in the length of the arc at each cut-off point. 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 but at a different axial position. One or more plates (19,19') made of a conductive material are assembled in the stator (11) outside the rotor, which respectively incorporate footings (20,20') 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 2b, 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.

[0033] The plates (19,19') are permanently pressed against the fixed contacts (9) by elastic means, in this case by means of formed flat bars (21,21') placed between the plates (19,19') and the fixed terminals (4,4').

[0034] A pair of metal connection terminals (22,22') in the form of a plate serve to electrically connect the switch with an external circuit. Said terminals (22,22') are plate-shaped 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.

[0035] On the other hand, the rotor (2) is open at its ends, i.e., it is a tubular body, and the switch has a rear closure valve (24) assembled in a fixed position in the rear portion of the casing (7,7,), for example by means of a support (26) attached to the casing. The rear valve (24) is configured to be inserted and slid inside the rotor in a tight manner by its rear portion when the rotor moves towards said valve in its end position in the movement to cut off power. In the electrically closed position of the switch, the rear closure valve (24) does not seal the rotor, as seen in Figure 2b, so it allows air to circulate towards the inside thereof.

[0036] Similarly, in the front portion of the rotor (2) the switch has a front closure valve (25) assembled in a fixed position in the front portion of the casing (7,7,), for example by means of a support (27) attached to the casing. The front valve (25) is housed at all times inside the rotor, specifically in its front portion, and is configured to slide inside the rotor in a tight manner, hermetically sealing it. Alternatively, instead of having a valve, in the embodiment of Figures 1 to 4 the rotor (2) can have a closed end and an open end, such as the rotor of Figure 6.

[0037] The front and rear valves (25,24) are cylindrical-shaped and made of an elastic insulating material, for example a rigid or flexible plastic material.

[0038] On the other hand, the rotor (2) has at least one through hole (28) preferably located at the edge of one of the holes (8), such that said through hole communicates the inside of the rotor with the outside, and is intended for allowing suctioning the electric arc towards the inside of the rotor, as will be described below.

[0039] The operation of the switch for closing and cutting off the electric current is illustrated in Figures 2 to 4.

[0040] In the situation of Figure 2, the switch is in the electrically closed position, and as shown in the drawing, the three moving contacts (9) are connected in series by means of the plates (19,19') and their footings (20,20'), and a moving contact (9) is in turn connected with a first fixed contact (4), and another moving contact (9") is connected with a second fixed contact (4'), establishing electrical continuity and therefore allowing current circulation, as indicated by the arrows of Figure 2b.

[0041] In this same situation, the ventilation windows (13,14) of the rotor and stator, respectively, coincide, i.e., they are superimposed as seen in Figure 2d, so the inside of the rotor is communicated with the outside of the stator, allowing the natural ventilation thereof by air circulation, as indicated by the arrows of Figure 2d. Furthermore, as a result of the windows (13,14) coinciding in this position, the moving contacts (9,9',9") inside the rotor can be seen from outside the switch, which provides the additional advantage that the state of the switch can be visually inspected, which can be useful, for example, for an operator performing maintenance tasks.

[0042] To cut off power, the rotor (2) is rotated clockwise as seen in Figure 2a, with which the rotor moves axially and defines a helicoidal trajectory in the direction of arrow "A" of Figure 3b, while at the same time the rear closure valve (24) seals the rear open end of the rotor when reaching a rotation of about 40° before cutting off current circulation. The moving contacts (9,9',9") move in a helicoidal manner in the same direction, sliding over the footings (20,20') until they reach a position in which they are no longer connected with the footings and current circulation is cut off, as seen in Figure 3d.

[0043] The rotor (2) is configured such that in the open position of the switch, the rotor is in direct contact with the contact surfaces of the footings (20,20') and covers most of the surface of that contact surface, as clearly seen in Figure 3d. One of the effects or advantages associated with that feature is that in the same instant that the footings (20,20') and the moving contacts (9,9',9") are no longer connected, the actual insulating material of the rotor (2) comes into direct contact with the footings at the same time it slides over them, so power is cut off by means of the immediate interposition of a solid material or medium, instead of air as conventionally occurs in the state of the art.

[0044] That interposition of a solid medium occurs at the same time in the two pairs of footings (20,20'), i.e., dual insulation, and is performed under pressure due to the pressure of elastic means, in this case springs (23,23') pressing on the contact terminals (6,6'), which are in the form of a flat bar and have certain bending capacity. The electric insulation between the two fixed terminals (4,4') is thereby significantly enhanced, so it is even more difficult for an arc to be generated.

[0045] At the same time the rotor (2) starts to rotate, the ventilation windows of the rotor (13) start to be concealed below the rings (10), which are suitably located for such function, and the rotor itself in turn closes the ventilation windows (14) of the stator. The rotor (2) approaches the rear closure valve (24) sealing the rear opening of the rotor. When the rotor has rotated 45° it is in the position of Figure 3, where the inside of the rotor is completely sealed because the ventilation windows are closed, and the front and rear ends of the rotor are sealed by the valves (24,25).

[0046] In such situation, air can only circulate through the through holes (28), such that the relative movement between the rotor and the front and rear valves (25,24), generates a suction similar to that produced by a plunger in a syringe, which suctions the electric arc towards the inside of the rotor, which in turn entails stretching the arc and cooling the cut-off area due to the suction current.

[0047] To go from the electrical cut-off position to the electrically closed or electrical continuity position, the rotor is rotated counter-clockwise, as seen in Figure 4a, whereby the rotor moves in the direction opposite that indicated by the arrow of Figure 3b, until the rotor again reaches the position of Figure 2.

[0048] Alternatively, in the embodiment of Figures 1 to 4, the rotor (2) can have another shape other than being cylindrical, for example, it can have the shape of the rotor (2) shown in Figure 6 with or without fins (32). Said Figure 6 depicts another preferred embodiment of the invention, in which in addition to the switch function, the moving contacts (9,9',9") and the footings are relatively placed with respect to one another and are configured in such a manner that as the rotor moves with its helicoidal movement about the axis (X), i.e., by means of a combination of simultaneous linear and angular movements, the connection of the moving contacts by means of the footings is switched from a series connection to a parallel connection and vice versa in the reverse operation.

[0049] Therefore, in the transition instants in which the electric arc can occur, i.e., transition from conduction to power cut off (going from On to Off) (Figures 8c, 8d, 8e) and vice versa, the footings connect the moving contacts in series for the purpose of having several cut-off points in series and thereby splitting the arc and making it easier to put out.

[0050] In a subsequent instant when the possible electric arc has already disappeared, i.e., when the normal state of electrical conduction is reached (Figures 8f, 8g, 8h), as the rotor moves forward, the footings connect the moving contacts in parallel for the purpose of splitting the current circulation between the existing moving contacts and thereby reducing the temperature of each of them.

[0051] The switch of Figure 6 comprises likewise a stator (11) including a casing made of an insulating material formed by two halves (7,7') coupled to one another, inside which there is a chamber (3) in which a rotor (2) made of an insulating material is housed. In this embodiment there are no insulating rings (10) as in the case of Figure 1, instead the rotor (2) forms a cylindrical sector (43) with which it is supported and slides over a complementary surface (45) formed internally in the stator (11).

[0052] The rotor (2) is likewise hollow and movable with a helicoidal movement 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 said threaded coupling, in the embodiment of Figures 6 and 7, consists of a pair of metal balls (39,39') placed at diametrically opposed points of the rotor (2), particularly of a cylindrical sector (43) formed in said rotor (2), such that the rotor forms a type of bearing.

[0053] In a complementary manner, the stator (11) has on the inner surface of the chamber (3) a pair of channels (44,44') having a helicoidal trajectory cooperating with the balls (39,39') such that each ball slides along a channel to produce the movement of the rotor (2) with that trajectory with respect to its axis of revolution (X).

[0054] Alternatively, the rotor (2) can be assembled in an external body outside the stator (11) and be threaded in that external body as in the embodiment of Figure 5.

[0055] The stator (11) and the rotor (2) have ventilation windows, specifically the windows (40) of the rotor (2) and the windows (14,14') of the stator (11), for ventilating the inside of the switch, to which the ventilation fins (32) of the rotor (2) contribute in this embodiment by stirring the air inside the chamber (3), and expelling it out through the ventilation windows (14,14') of the stator (11) for the purpose of improving the reduction of the switch temperature.

[0056] The configuration and arrangement of the fixed and moving contacts of this embodiment is best seen in Figures 7 and 8. The rotor (2) is hollow and has three groups of moving contacts (9,9',9"), each group formed by two or more metal plates (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) slightly project through holes (8) of the rotor (2) located at diametrically opposed points thereof. The ends of the plates (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 7, but at a different axial level with respect to the axis (X).

[0057] On the other hand, in this embodiment, the switch incorporates as fixed contacts an upper pair of conductor footings (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 conductor footings (19',42') assembled in a lower fixed position of the stator (11). Both the upper pair of conductor footings (19,42) and the lower pair of conductor footings (19',42') are aligned according to the longitudinal span of the rotor (2) and are adjacent to one another. To assure electric insulation between those conductor footings, 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 footings (19,42), and a second insulating plate (41') between the two lower conductor footings (19',42').

[0058] The conductor footings (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').

[0059] The switch incorporates a pair of fixed contacts, specifically an upper fixed contact (4) in electrical contact with only the conductor footing (42) and a lower fixed contact (4') in electrical contact with only the conductor footing (19') as seen more clearly in Figure 8.

[0060] As seen in Figure 6, a pair of metal connection terminals (22,22') in the form of a plate serve for the electrical connection of the switch with an external circuit. Said terminals (22,22') are plate-shaped and are arranged in opposite portions of the casing (7,7') and are electrically connected with the fixed contacts (4,4').

[0061] As best seen in Figure 7, the rotor (2) does not have to be completely cylindrical because in this case the rotor (2) is a cylinder cut by two planes parallel to one another, defining 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).

[0062] The ventilation fins (32,32') are arranged in said planar surfaces (33,33') and extend along the rotor according to a line parallel to the axis (x), and they 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 enhance that insulation effect, the rotor (2) further incorporates respective channels (35,36') extending along same.

[0063] The moving contacts (9) project in both curved surfaces (34,34') and have ends with the same curvature.

[0064] It can also be seen in this embodiment of Figure 7 that the rotor (2) has a closed front end (37), and an open rear end (38) which is coupleable to a suction valve (24) which causes the suction of the arc when the rotor (2) is decoupled with its movement from the valve in a manner similar to that described in relation to Figure 1. The suction valve (24) is cylindrical-shaped and made from an elastic insulating material, and it is configured to be coupled in a tight manner inside the rotor (2).

[0065] To produce said suction of the arc, the rotor (2) has at least one through hole or hole (40) which communicates the inside of the rotor with the outside.

[0066] Alternatively, the rotor (2) of the embodiment of Figures 6 to 8 can be cylindrical, with one or two open ends. Alternatively, the rotor (2) of the embodiment of Figures 6 to 8 can be operated by means of an external mechanism outside the casing (7,7'), such as that shown in Figure 5, for example, or by means of an operating mechanism such as the one of the embodiment of Figure 1.

[0067] 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 reference to the sequence of figures of Figure 8.

[0068] 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 8a, 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 8b, the ends of the moving contacts have approached the pairs of upper and lower conductor footings (19,42,19',42'), but there still is no electrical connection.

[0069] In a subsequent instant when the moving contacts (9,9',9") have rotated 30°, Figures 8c and 8d, the ends of the moving contacts (9,9',9") come into contact, respectively, with the upper and lower footings (19,42,19',42') electrical conduction being started as indicated by the arrows of Figure 8c, and such that the three groups of moving contacts (9,9',9") are connected in series by means of the plates (19,42,19',42') so the electric current would circulate as indicated by the arrows in the drawing. 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.

[0070] Specifically, a first end of the first group of moving contacts (9) is in contact with the footing (19'), and a second end of that same contact is in contact with the footing (19). A first end of the second group of moving contacts (9') is in contact with the footing (42'), and a second end of that same contact is in contact with the footing (19). A first end of the third group of moving contacts (9") is in contact with the footing (42'), and a second end of the same contact is in contact with the footing (42).

[0071] The rotor (2) continues to rotate in the same direction, so the moving contacts (9,9',9") move forward sliding respectively over the footings (19,42,19',42'), reaching a rotation position of 45° (Figure 8e), 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 footing (42).

[0072] When the moving contacts reach the rotation position of 60° (Figure 8f), the upper end of the second group of moving contacts (9') comes into contact with the footing (42) and remains in contact with the footing (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 8g and 8h, 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.

[0073] 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 footings (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").

[0074] In the series-parallel transition, the first group of moving contacts (9) is always connected between the footings (19,19'), and the third group of contacts (9") is always connected between the footings (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 footings (19,42') to being connected between the footings (19,42) and the footing (42').

[0075] Therefore, the switch of the present invention with a simple structure, is capable of reconfiguring the connection of the same internal contacts in two different modes of operation in order to perform their most critical job, which is to cut off or open the electric current with the occurrence of an electric arc, and to connect them in a more optimal manner, i.e., in parallel when the current cut-off function has ended to reduce heating of the switch and energy losses.

[0076] 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 or other similar insulating materials, obtaining the same advantages discussed above with respect to glass.

[0077] 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,
- current cut-off with the instantaneous interposition (in the very moment of the cut-off) of a solid insulating material,
- 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.

[0078] 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.

[0079] 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.

[0080] 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.

[0081] The various embodiments and alternatives described herein can be combined with one another, giving rise to other embodiments, such as those obtained with the multiple combinations of the attached claims, for example.

Claims

1. Helicoidal switch comprising:

> at least one pair of fixed contacts and a 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 current circulation is prevented, **characterized in that** it further comprises a rotor made of an insulating material, and
> where said at least one moving contact is assembled with the rotor,
> where the rotor is movable defining a helicoidal movement about an axis of rotation between a closed position and an electrical cut-off position of the switch.

2. Helicoidal switch according to claim 1, where the rotor is elongated with respect to its axis of rotation, and the at least one moving contact is configured such that it has two ends accessible through different points on the outer surface of the rotor.

3. Helicoidal switch according to claim 1 or 2, wherein at least one pair of fixed contacts has a contact surface arranged for being contacted by a moving contact, and where the rotor is configured such that in the open position of the switch, the rotor is in direct contact with the fixed contacts and covers most of the contact surface of the fixed contacts.

4. Helicoidal switch according to any of the preceding claims, further comprising a stator including a casing made of an insulating material, where said fixed contacts are assembled in said stator, and where the rotor is housed inside the stator, and where the stator and the rotor are configured forming a complementary threaded coupling therebetween to cause the helicoidal movement of the rotor, reciprocally between the closed and open positions of the switch.

5. Helicoidal switch according to any of the preceding claims, where the stator has a cylindrical chamber in which the rotor is housed, where the rotor is at least partially hollow, and where the stator and the rotor have ventilation windows placed such that they are superimposed in the electrically closed position of the switch, defining a ventilation channel communicating the inside of the rotor with the outside of the stator.

6. Helicoidal switch according to any of the preceding claims, where the rotor has at least two holes located at diametrically opposed points of its outer surface, and where the moving contact is one or more superimposed metal plates housed in the rotor such that the two ends of the moving contact project from said holes of the rotor and are arranged for contacting with the corresponding fixed contacts in the closed position of the switch.

7. Helicoidal switch according to any of the preceding claims, further comprising at least one ring made of an insulating material, assembled integrally in the cylindrical chamber of the stator, such that the rotor slides over said rings, and in that the moving contacts are arranged such that in the electrical cut-off position, their free ends are facing an insulating ring.

8. Helicoidal switch according to any of the preceding claims, further comprising two or more moving contacts assembled in the rotor, and one or more footings made of a conductive material outside the rotor, the footings being arranged such that in the electrically closed position of the switch they connect the moving contacts between the fixed contacts in series.

9. Helicoidal switch according to any of the preceding claims, where the rotor has a through hole 22 communicating the inside of the rotor with the outside, and in that it has suction means arranged for producing suction inside the rotor for the purpose of suctioning the electric arc towards the inside of the rotor with the movement thereof.

10. Helicoidal switch according to claim 9, where said suction means comprise at least one closure valve arranged such that it is facing an open end of the rotor, where said valve is suitable for sliding inside the rotor for producing suction.

11. Helicoidal switch according to any of the preceding claims, where the rotor is made of porcelain or glass.

12. Helicoidal switch according to any of the preceding claims, further comprising:

at least two moving contacts assembled in the rotor, where each moving contact is configured such that it has two ends accessible through different points on the outer surface of the rotor, and where the moving contacts are placed in the rotor at a different axial level with respect to the axis of the rotor,

a first pair of conductor footings arranged adjacent to one another and aligned according to the longitudinal span of the rotor, and arranged for being contacted by a first end of the moving contacts, and where one of these footings is connected with a first fixed contact of the switch,

a second pair of conductor footings arranged adjacent to one another and aligned according to the longitudinal span of the rotor, and arranged for being contacted by a second end of the moving contacts, and where one of these footings is connected with a second fixed contact of the switch,

where the moving contacts and the footings are relatively placed with respect to one another such that as the rotor moves axially, in a first axial position of the rotor, the moving contacts are connected to one another in series through the footings, and in a second axial position of the rotor, the moving contacts of the rotor are connected to one another in parallel through the footings.

13. Helicoidal switch according to any of the preceding claims, where the rotor is configured such that it has two planar surfaces parallel to one another arranged on diametrically opposed sides of the rotor with respect to its axis, and in that it incorporates a cylindrical sector whereby it is supported and slides with respect to the stator.

14. Helicoidal switch according to claim 13, where the rotor incorporates ventilation fins projecting from said planar surfaces.

15. Helicoidal switch according to any of the preceding claims 1 to 3 and/or 5 to 14, incorporating external body outside the casing, and in that the rotor has a portion housed inside that external body and rotates about it by means of a threaded coupling formed in a complementary manner in both elements to produce the helicoidal movement of the rotor.

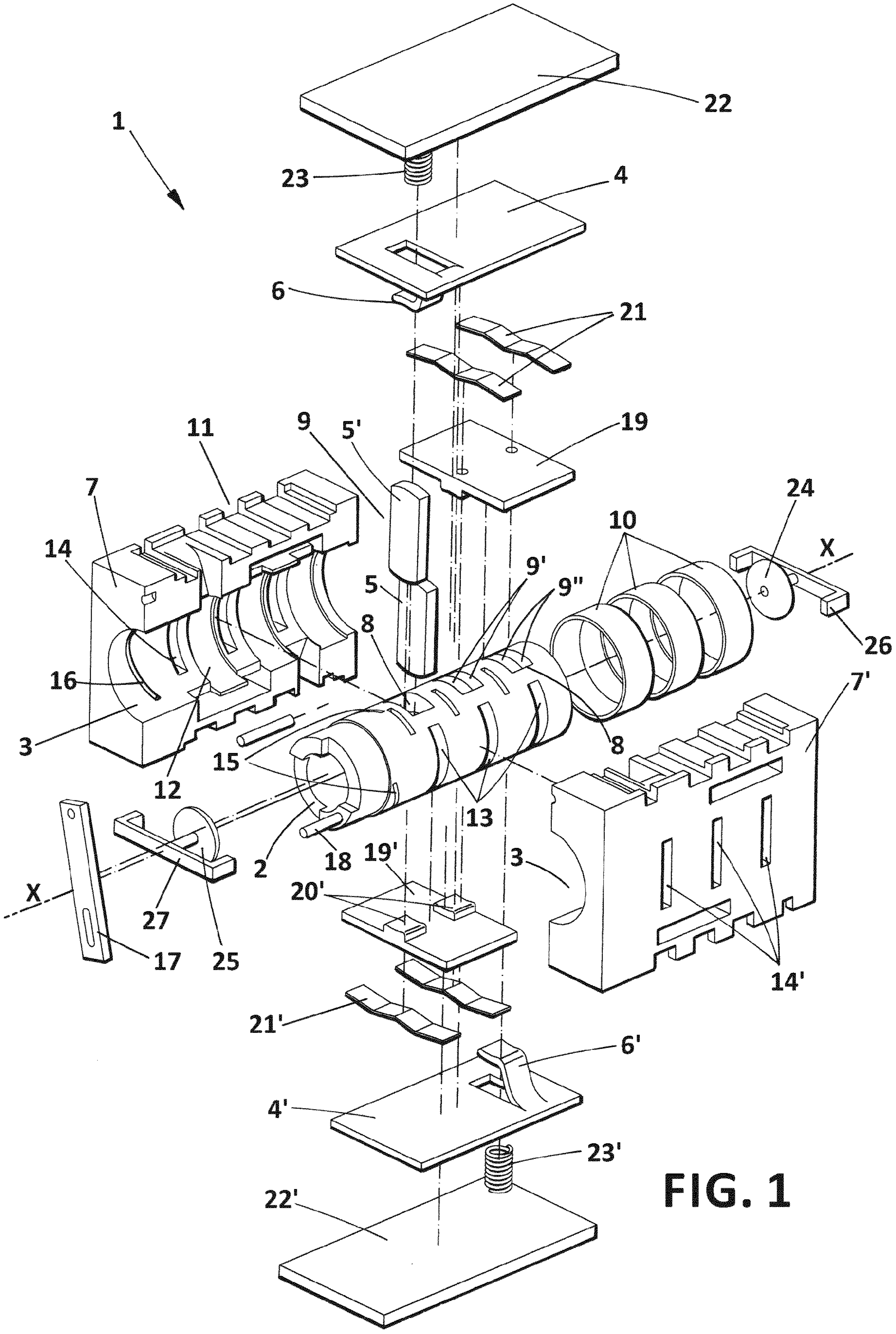
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FIG. 1

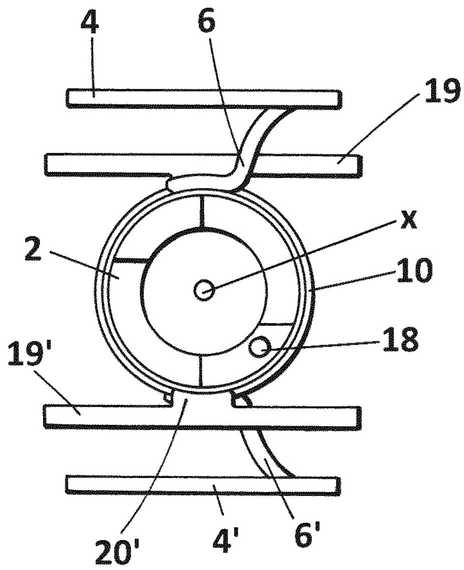

FIG. 2a

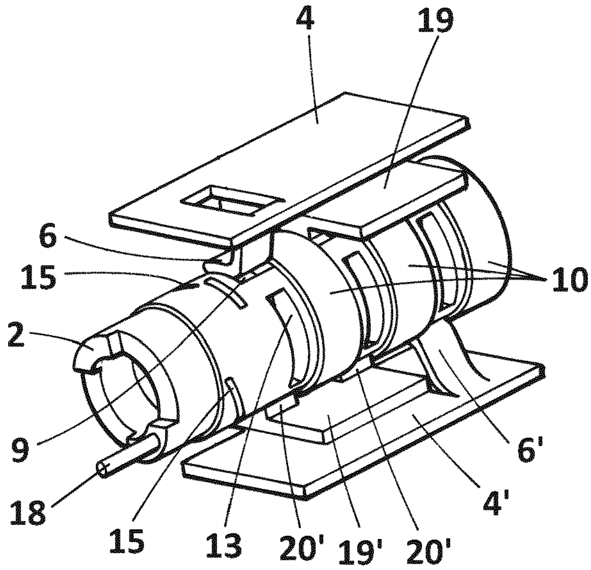

FIG. 2c

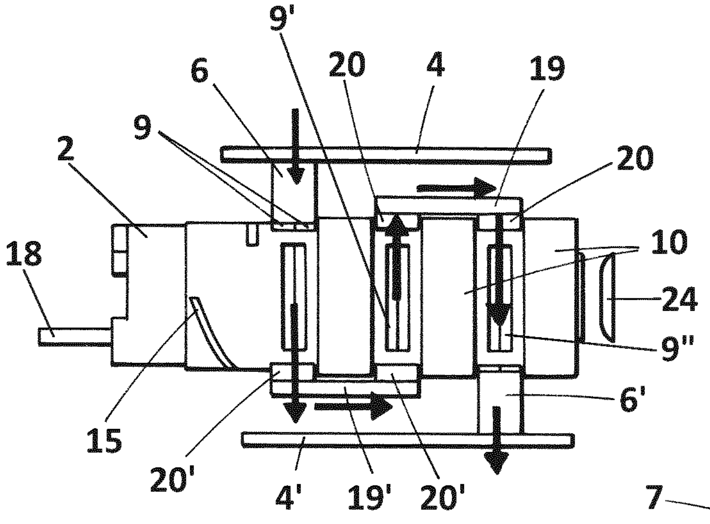

FIG. 2b

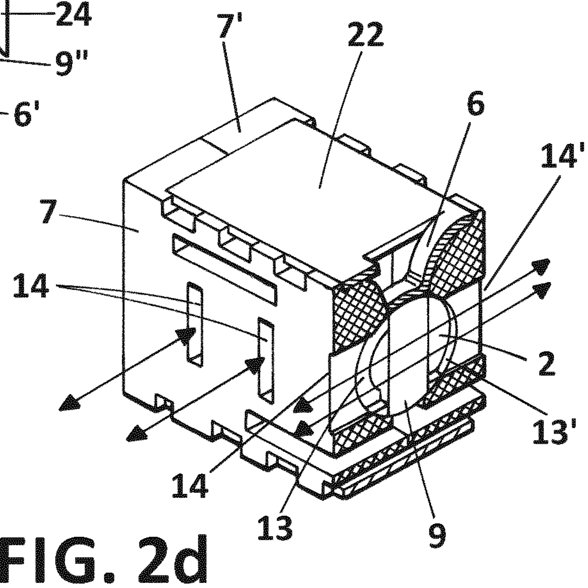

FIG. 2d

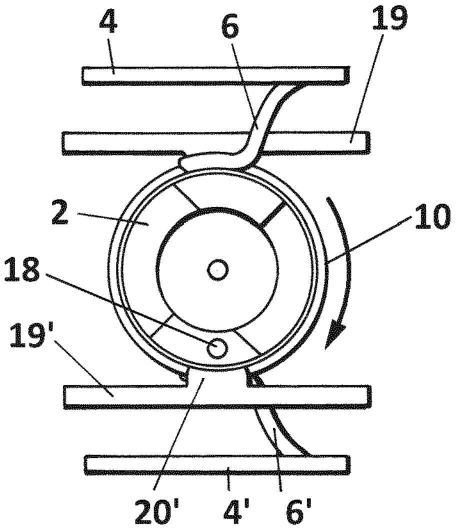

FIG. 3a

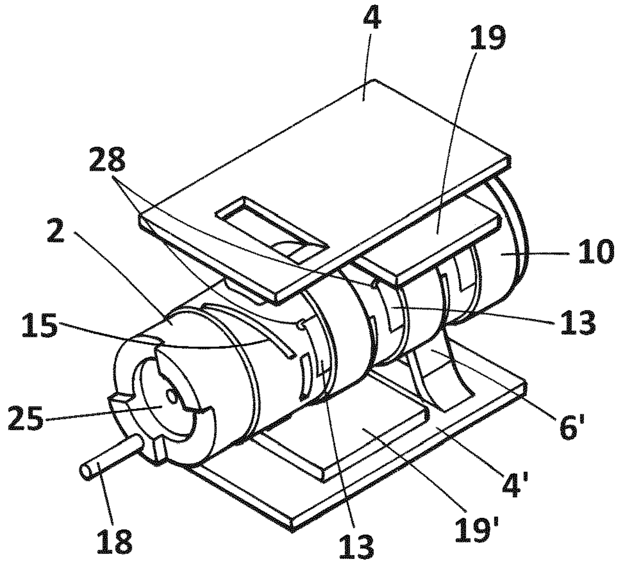

FIG. 3c

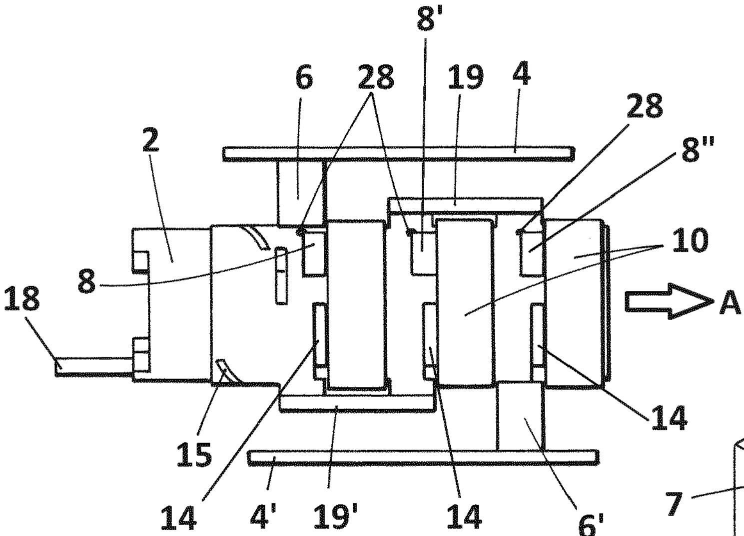

FIG. 3b

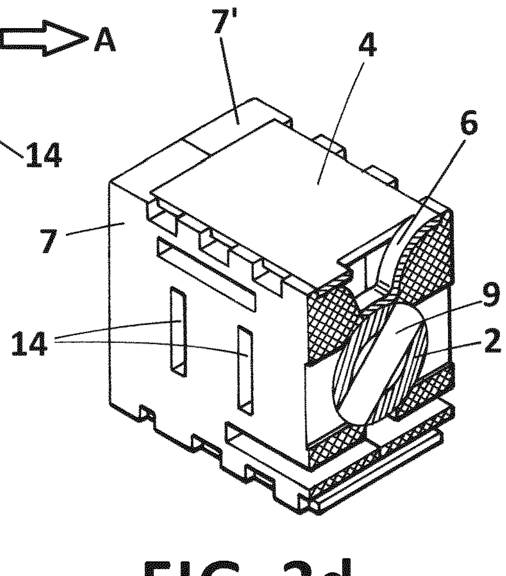

FIG. 3d

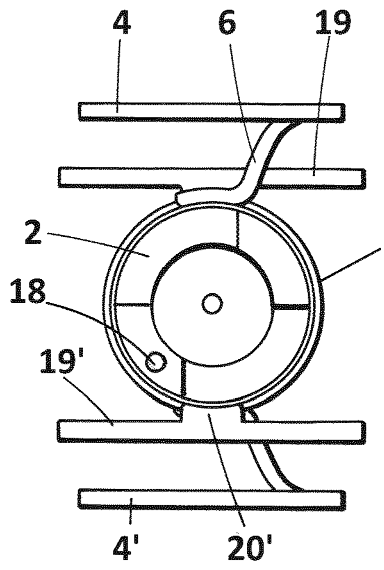

FIG. 4a

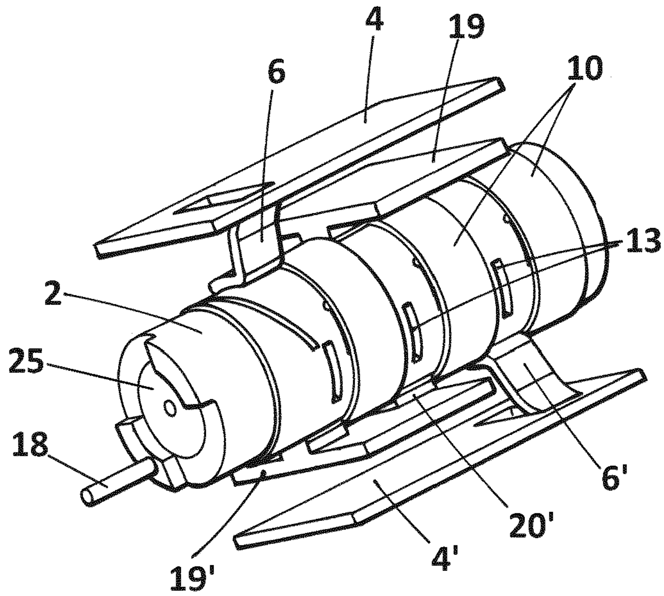

FIG. 4c

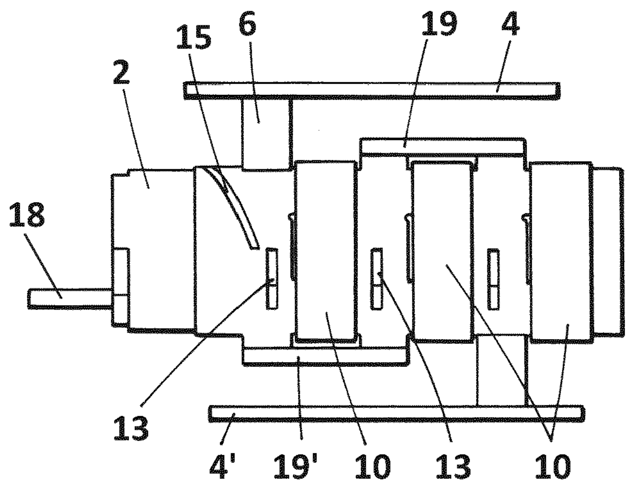

FIG. 4b

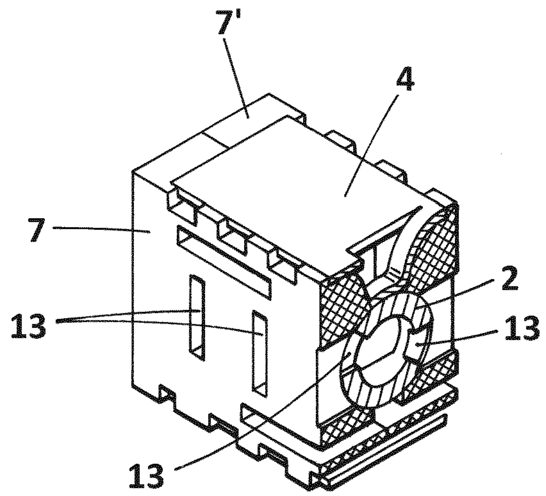

FIG. 4d

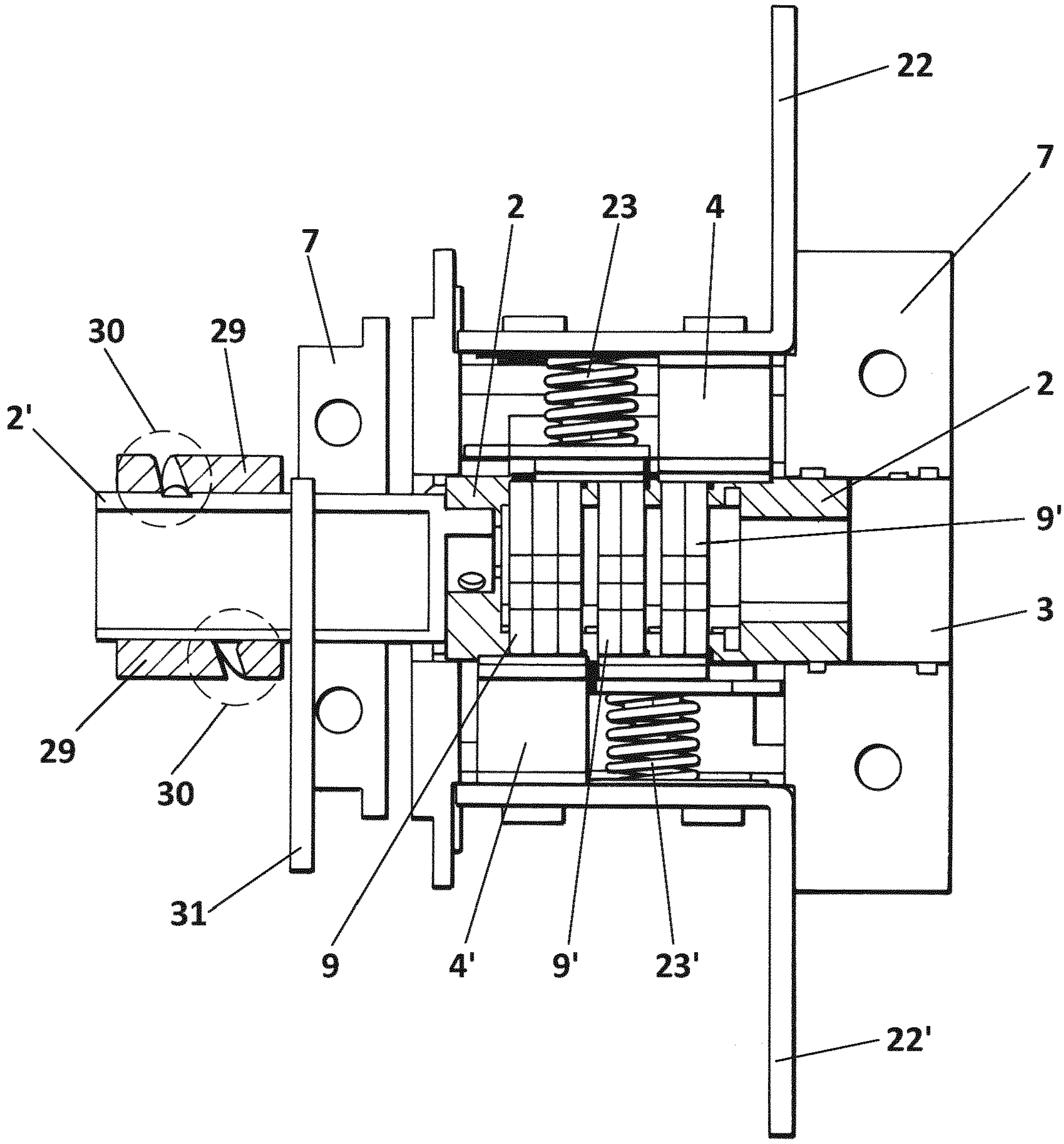

FIG. 5

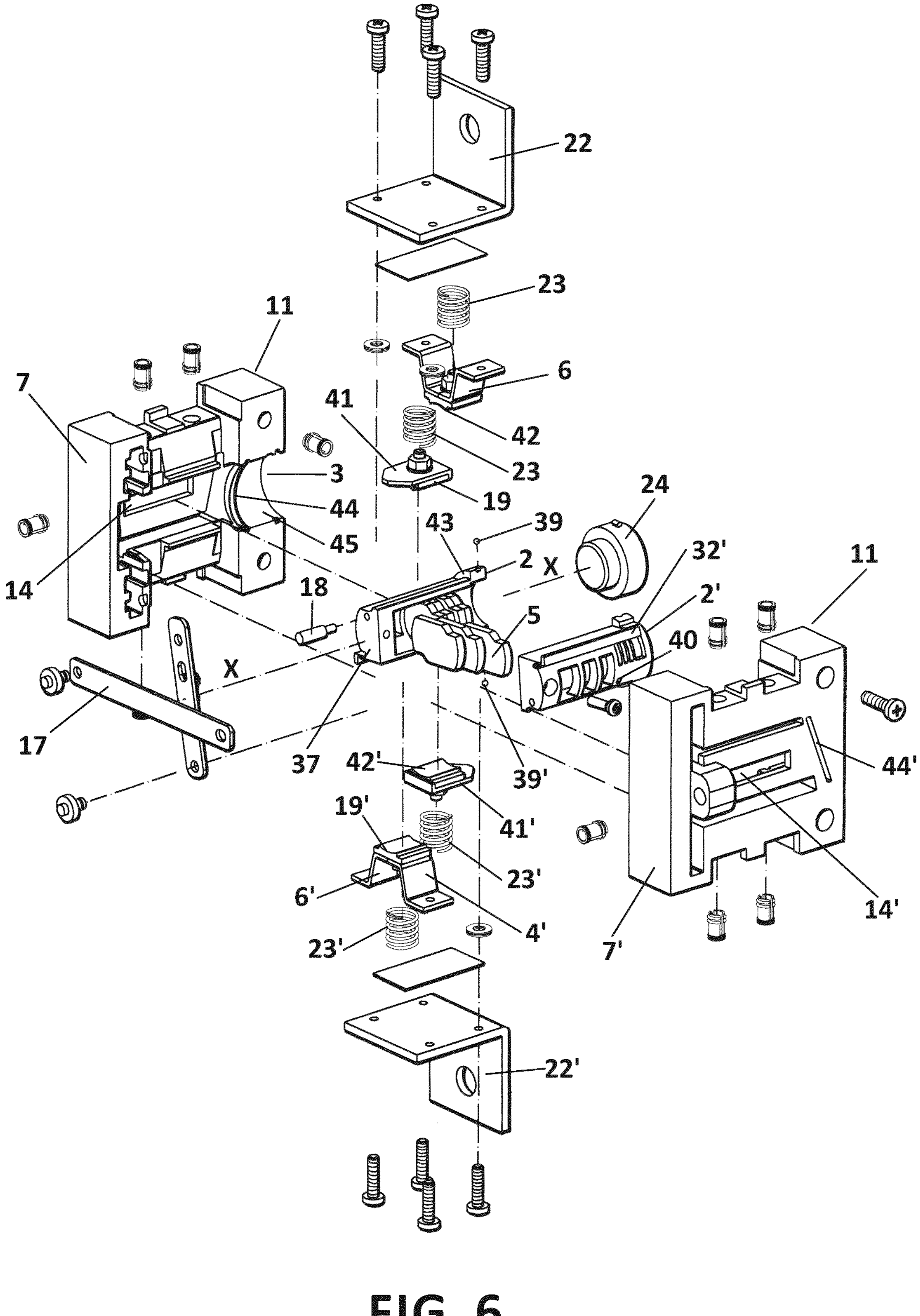
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FIG. 6

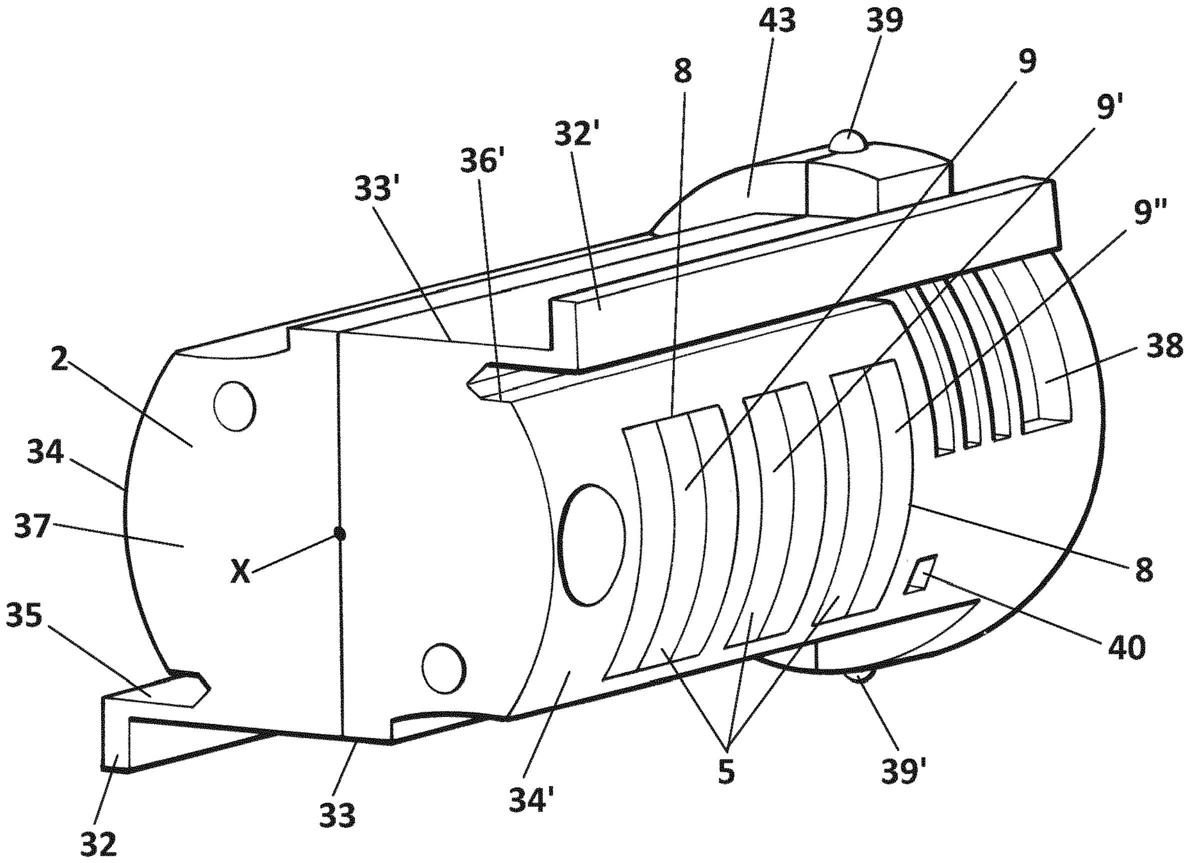

FIG. 7a

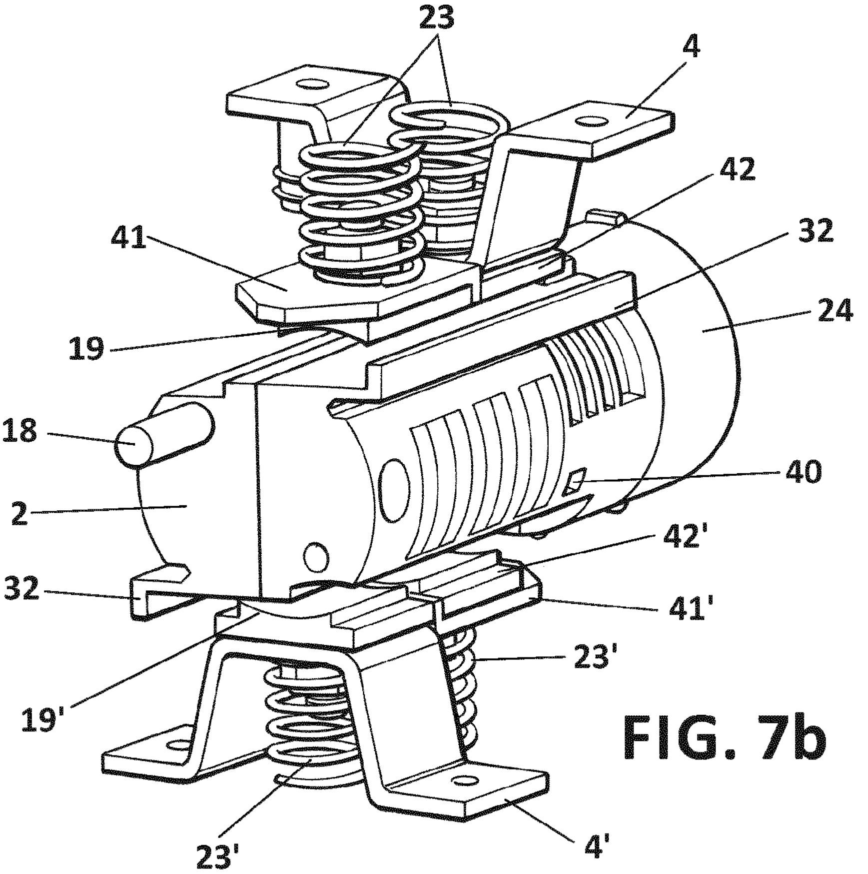
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FIG. 7b

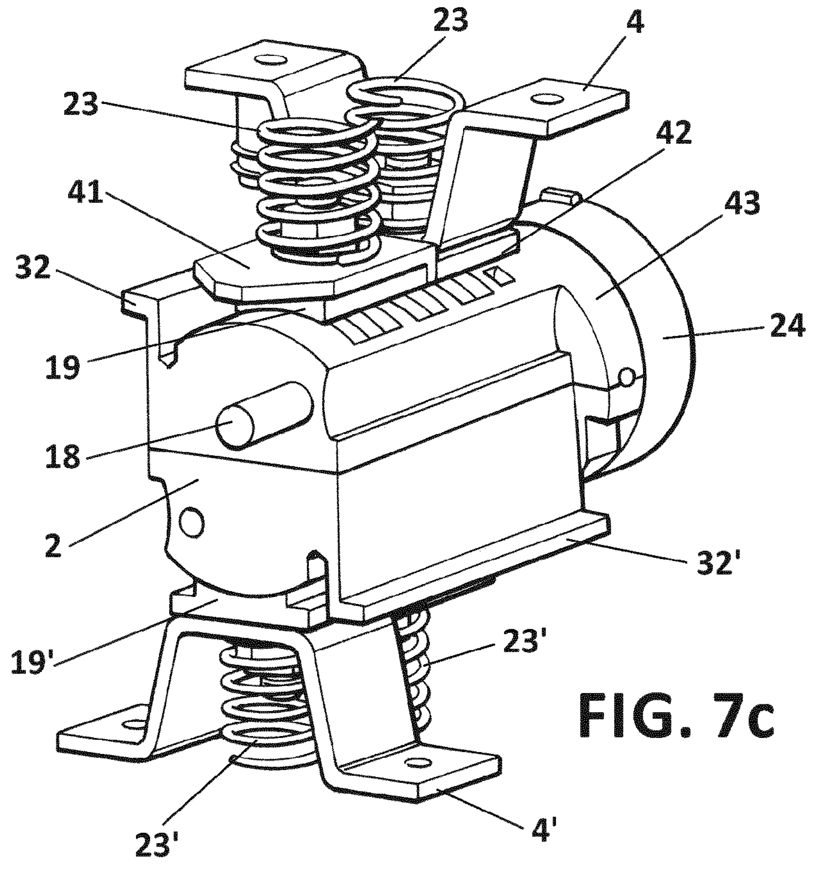
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FIG. 7c

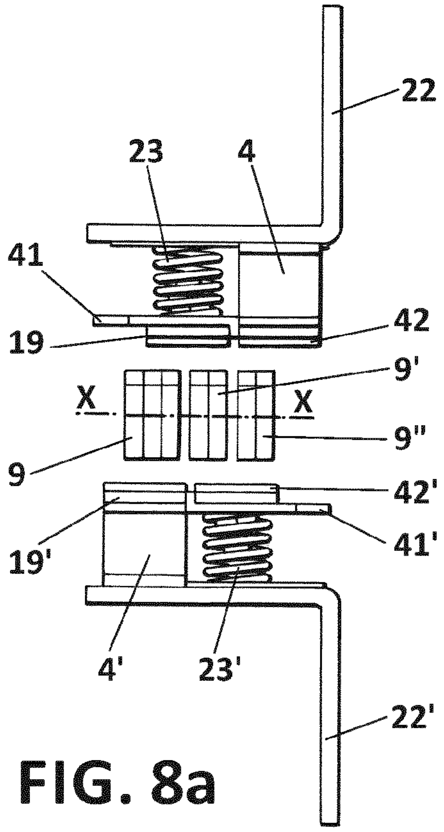

FIG. 8a

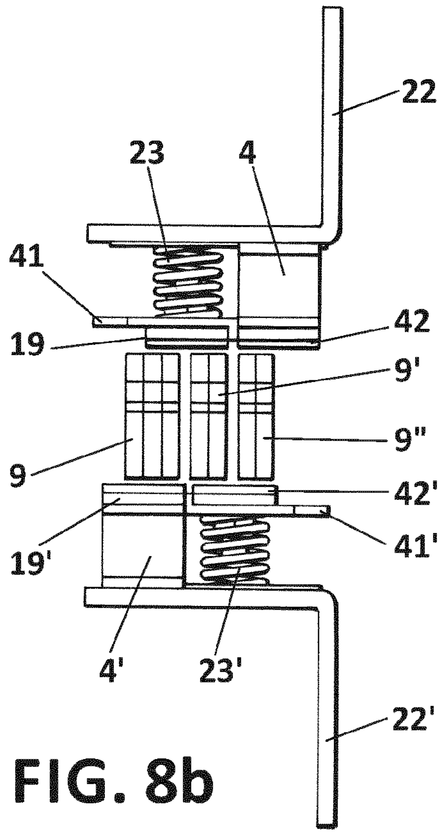

FIG. 8b

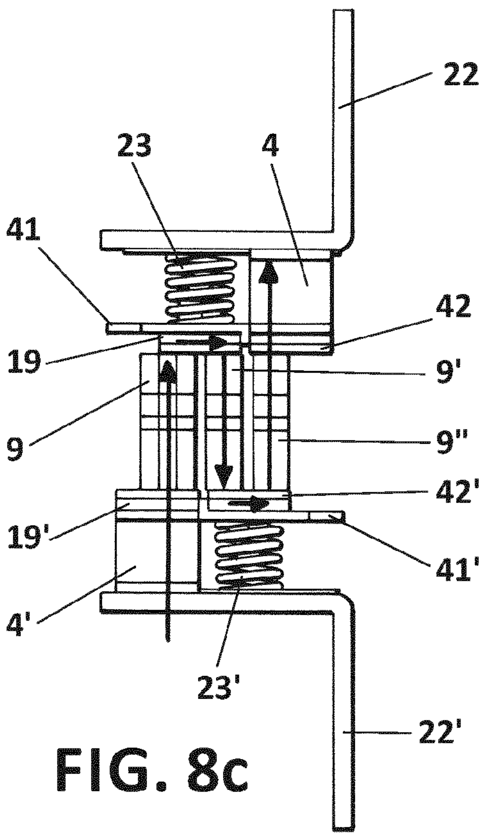

FIG. 8c

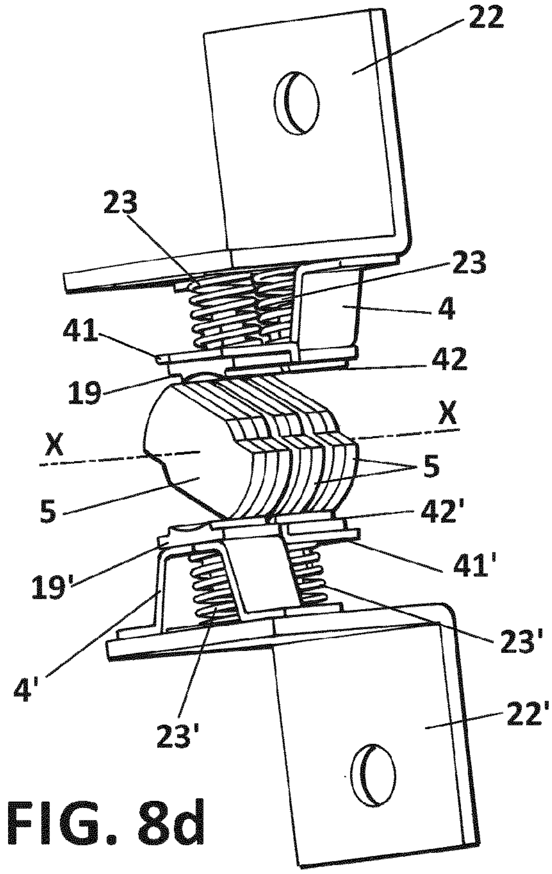

FIG. 8d

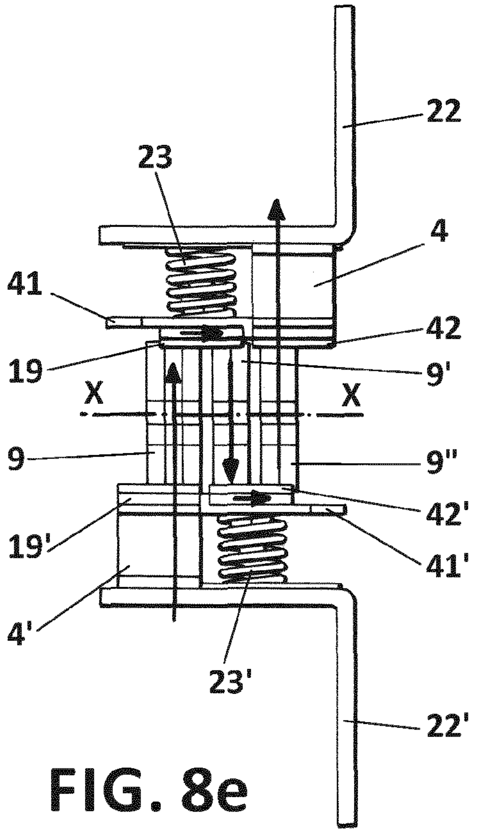

FIG. 8e

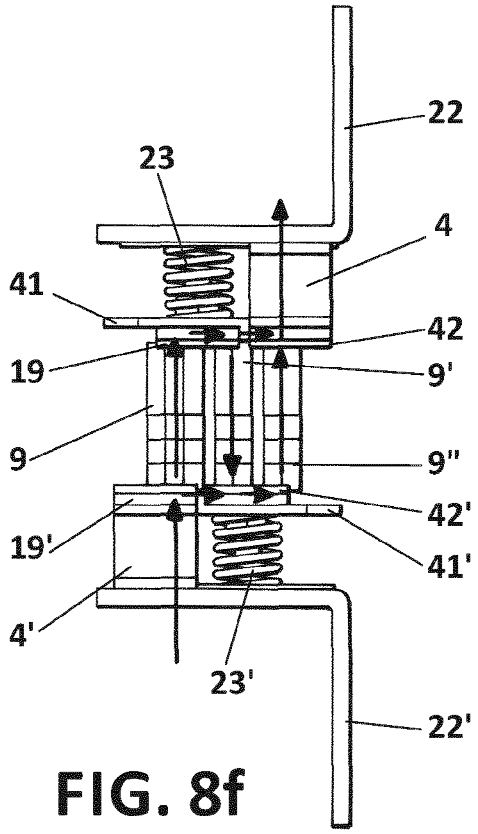

FIG. 8f

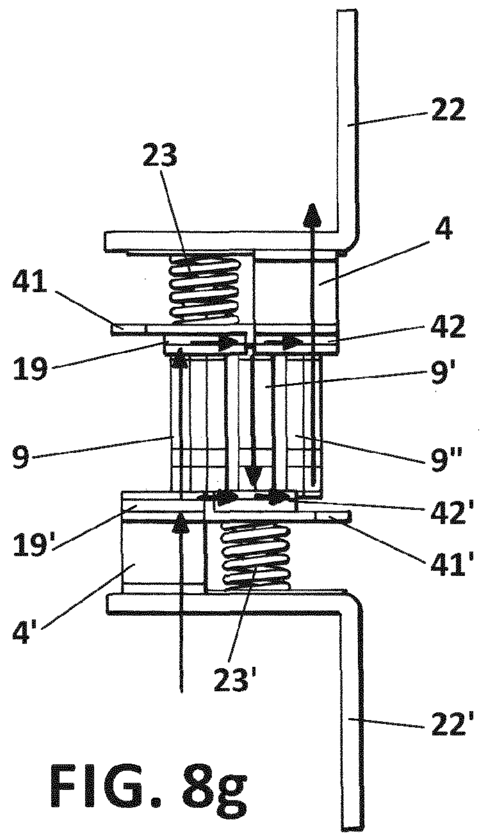

FIG. 8g

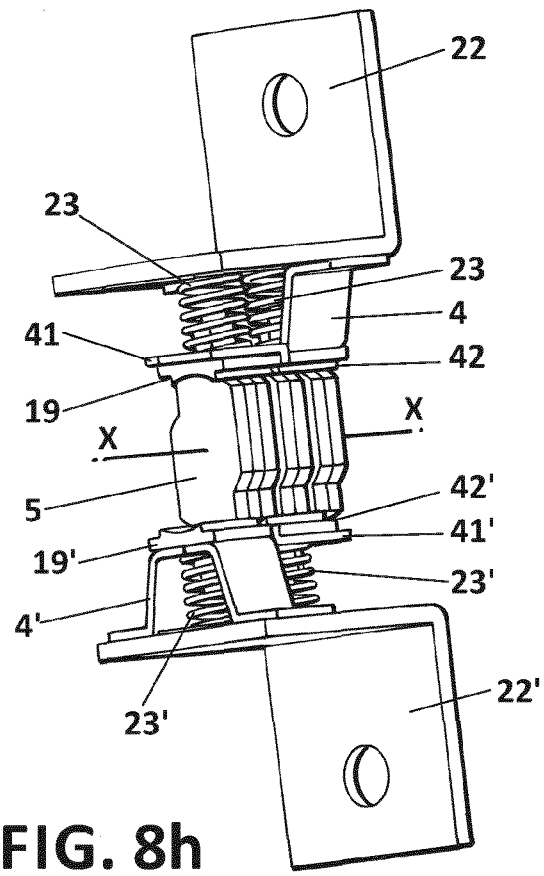

FIG. 8h

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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 9858

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 4 841 833 A (SCHERBARTH DAVID W [US] ET AL) 27 June 1989 (1989-06-27) * column 4, line 7 - column 5, line 53; figures 2,3,7 *	1-4,6, 11,15 5,7-10, 12-14	INV. H01H19/56 H01H1/36 H01H33/00 H01H9/32 ADD. H01H9/52
X Y	US 3 330 928 A (WENDELL SEABLOM) 11 July 1967 (1967-07-11) * column 7, line 15 - line 48; figures 16,18 *	1,3,4,7, 13,15 5,8-10, 12,14	
Y	US 4 426 562 A (KEMENY GEORGE A [US]) 17 January 1984 (1984-01-17) * column 5, line 47 - column 11, line 25; claim 24; figures 2-4 *	5,7,8, 12-14	
Y	EP 1 267 373 A1 (YAZAKI CORP [JP]) 18 December 2002 (2002-12-18) * column 7, line 1 - column 9, line 24; figures 7,11 *	5,13	
Y	EP 0 741 399 A1 (ANSALDO IND S P A [IT]) 6 November 1996 (1996-11-06) * column 5, line 39 - column 8, line 9; figures 1,2 *	9,10	TECHNICAL FIELDS SEARCHED (IPC) H01H

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	16 May 2017	Pavlov, Valeri

CATEGORY OF CITED DOCUMENTS

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16-05-2017

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4841833	A	27-06-1989	NONE			
US 3330928	A	11-07-1967	NONE			
US 4426562	A	17-01-1984	NONE			
EP 1267373	A1	18-12-2002	DE	60208972	T2	03-08-2006
			EP	1267373	A1	18-12-2002
			US	2002187659	A1	12-12-2002
EP 0741399	A1	06-11-1996	AT	176082	T	15-02-1999
			BR	9602157	A	30-12-1997
			DE	69507453	D1	04-03-1999
			DE	69507453	T2	02-09-1999
			EP	0741399	A1	06-11-1996
			HU	9601142	A2	28-05-1997
			US	5723840	A	03-03-1998

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