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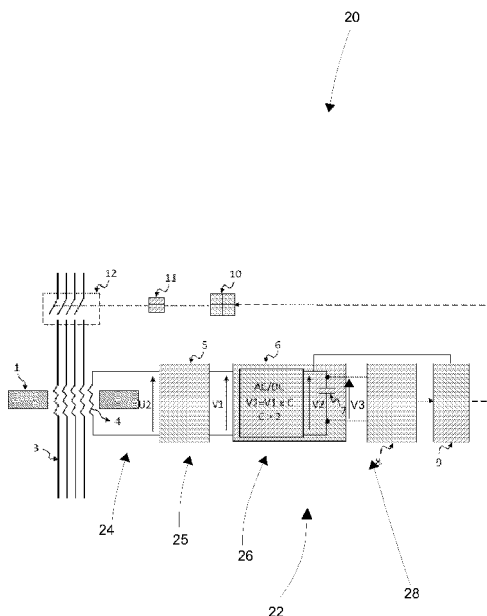


Fig. 1

(57) Abstract : The invention relates to a differential protection device (20) comprising a differential defect detector (22) provided with a voltage multiplication device (6) with a multiplication factor of more than two. The invention also relates to a differential circuit breaker comprising such a differential protection device (20) and at least one disconnection device. Furthermore, the invention relates to a method for controlling a disconnection device by means of a differential protection device (20).

(57) Abrégé : La présente invention a pour objet un dispositif (20) de protection différentielle comprenant un détecteur de défaut différentiel (22) doté d'un dispositif de multiplication de tension (6) d'ordre supérieur à deux. L'invention a également pour objet un disjoncteur différentiel comprenant un tel dispositif (20) de protection différentiel et au moins un dispositif de coupure. Finalement, l'invention a pour objet un procédé de commande d'un dispositif de coupure à l'aide d'un dispositif de protection différentielle (20).

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DIFFERENTIAL PROTECTION DEVICE

5 The invention relates to a differential protection device, a differential circuit breaker comprising such a differential protection device, a differential switch comprising such a differential protection device and a method for controlling at least one electrical appliance, preferably at least one switching device, by means of a differential protection device.

10 By definition, this differential circuit breaker comprises, on the one hand, a number of switching devices and, on the other hand, a differential protection device. It may, for example, be a bipolar differential circuit breaker, the differential circuit breaker then comprising a differential protection device and two cut-off devices, or a four-pole
15 differential circuit breaker, the differential circuit breaker then comprising four cut-off devices and one differential protective device.

In a differential circuit breaker of this type, the breaking devices may be magneto-
20 thermic type circuit breakers, which, for example, comprise a thermal actuator and a magnetic actuator capable of initiating the opening of contacts as a function of two different types of faults (respectively overload on the line to be protected or short circuit on the line to be protected).

25 In a differential switch, the switching devices are switches which may be capable of allowing the contacts to be opened or closed manually by means of a control handle of the switching device and automatic opening of the contacts by means of a differential switching module for example.

30 Each of the switching devices is associated with an input terminal and an output terminal, with switching contacts between them, at least one of which is movable under the control of a mechanism commonly known as a lock.

35 When the corresponding pole protects a phase conductor, this mechanism is itself under the control of at least one triggering member, such as, for example, a magnetic triggering device and / or a thermal triggering device, capable of causing if necessary to open the contacts of the switch.

40 When the pole protects a neutral conductor, which may be the case, for example, when the differential circuit-breaker is a four-pole differential circuit-breaker, such a neutral is associated with three phases, but no triggering element is normally provided, the corresponding mechanism is then simply under the control of the mechanism of any of the other phases.

45 Indeed, whether it is a matter of protecting a phase or neutral conductor, the mechanisms of the various switching devices are usually coupled together, so that any opening command of any of them causes a command of the same type for all of them.

5 As a corollary, the differential protection device is equipped with a fault detector able to detect the presence of a differential current between the electric lines to be protected or between an electric line to be protected and ground, this defect is commonly called differential fault. The differential protection device is also equipped with a mechanism commonly known as a differential lock capable of triggering the mechanism of at least one of the cut-off devices.

10 The present invention relates more particularly to the case in which the multipolar differential protection device or modular differential interrupter concerned constitutes the so-called modular apparatus. As is known, the casing of such a modular apparatus has two main faces parallel to one another. The width of the modular apparatus is equal to the distance separating the main faces from one another. The width of the modular apparatus is then a multiple of a given basic module common to all modular apparatus of the same type.

15 These modular apparatuses are thus advantageously capable of being placed side by side on the same support rail.

20 They are then attached to the latter by a fastening face which belongs to the edge of their casing.

25 In multi-pole differential circuit breakers in such a modular design, the switching devices are usually arranged parallel to one another and they all have the same width equal to the basic module.

30 As a corollary, the differential protection device also extends generally to this day parallel to the switching devices, being in practice attached thereto at one or the other of the ends of the alignment it forms and its width, equal to three times the base module. As a result, to date, the overall width of a four-pole differential circuit breaker, for example, is traditionally equal to seven times the base module.

In the publication of patent application FR 2 777 110, an embodiment has been proposed in which this overall width has been reduced to four times the base module.

35 According to this embodiment, for a four-pole differential circuit-breaker, the differential protection device is brought back to a width equal to four thirds of module, which, for a differential circuit breaker having a width equal to four modules, leaves a width of two thirds of the module width for each tripping device.

40 These differential circuit breakers have the disadvantage that the short-circuit performance, in particular of the switching devices, is relatively low. These differential circuit breakers also have the disadvantage that heating of the switching devices is difficult to contain.

45 It is therefore desirable to provide a differential protection device for a differential circuit breaker which can advantageously avoid these disadvantages while leading to a comparable compactness of the differential circuit breaker.

It is an object of the invention to substantially overcome or at least ameliorate one or more of the aforementioned disadvantages of the prior art, to meet one or more of the above desires, or to provide a useful alternative.

5 One aspect of the present disclosure provides a differential protection device including a differential fault detector comprising a first electrical circuit and a second electrical circuit, the first electrical circuit including a coil,

said differential fault detector further including a toroid which can be traversed with at least one repeat by at least one conductor, the coil being wound around the toroid and connected to the first electrical circuit for applying a first voltage to the first electrical circuit when a magnetic flux is induced in the toroid, wherein

10 said differential fault detector includes at least one voltage multiplication device connected to the second electrical circuit and capable of applying a second voltage to the second electrical circuit as a function of the first voltage,

15 said multiplication device includes at least one electrical energy storage device;

the multiplication device is capable of applying the second voltage to the second circuit such that the second voltage is greater than the first voltage by a multiplicative factor greater than 2.

20 In one embodiment, a differential protection device comprises a differential fault detector comprising a first electrical circuit and a second electrical circuit, the first electrical circuit comprising a coil,

25 said differential fault detector further comprising a toroid which can be traversed at least once, by at least one conductor,

the coil being wound around the toroid and connected to the first electrical circuit for applying a first voltage to the first electrical circuit when a magnetic flux is induced in the toroid,

30 said differential fault detector comprising at least one voltage multiplying device connected to the second electrical circuit and capable of applying a second voltage to the second electrical circuit as a function of the first voltage,

said multiplication device comprising at least one device for accumulating electrical energy,

35 wherein the multiplication device is able to apply the second voltage to the second circuit so that the second voltage is greater than the first voltage by a multiplicative factor greater than 2.

40 Thus, the differential fault detector may be provided with a toroid of reduced size with respect to the toroids known in the prior art, so that the dimensions of the differential protection device can be reduced further, while keeping a tripping time in the event of a differential fault of less than 300 ms (time specified by the standards on differential products).

45 The multiplication device is preferably capable of applying the second voltage to the second circuit in such a way that the second voltage is greater than the first voltage by an ideal multiplicative factor greater than 2.

Generally speaking, the coefficients for the multiplication devices, often called voltage multipliers, are given for perfect, ideal, loss-free voltage multipliers. In fact, voltage doublers often have a real coefficient substantially equal to 1.4 and not 2.

Preferably, the voltage multiplier of the differential protection device is capable of applying a second voltage greater than the first voltage by a multiplicative factor of less than or equal to 8.

Preferably, the voltage multiplier of the differential protection device is capable of applying a second voltage greater than the first voltage by an ideal multiplicative factor less than or equal to 8.

According to a possible additional characteristic, the voltage multiplier may be able to deliver triple, quadruple, sixfold, or eightfold voltage.

Thus, the size of the toroid and the width of the differential protection device can be reduced while keeping the tripping time

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sufficiently short. The higher the voltage multiplier circuit, the smaller the size of the torroid.

5 According to one possibility, the differential fault detector may comprise an intermediate electrical circuit connected to the first electrical circuit by means of a conditioning module capable of supplying a conditioned voltage, as a function of the first voltage, to the intermediate circuit, the circuit preferably connected to the second electrical circuit via the voltage multiplication device.

10 According to one possibility, the electrical energy storage device is an electrical capacitor having a capacitance between 470 nF and 2200 nF.

According to one possibility, the device for accumulating electrical energy is a set of electrical capacitors having a capacity between 470 nF and 2200 nF.

15 According to an additional possible characteristic, the coil may comprise a number of turns comprised between 800 turns and 1100 turns.

20 According to one possibility, the voltage multiplication device may comprise an AC / DC converter capable of converting an AC voltage applied to the first circuit and / or, where appropriate, to the intermediate circuit, a DC or quasi-DC voltage applied to the second circuit.

25 The invention also relates to a differential circuit breaker comprising at least two switching devices and a differential protection device according to the invention, the switching devices each comprising at least one conductor passing through the torroid of the differential protection device at least once.

30 Thus, the invention proposes a differential circuit breaker of compact dimensions with satisfactory performances required by a user.

35 According to a possible additional characteristic, the differential circuit breaker may comprise four switching devices each comprising a conductor passing through the torroid of the differential protection device respectively at least one time, the differential protection device and the switching devices being preferably arranged in such a way that two cut-off devices are respectively disposed on either side of the differential protection device.

40 Thus, a four-phase differential circuit-breaker is proposed to minimise the lengths of the conductors of the cut-off devices passing through the torroid, which means that the heating of the conductors can be reduced to a minimum.

45 Furthermore, according to one possibility, the cut-off device connected to the neutral can be, with respect to the front face, disposed at the right extremity or at the left extremity of the circuit breaker.

According to a possible additional characteristic, the differential protection device has a first width substantially equal to the width of a basic module.

According to one possibility, the breaking device or devices may have a second width substantially equal to 0.75 times the width of a base module.

5 A base width may substantially correspond to a width of about 17.5 mm. This basic width is standardized between the different manufacturers of electrical equipment of the modular circuit breaker type and is generally between 17 and 18 mm depending on the manufacturers.

10 Thus, this size of the breaking device allows a breaking chamber of sufficiently large size to satisfy the performance requirements of the short circuit breaker while maintaining the compactness of the circuit breaker. Moreover, the extra space available compared to the prior art solutions allows the use of cut-off devices of sizes up to 40 amps and of switching capacity up to 10 k Ampere.

15 The invention has also for objective, a method for controlling at least one electrical device, preferably at least one switching device, by means of a differential protection device according to the invention, comprising the following successive steps:

20 Applying a first voltage to a first electrical circuit from a magnetic field using a torroid and a coil;

25 Applying a second voltage to a second electrical circuit as a function of the first voltage by means of a voltage multiplication device, the second voltage being greater than the first voltage by a factor greater than 2 and

Accumulating energy by means of an energy accumulation device connected to the second electrical circuit.

30 According to one possibility, the method may comprise the following additional step:

Discharging the electrical energy accumulated in the energy storage device into a third circuit when a third voltage detected in the energy storage device exceeds a predetermined threshold voltage.

35 According to one possibility, the method may comprise the following additional step:

Sending a command intended for the electrical apparatus by discharging into the third circuit the electrical energy accumulated in the energy storage device.

40 According to one possibility, sending the command intended for the electrical appliance may consist in applying a force to a control member of the cut-off device by means of an actuator.

45 The characteristics and advantages of the invention will emerge from the following description, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 is a schematic representation of a differential protection device according to the invention;

FIG.2 is a schematic representation of a voltage doubler;

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FIG. 3 is a schematic representation of a voltage fourfold multiplier;

FIG.4 is a curve representing the voltage provided by the voltage doubler and by the voltage fourfold multiplier as a function of time;

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Fig 5 is the schematic representation of a differential fault detector comprising a voltage doubler;

Fig 5A is a schematic representation of a voltage trebling device;

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FIG. 5B is a schematic representation of a voltage fourfold multiplier;

FIG.5C is a schematic representation of a voltage eightfold multiplier;

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FIG. 5D is a schematic representation of a voltage sixfold multiplier;

FIG. 6 is a perspective view of a differential circuit breaker according to the invention, comprising four cut-off devices;

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FIG. 7 is a schematic representation of the differential circuit breaker from FIG. 6;

Fig. 8 is a perspective view of the differential protection device according to the invention;

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FIG. 9 is a perspective view of the differential circuit breaker from FIG. 6;

FIG. 10 is a plan view of the differential circuit breaker from FIG. 6, with the cut-off device to be connected to the neutral phase arranged on the right; and,

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FIG. 11 is a plan view of the differential circuit-breaker from FIG. 6, with the cut-off device to be connected to the neutral phase arranged on the left.

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As shown in FIG. 1, the invention provides a differential protection device 20 capable of detecting differential fault currents and/or leakage currents to earth. The differential protection device 20 comprises a detector 22 comprising a first electrical circuit 24 and a second electrical circuit 26.

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The first electrical circuit 24 comprises a coil 4. The differential fault detector 22 furthermore comprises a torroid 1 which can be traversed at least once by at least one conductor 3. The coil 4 is wound around the torroid 1 and connected to the first electrical circuit 24 to apply a first voltage U_2 in the first circuit 24 when a magnetic flux is induced in the torroid 1.

The differential fault detector 22 comprises at least one voltage multiplication device 6 connected to the second electrical circuit 24 and capable of applying a second voltage V2 to the second electrical circuit 26 as a function of the first voltage U2.

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The voltage multiplication device 6 comprises at least one device 7 for accumulating electrical energy. The voltage multiplication device 6 is capable of applying the second voltage V2 to the second circuit 26 so that the second voltage V2 is greater than the first voltage U2 by a factor greater than two.

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The voltage multiplication device 6 of the differential fault detector 22 disclosed in FIG. 1 may be a voltage trebling, a voltage fourfold multiplier, a voltage sixfold multiplier or a voltage eightfold multiplier.

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The differential fault detector 22 may comprise a third electrical circuit 28 comprising a comparison module 8. The electrical energy storage device 7 can apply the third voltage V3 to the third electrical circuit 28. At least one device 6 for multiplying voltage connected to the second electrical circuit 26 is capable of applying a second voltage V2 to the second electrical circuit 26 as a function of the first voltage U2.

20

Torroid 1 can be traversed at least once by at least one conductor 3. In the case disclosed in FIG. 1, torroid 1 is traversed by four conductors 3 corresponding to the four phases. The appearance of the first voltage U2 in the first electrical circuit 24 then indicates that the sum of the magnetic fields generated by the conductors 3 is not null.

25

The differential fault detector 22 may further comprise an intermediate electrical circuit 25 connected to the first electrical circuit 24 via a conditioning module 5 capable of supplying a conditioned voltage V1 to the intermediate circuit 25 as a function of the first voltage U2 . The intermediate circuit 25 can be connected to the second electrical circuit 24 via the voltage multiplication device 6, the first voltage U2 then constituting the input voltage of the conditioning module 5.

30

The conditioning module 5 may be capable of performing the following main functions: filtering, protection against strong currents, EMC adaptation and others. The output of the conditioning module 5 then constitutes the input of the voltage multiplier 6. The voltage multiplier 6 enables, on the one hand, the amplification of the first voltage U 2 and/or the conditioned voltage V1 and the storage of energy necessary for triggering a relay 10 in the device 7 for accumulating electrical energy or several electrical energy storage devices 7. The electrical energy storage devices 7 may be capacitors 7. The capacitors 7 may be referred to as capacitors 7.

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The second voltage V2 is constantly compared with a reference using the comparison module 8. When the second voltage V2 exceeds the reference, order is given to a control unit 9 for discharging the capacitor 7 into the relay 10 to using the third electrical circuit 28. The triggering of the relay 10 allows the unlocking of a differential lock 11 thus causing the opening of contact 12.

45

Thus, by using a voltage multiplier of order greater than 2, a torroid 1 of relatively small volume can be used. As the cost of a torroid 1 increases with the increase in the volume of its material, a relatively small torroid 1 makes it possible to reduce the costs of the differential fault detector 22. Moreover, the integration of a torroid 1 of reduced size further simplifies its integration into the product.

FIG. 2 discloses a voltage multiplication device 6a of the order of magnitude two, that is to say, a voltage doubler 6a. Such a voltage doubler 6a for a differential fault detector 22 is known from the prior art FR 2 777 110.

The differential fault detector 22 of the differential protection device 20 according to the invention comprises a voltage multiplication device 6 of a higher order than two, that is to say, a voltage trebling device, a voltage fourfold multiplier, Voltage sixfold multiplier or a voltage eightfold multiplier. These voltage multiplication devices 6 of greater order than two are disclosed by way of example in FIGS. 3, 5A and 5B. FIGS. 3 and 5B disclose voltage fourfold multiplier and FIG. 5A a voltage trebling device. By comparing a voltage-multiplication device 6a of less than an order of two with a voltage multiplication device 6 of greater than an order of two, the latter needs an input voltage U_2 , V_I that is substantially reduced compared to that required by the second-order voltage multiplier device 6a. Nevertheless, the voltage multiplication device 6 of greater than two order takes more time to reach the steady state of the output voltage.

To summarise, the voltage multiplication devices 6 of order greater than two requires more time to accumulate the energy required for the triggering of the relay 10 for a lower input voltage, which results in less large torroid 1 and/or a reduced number of primary passages. The number of primary passes is the number of times each conductor passes through the torroid.

A reduced number of primary passages makes it possible to simplify the manufacturing process and allows easy configuration of the current paths in the product, to reduce the material used in the connections, to reduce the heating and eventually to reduce the impact of the magnetic radiation of the current paths on the other bricks in the product and reduce the overall volume of the torroid and the primary conductors taken in a set.

The reduction in the volume of torroid 1 allows reduction of its cost and allows simplification of the process of its integration into the product. It also makes it possible to increase the cross-section of the conductors 3 to reduce, among other things, the heating or the passage from one gauge to another at a lower cost.

For a second voltage V_2 , for example 5.55 volts, a voltage multiplication device 6a of order of two fold needs an input voltage U_2 , V_I of 2.88 volts. For the same second voltage of 5.55 volts, a voltage multiplier 6 of order of four fold requires an input voltage U_2 , V_I of only 1.5 volts.

However, the four-fold voltage multiplier 6 requires more time (243 ms = 345 ms-103 ms) to exceed the reference voltage (example 4.5 volts) and trigger the relay 10 , while remaining below a tripping time of 300 ms. These results are disclosed in FIG.4

5 The trip time of the differential fault detector 22 of the differential protection device 20 equipped with a voltage multiplier 6 of order greater than two is longer than that of the voltage multiplication device 6 of order 2, which can have the consequence that the trip time exceeds the normative value of 300 ms or the desired target.

10 To overcome these disadvantages, it may be necessary to reduce the trip time by the use of remedial solutions.

Such a reduction in the tripping time can be obtained by reducing the impedance of the torroid 1. This reduction in the impedance of the torroid 1 results in a reduction
15 in the number of turns of the coil 4.

The coil 4 of the differential protection device 20 according to the invention may comprise between 800 and 1,100 turns in order to obtain a sufficiently short tripping
20 time.

Furthermore, the reduction of the trip time can be obtained by reducing the value of the storage capacitor 7 to a minimum value ensuring the triggering of the relay 10, i.e. to give the relay the energy just necessary for safe operation.

25 The invention also relates to a differential circuit-breaker 40 comprising at least one differential protection device 20 and at least one switching device 60. The differential circuit-breaker 40 may, for example, consist of four cut-off devices 60 and A differential protection device 20. The differential circuit breaker 40 can be a modular apparatus comprising a first main face 42 and a second main face 44. As can be seen
30 in particular in FIGS. 6 and 7, the differential circuit breaker 40 may be arranged so that two circuit breakers 60 are disposed on either side of the differential protection device 20.

Each cut-off device 60 may be provided with an input terminal 62 and an output
35 terminal 64. The input terminals 62 and the output terminals 64 may be arranged linearly, respectively. The input terminals 62 and the output terminals 64 may also be respectively arranged equidistantly from one another.

The differential protection device 20 is provided with a first width L1. The cut-off
40 devices 60 are provided with a second width L2. The first width L1 is preferably sensibly equal to the width of a base module. The second width, itself may correspond to a width sensibly equal to 0.75 times the width of a basic module. The width of a base module corresponds approximately to a width of 17.5 mm. This basic width is standardized between the different manufacturers of electrical equipment of the
45 modular circuit breaker type and is generally between 17 and 18 mm depending on the manufacturers. The differential circuit breaker 40 is therefore provided with a width equal to four modules (four times the second width L2 of the cut-off device and once the first width L1 of the differential protection device 20).

Thus, the available space as compared with the solutions of the prior art allows the use of cut-off devices 60, of 40 amps and cut-off capacity up to 10 k Ampere.

5 The width of a module of 17.5 mm corresponds to the pitch of the bridging terminals which can be connected to the terminals 62, 64 of the breaking devices 60.

The subject of the invention is also a circuit breaker, preferably a differential circuit breaker, having a mechanism for opening and closing at least one electrical contact between an upstream electrical line and a downstream electrical line.

10 In general, the opening and closing mechanism has two stable states, a first state that can be referred to as the "open contacts" state for which the upstream electrical line is not electrically connected to the downstream line and a second state that can be called "closed contacts" state for which the upstream electrical line is electrically
15 connected to the downstream line. The main function of the circuit breaker is to protect the downstream power line from defects, electrical overload faults, short circuit, ground fault.

20 In general, the circuit breaker comprises an actuator capable of returning the opening and closing mechanism to the first state ("open contacts" state) in the event of an overload (abnormal overcurrent) on the protected line. Preferably, the actuator is a thermal actuator capable of deforming as a function of its temperature. Preferably, the actuator may consist of a bimetal strip which may or may not be traversed by the current.

25 The circuit breaker may also include a driver, preferably a thermal driver. The driver is generally the part linking the opening and closing mechanism to the actuator (against overload).

30 Generally, the opening and closing mechanism of the contacts is provided with a trigger, which, when moved by the actuator, permits the opening of the contacts, that is to say, permits the change of state from the closed contact state (second state) to the open contact state (first state) of the contact opening and closing mechanism.

35 The opening of the contacts can be carried out when the mechanism for opening and closing the contacts changes from the second state to the first state.

40 In general, the trigger may be equipped with a projection capable of being moved directly by the actuator in order to trigger the mechanism for opening and closing the contacts. In other cases, this connection can also be achieved by means of a part disconnected from the trigger, called a driver or a thermal driver. The driver can generally be guided mechanically into envelope parts of the apparatus and may be in pivot contact or connection with the trigger.

45 In some cases, the connection can be made directly between the trigger and the actuator (thermal).

In cases where the connection is made indirectly, that is to say by means of a part (the driver), several different types of connection may be possible:

- The driver is rotating in the trigger and is guided in translation in the envelopes;
- Driver in translation guided in the envelope parts and in punctual contact on the trigger.

In the case where the trigger is equipped with a projection able to be moved directly by the actuator in order to trigger the mechanism for opening and closing the contacts, the clutter of this function during arming and triggering of the lock mechanism can become important, in fact the mechanism for opening - closing of the contacts passing from one stable state to the other generally by a rotational movement about an axis, the trigger can also be rotated, the angular sector swept by the mechanism can also be swept by the projection of the trigger. This movement imposes the fact of having a free space enabling the trigger to move freely during the change in state of the opening and closing mechanism of the contacts. This free space is all the more important for the following reason: when the contacts are closing, if the trigger is retained by any component, it can automatically actuate the opening and closing mechanism of the contacts, which may prevent the contacts from closing unintentionally, which may cause the circuit breaker to malfunction. As a result, in the apparatus equipped with this technical solution, a large space is released around the trigger, which prevents the production of compact units or in a limited space.

In the case where the connection is made by means of a driver in rotation with respect to the tripping device, the travel of the driver can be important since it is directly linked to the movement of the tripping device during the opening and closing movements of the contacts. The guidance of the driver can also be difficult to achieve in order to find the right compromise between the various positions (open and / or closed contact), the correct orientation of the forces during an unlocking operation, avoiding the buckling between the driver and the guiding envelope parts and keeping precision guidance to reduce the variability of the function.

In the case where the connection is made by means of a translator in the envelope parts, the circuit-breaker may be difficult to assemble in an architecture where the assembly is made by stacking, especially if a lock comprises two contacts. In this case, there must be a driver on either side of the lock (one driver per thermal function). A system should then be found to preassemble the driver in the envelope parts and to hold it before assembling the lock on the envelope piece.

Such circuit breakers of the prior art are known, for example, from documents FR 2 661 776 and EP 0 295 158 B1.

The object of the application is therefore to overcome the difficulties of congestion related to the movement of the parts, difficulties in guiding, or of assembly. The object of the application is also to obtain a complete and compact subassembly which can be installed in an environment with a reduced space.

To this end, the application proposes a circuit breaker comprising a subassembly comprising an opening and closing mechanism having at least two stable states, a first state for which an upstream electrical line is not electrically connected to a downstream line (open contact) and a second state for which the upstream electrical line is electrically connected to the downstream line (closed contact), the said circuit breaker including a trigger adapted to switch the mechanism for opening and closing the second state to the first state when the trigger is moved, relative to the opening and closing mechanism, for returning the opening and closing mechanism to the first state, the said subassembly also comprising a driver and an actuator, preferably a thermal actuator capable of moving the driver so as to return the opening and closing mechanism to the first state when a product connected to the downstream power line is traversed by a current greater than the nominal current for which the product is provided (overload current).

Preferably, the circuit breaker comprises at least one envelope piece forming a retaining shell and comprising means for guiding the driver, the driver being held in the guide means by deformable clips of the envelope pieces or by an additional piece coming from to be fixed on the envelopes part or by at least one clipping lug.

Preferably, the subassembly comprises means for guiding the driver.

Preferably, the driver has a general U shape, the first branch of the U being connected to the trigger and the second branch of the U being connected to the actuator, the middle part of the U connecting the two branches of the U.

Thus, the circuit-breaker can gain in compactness (and therefore in the margin of adjustment of the thermal protection).

Preferably, the driver can be, on the one hand, connected to the actuator and, on the other hand, connected to the trigger.

Preferably, the driver is made of metallic material, preferably from a metal wire. Preferably, the cross-section of this wire may be round or square. The metallic wire has the advantage of being easily made and rigid using a wire of small diameter (compared to a plastic part).

Preferably the driver is made of plastic material.

Preferably, the driver is guided on the envelopes. Preferably, the envelopes can hold the various parts of the lock (sub-assembly) (including thermal) in a guide rail. Preferably, the driver can be held in the guide rail by deformable clips of the envelope for holding the subassembly or by an additional piece that can be fixed to the envelopes or by at least one clipping lug. Thus the sub-assembly is complete and autonomous.

The sub-assembly comprises at least one holding shell which can be produced by at least one envelope piece, preferably two envelope pieces.

5 Preferably, the driver is guided in translation in the guide means in a translation direction. Preferably, the driver has no rigid connection with the trigger, which reduces its bulk during operation.

10 Preferably, the driver operates in translation and has no rigid connection with the triggering part, which reduces its bulk during operation.

15 Preferably, the trigger is provided with an orifice in which the driver is arranged. Preferably, the first limb of the U in a largely U-shaped driver is arranged in the orifice.

20 Preferably, the actuator is capable to return the mechanism for opening and closing of the second state to the first state by coming in contact against the driver when a product connected to the downstream power line is traversed by a current greater than the nominal current.

25 Preferably the actuator is adapted to return the mechanism for opening and closing the second state to the first state by coming into contact against the second branch of the U of the U-shaped driver when the product connected to the power line Downstream is traversed by a current greater than the nominal current.

30 Preferably the driver can bear against an edge of the orifice when the opening and closing mechanism is in its second state in order to switch the opening and closing mechanism from the second state to the first state. Preferably the first U-shaped leg of the general U-shaped driver can bear against the edge of the orifice when the opening and closing mechanism is in its second state to make switch the opening and closing mechanism from the second state to the first state.

35 Preferably, the orifice has a substantially oblong and curvilinear shape. Preferably, the orifice essentially has a shape of bean and / or banana and / or C.

40 Preferably, the driver can assume a neutral position in which the opening and closing mechanism can freely switch from the first state to the second state and vice versa.

45 Preferably the orifice is designed to permit the switching of the opening and closing mechanism from the first state to the second state and vice versa when the driver takes the neutral position.

50 Preferably the driver can also assume an actuating position which is offset from the neutral position in the translational direction.

55 Preferably, when the driver takes the actuating position, a switching of the opening and closing mechanism from the first state to the second state causes the driver to move from the actuating position to the neutral position.

In this circuit breaker, the driver is free and does not move relative to the fixed parts of the product during the mechanical movement (opening or closing of the contacts).

5 Preferably, the driver can be clipped into the envelope parts, which eliminates the assembly difficulties for this type of sub-assembly (a mechanism with two contacts and a translational drive with a stacking assembly). The driver may also be held in the envelope parts by an additional piece which would itself be fixed to the envelopes.

10 Thus the driver can be assembled by simple clipping after construction of the complete sub-assembly, thus the complete sub-assembly is functional and can be tested in a template before assembly of the complete product, thus independently of the complete product. This functionality cannot be achieved in the case where the driver for example is guided by the envelope of the product.

15 Preferably, the deformable clips extend in a direction substantially perpendicular to the direction of translation.

20 Preferably, the trigger is pivotally mounted with respect to at least one envelope piece about a pivot axis.

25 The circuit-breaker that is the object of this present application, has the advantage of gaining space for future developments more and more compact, as well as having a complete and independent mechanical sub-assembly with the already assembled driver onto, or to be assembled in the final environment without the constraint of a retention required in the envelopes (in the case of a stacking assembly).

30 The features and advantages of the circuit breaker proposed by the application will emerge from the following description, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Fig. 12 is a schematic representation of a driver in pivot connection in a triggering part and guided in translation in the envelopes of a circuit breaker known in the prior art;

35 Fig. 12a is a schematic representation of the driver in pivot connection in the triggering part and guided in translation in the enclosures of the circuit breaker known in the prior art;

Fig. 13 is a schematic representation of a circuit breaker proposed by the application;

40 Fig. 13a is a schematic representation of a driver of the circuit breaker proposed by the application;

Fig. 14 is a schematic representation of the circuit breaker proposed by the application in a first position (open contact position);

45 Fig. 15 is a schematic representation of the circuit breaker proposed by the application in a second position (closed contact position).

FIGS. 12 and 12a disclose a sub-assembly 523 of a circuit breaker known in the prior art comprising an opening and closing mechanism 560 which can be mounted to rotate with respect to an axis of rotation R. The sub-assembly 523 also comprises a driver 520 which is rotary mounted in the opening and closing mechanism 560 and is guided in translation in envelope parts 521. The said circuit-breaker further comprises a trigger 540 capable of switching the opening and closing mechanism 560.

In general, the circuit breaker may further comprise an electrical contact comprising a movable contact element 561 and a fixed contact element. The movable contact member 561 may be mechanically connected to the trigger 540.

FIGS. 13 to 15 disclose a circuit breaker 100 in accordance with the invention comprising a sub-assembly 123 comprising an opening and closing mechanism 160 having at least two stable states, a first state for which an upstream electric line is not electrically connected to a downstream line (open contact) and a second state for which the upstream electrical line is electrically connected to the downstream line (closed contact). The said sub-assembly 123 also comprises a driver 120 and an actuator 150, preferably a thermal actuator, able to return the opening and closing mechanism 160 to the first state when a product connected to the downstream electrical line is traversed by a current greater than the nominal current for which the product is intended (current overload). The said circuit breaker 100 may include a trigger 140 capable of trip the opening and closing mechanism 160 from the second state to the first state when the trigger 140 is moved relative to the opening and closing mechanism 160 to return the opening and closing mechanism 160 to the first state.

Preferably, the subassembly 123 comprises guiding means 124 for the driver.

Preferably, the driver 120 is generally U-shaped, the first branch 125 of the U being connected to the trigger 140 and the second branch 126 of the U being connected to the actuator 150, the central part 127 of the U connecting the two branches 125, 126 of the U.

Thus, the circuit breaker 100 can increase in compactness (and thus in the margin of adjustment of the thermal protection).

Preferably, the driver 120 can be, on the one hand, connected to the actuator 150 and, on the other hand, connected to the trigger 140.

Preferably the driver 120 is made of metallic material, preferably from a metal wire. Preferably, the cross-section of this metallic wire may be round or square. The metallic wire has the advantage of being easily made and rigid using a wire of small diameter (compared to a plastic part).

Preferably the driver is made of plastic material.

Preferably, the driver 120 is guided onto the envelopes 121, 122

Preferably, the envelopes 121 122 can hold the various parts of the lock (sub-assembly 123) (including the thermal) and in particular the driver 120 in the guiding means 124.
5 Preferably, the various parts of the lock can be held by deformable clips 128 or by an additional part that can be fixed to the envelopes 121, 122 or by at least one clipping lug. Thus the sub-assembly 123 is complete and autonomous.

10 The driver 120 can be connected to the trip device by means of a mechanical connection allowing the driver to toggle relative to the trigger.

The sub-assembly 123 comprises at least one retaining shell which can be produced by at least one envelope piece 121, 122, preferably two envelope pieces 121, 122.

15 Preferably, the driver 120 operates in translation and has no rigid connection with the trigger 140, which reduces its bulk during operation.

In this invention, the driver 120 is free and has no relative movement with respect to the fixed parts of the product during the movement of the mechanism (opening or closing of the contacts).
20

The driver 120 can be guided in translation in the guide means 124 in a direction of translation T.

25 As can be seen in FIGS. 14 and 15, the trigger 140 may be provided with an orifice 141 in which the driver 120 is arranged. Preferably, the first leg 125 of the U of the generally U-shaped driver is arranged in the orifice 141.

30 The actuator 150 may be suitable to return the opening and closing mechanism 160 from the second state to the first state by coming to bear against the driver 120 when a product connected to the downstream power line is traversed by a current greater than the current nominal.

35 The actuator may be suitable to return the opening and closing mechanism 160 from the second state to the first state by coming to bear against the second leg 126 of the U of the U-shaped driver 120 when the product connected to the line Electric current is passed through by a current greater than the nominal current.

40 The driver can come to bear against an edge 142 of the orifice 141 when the opening and closing mechanism 160 is in its second state in order to toggle the opening and closing mechanism 160 from the second state to the first state. The first leg 125 of the U of the generally U-shaped driver 120 can bear against the edge 142 of the orifice 141 when the opening and closing mechanism 160 is in its second state in order to switch the opening and closing mechanism 160 of the second state in the first state.

45 The orifice 141 may have a substantially oblong and curvilinear shape. Preferably, the orifice essentially has a shape of bean and / or banana and / or C.

FIGS. 14 and 15 show the driver 120 taking a so-called neutral position.

When the driver 120 assumes its neutral position, the opening and closing mechanism 160 can be designed to be able to freely switch from the first state to the second state and vice versa.

Preferably, the orifice 141 is designed to allow the opening and closing mechanism 160 to toggle from the first state to the second state and vice versa when the driver 120 assumes a neutral position.

In addition, the driver 120 can assume an actuating position (not disclosed in the figures) which is offset with respect to the neutral position in the direction of translation T.

Preferably, when the driver 120 takes the actuating position, a switching of the opening and closing mechanism 160 from the first state to the second state causes the driver 120 to move from the actuating position to the position neutral.

Preferably, the driver 120 can be clipped into the envelope pieces 121, 122, which eliminates the difficulties of assembly for this type of sub-assembly 123 (a mechanism with two contacts and a translational drive with a stack assembly). The driver 120 can also be held in the envelope pieces 121, 122 by an additional piece which would itself be fixed to the envelopes 121, 122.

Thus, the driver 120 can be assembled by simple clipping after formation of the complete sub-assembly 123, so the complete sub-assembly 123 is functional and can be tested in a jig before assembly of the complete product, i.e. independently of the complete product. This functionality cannot be achieved in the case where the driver 120 is guided by the envelope parts 121, 122 of the product, for example.

Preferably, the deformable clips extend in a direction substantially perpendicular to the direction of translation.

Preferably, the trigger 140 is pivotally mounted with respect to at least one casing part 121, 122 about a pivot axis.

The circuit-breaker which is the object of the request has the advantage of gaining space for future developments that are more and more compact, as well as having a complete and independent mechanical sub-assembly with the driver already assembled thereon or assembled in the final environment without the constraint of a necessary fixing in the envelopes (in the case of a stack assembly).

The subject of the application is also a modular differential circuit-breaker.

Circuit breakers of this type may comprise at least one switching compartment and a differential protective compartment, the switching compartment(s) having a mechanism for opening and

closing at least one electrical contact between an upstream electrical line and a downstream power line.

5 Differential circuit breakers may include test functions allowing testing the proper operation of the differential protection compartment. The differential protection compartment then comprises a test circuit, the test circuit comprising a first switch which can be closed by pressing a test button

10 This test can be carried out by pressing the test button which closes the test circuit which simulates a differential fault which causes the differential module of the product to trip, generally this differential defect is achieved by a leakage current between neutral and at least one phase of the product, this current passing through a resistor having the effect of limiting the leakage current.

15 In general, the circuit breaker comprises a connecting piece mounted inside the differential protection compartment and which makes it possible to mechanically connect the cut-off compartment(s) to one another by means of at least one lateral lug, preferably two lateral lugs. The connecting piece can protrude on either side of the differential protection compartment and can penetrate into the compartments of the cut-off located, if necessary, on either side of the differential protection compartment.

20 The connecting piece can actuate the opening of the contact of the cut-off compartments during a differential defect by means of its lateral lugs.

25 Such a circuit breaker known from the prior art is for example disclosed in document EP0948021 B1

30 The circuit-breakers known from the prior art have the disadvantage of leaving the test circuit active after a mechanical opening of the contacts of the cut-off compartments and / or after a differential fault and thus unnecessarily leaves the current in the test circuit, when a prolonged press on the test button, which could result in the destruction of the test function by damaging a resistance of the test function.

35 The object of this application is to overcome these disadvantages.

40 To this end, the application proposes a differential circuit breaker comprising a test circuit comprising a first switch which can be opened and / or closed by means of a test push-button and a second switch which can be opened and / or closed by a connecting piece. Preferably, the connecting piece closes the second switch when the contact of the switching compartment (s) is / are closed. Preferably, the connecting piece opens the second switch when the contact of the switching compartment (s) is / are open and / or when the differential protection compartment detects a fault.

Preferably, the connecting piece can deactivate the test circuit during a mechanical opening of the switching compartments and / or by the differential protection compartment during a differential fault.

5 Preferably, when the circuit breaker is in the ON position, that is to say when the contact of the switching compartment (s) is (are) closed and the differential protection compartment does not detect a fault, the connecting piece can be adapted to enable the correct contact of the test circuit to be established in the differential compartment, that is to say to close the test circuit (second switch closed, possibility of performing
10 the test function).

Preferably, when the circuit breaker is in the OFF position, that is to say when the contact of the switching compartment (s) is / are open and / or when the differential protection compartment detects a fault, the connecting piece physically opens the test
15 circuit (second switch open and thus protects it from a short circuit in case of prolonged pressing and closing of the contact of the test button). Indeed, when the test button is pressed, the first switch of the test button is closed, but since the second switch is open, the test function is deactivated.

20 Thus, the connecting piece can deactivate the test circuit during a mechanical opening of the switching compartments and / or by the differential protection compartment during a differential fault.

Preferably, the first switch and the second switch are connected in series.

25 Preferably, the second switch comprises a first contact element and a second contact element, the connecting part being able to move the first contact element away from the second contact element in order to open the second switch by coming to bear against the first element of contact.

30 Preferably, the first contact element is rotary mounted in a housing of the differential circuit breaker.

The features and advantages of the circuit breaker proposed by the application will
35 emerge from the following description, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIG. 16 is a schematic representation of the circuit breaker proposed by the application comprising of connecting the part of FIG. 16

40 FIG.16a is a schematic representation of the circuit breaker proposed by the application comprising the connecting piece of FIG. 16;

45 FIG.17 is a schematic representation of the circuit breaker proposed by the application in the ON position;

18 is a schematic representation of the circuit breaker proposed by the application in the OFF position;

As is disclosed in FIGS. 16 to 18, the application concerns a circuit breaker 210 comprising a test circuit comprising a first switch 220 which can be opened and / or closed by means of a press on a test button 222 and a second switch 230 which can be opened and / or closed by a connecting piece 250. Preferably, the connecting piece 250 closes the second switch 230 when the contact of the switching compartment (s) is / are closed. Preferably, the connecting piece 250 opens the second switch 230 when the contact of the switching compartment (s) is / are open.

Preferably, the first switch 220 and the second switch 230 are connected in series.

Preferably, the connecting piece 250 can deactivate the test circuit during a mechanical opening of the switching compartments and / or by the differential protection compartment during a differential fault.

The connecting piece 250 may be mounted inside the differential protection compartment and may make it possible to mechanically connect the switching compartment (s) to one another by means of at least one lateral lug 251, 251, preferably two lateral lugs 251, 251. The connecting piece 250 can project from either side of the differential protection compartment and can penetrate into the switching compartments, where applicable, on either side of the differential protection compartment.

Preferably, when the circuit breaker 210 is in the ON position 253, that is to say when the contact of the switching compartment (s) is (are) closed and the differential protection compartment does not detect a differential fault, the connecting piece 250 can be adapted to enable the correct contact of the test circuit to be established in the differential compartment, that is to say to close the test circuit (second switch 220 closed, possibility of performing the function test).

Preferably, when the circuit breaker is in the OFF position 255, that is to say when the contact of the breaking compartment (s) is (are) opened and / or when the differential protection compartment detects a differential fault, the connecting piece 250 physically opens the test circuit (second switch open and thus shields it from a short-circuit if the contact of the test button 222 is pressed and closed). Indeed, when the test button 222 is pressed, the first switch 220 of the test button 222 is closed, but since the second switch 230 is open, the test function is deactivated.

As can be seen from FIGS. 17 and 18, the second switch 230 may include a first contact element 231 and a second contact element 232. The first contact element 231 can be moved away from the second contact element 232 to open the second switch 230. The connecting piece 250 can move the first contact element 231 away from the second contact element 232 by coming to bear against the first contact element 231. The first contact element 231 can be mounted rotary in a housing 211 of the differential circuit breaker 210.

Thus, the connecting piece can deactivate the test circuit during a mechanical opening of the switching compartments and / or by the differential protection compartment during a differential fault.

5 The subject of the invention is also a method for manufacturing a modular electrical device providing at least two electrical functions, preferably a modular differential circuit breaker.

10 Modular electrical apparatus, as well as circuit breakers of this type, may comprise at least one switching compartment and a differential protective compartment, the switching compartment (s) having an opening and closing mechanism of at least one electrical contact between an upstream electrical line and a downstream power line. The differential protection compartment may include a differential fault detector including a torroid and a detection circuit. The differential protection compartment
15 may further comprise a test circuit including a test button.

The principle of operation of a differential circuit-breaker is to compare the intensities on different conductors that pass through it. In the case of a single-phase differential circuit-breaker, it compares the current flowing in a conductor corresponding to the
20 phase and the current flowing in a conductor corresponding to the neutral. In other words, the differential circuit breaker verifies that the sum of the intensities of the currents flowing in the conductor corresponding to the phase and the conductor corresponding to the neutral cancel each other out. In the case of a multi-phase differential circuit-breaker, the differential circuit breaker checks that the sum of the
25 intensities of the current flowing in the conductors corresponding to the phases and the neutral cancel each other out.

The differential device is therefore based on the principle that, in a normal installation, the electric current which arrives by one conductor must exit by another conductor.
30 In a single-phase installation, if the current in the conductor corresponding to the phase at the start of an electrical circuit is different from that in the conductor corresponding to the neutral, it is because there is a leak.

35 For this purpose, each conductor passes through the torroid, each of these conductors thus forming identical and opposing electromagnetic fields which cancel each other out. In the event of a difference between the electromagnetic fields, the resulting electromagnetic field actuates a switching compartment which quickly cuts off the current by opening the electrical contact.

40 The present differential circuit-breakers are first assembled in their entirety and adjusted and controlled after assembly. In case of problems related to adjustment and/or to the control, the product is discarded because it is difficult to disassemble.

45 The object of the application is to propose a method for manufacturing an electrical appliance providing at least two electrical functions, preferably a modular differential circuit breaker, making it possible to reduce the number of rejected products.

To this end, the application proposes a method for manufacturing an electrical appliance providing at least two electrical functions, preferably a modular differential circuit breaker,

5 the aid apparatus comprising at least one switching compartment and a differential protective compartment,

the said differential protection compartment comprising a differential fault detector and a test circuit,

10 the said test circuit including a test button,

the said differential fault detector comprising a torroid and a detection circuit, the method comprising the following successive steps:

a) make available the differential protection compartment;

15 b) passing at least one primary connection, preferably two primary connections through the torroid;

c) testing the operation of the differential protection compartment by, on the one hand, pressing the test button and, on the other hand, applying a voltage to the primary connections, so that a magnetic flux is induced in the torroid and triggers the differential fault detector;

20 d) arranging the at least one switching compartment adjacent to the differential protective compartment.

25 Preferably, in step c), the magnetic flux is induced in the torroid by creating a leaking current between the primary connection corresponding to the neutral and one of the primary connections corresponding to a phase.

30 Preferably, the leaking current is limited by a resistor connected between the primary connection corresponding to the neutral and the primary connection corresponding to the phase.

35 Preferably, in step c), the correct operation of the differential protection compartment is detected if the induction of the magnetic flux in the torroid and / or creation of the leaking current triggers the differential fault detector.

40 Preferably, step d) is performed after, in step c), the proper operation of the differential protection compartment has been observed.

Preferably, the method comprises the further step of:

45 e) electrically weld at least one first external pole corresponding to one of the primary connections of the electrical appliance

Preferably, the method comprises the further step of:

f) embedding the cut-off compartment (s) and/or the electrical appliance, preferably in a housing.

45 Preferably, the method comprises the further step of:

g) electrically weld at least one second external pole corresponding to one of the primary connections respectively to a conductor of the switching compartment (s), each conductor preferably being connected to a magnetic coil of the switching compartment.

5

This step ensures that no mechanical differential defect will produce a reject because the product can still be repaired at this stage.

10

Preferably, the method comprises, between step c) and step d), the following additional step:

c1) insert the differential protection compartment in a housing.

15

Preferably at least one second external pole is located outside the housing of the differential protection compartment when the housing of the differential protection compartment is mounted on the differential protection compartment.

20

Preferably, at least one first external pole is located outside the differential circuit breaker housing when the differential circuit breaker housing is mounted on the differential circuit breaker.

25

The subject of the application is also a modular electric apparatus providing at least two electrical functions manufactured using the manufacturing method according to the application.

Preferably, the electrical apparatus is a modular differential circuit breaker.

30

The characteristics and advantages of the method of manufacturing an electrical appliance providing at least two electrical functions, preferably a modular differential circuit breaker proposed by the application, will emerge from the description which follows, by way of example, in reference to the accompanying diagrammatic drawings, in which:

35

FIG. 19 is a schematic representation of a differential protection compartment according to the subject of the application;

20 is a schematic representation of the differential protection compartment which is the subject of the application embedded in a case;

FIG. 21 is a schematic representation of a differential circuit breaker which is the subject of the application;

40

FIG. 22 is a schematic representation of the differential circuit-breaker which is the subject of the application;

45

FIG. 23 is a schematic representation of the differential circuit-breaker which is the subject of the application.

FIG. 19 is a schematic representation of a differential protection compartment 320 according to the subject of the application made available in step a) of the method. The differential protection compartment 320 comprises a differential fault detector and a test circuit, the said test circuit comprising a test button, the said differential fault detector comprising a torroid 302 and a detection circuit.

The test button can be used to open and / or close a test circuit switch. The switch can be connected to the test circuit. Opening the switch can open the test circuit. Closing the switch can cause the test circuit to close.

Four primary connections 304 pass through the torroid 302 after performing step b).

FIG. 20 is a schematic representation of the differential protection compartment 320 embedded in a housing 321 as it occurs after the execution of step c1).

FIG. 21 is a schematic representation of a differential circuit breaker 330 which is the subject of the application. The differential circuit breaker 330 comprises the differential protective compartment 320 shown in FIGS. 19 and 20. The differential circuit breaker 330 may comprise four switching compartments 340, two switching compartments 340 being arranged respectively on each side of the differential protection compartment 320.

The primary connections 304 may each comprise two poles 307. These poles may either be external poles 308, i.e. first external poles 308 'which are outside the housing 321 of the differential protection compartment 320 or the second external poles 308 " which are further outside a housing 331 of the differential circuit breaker 330, or be internal poles 306 located inside the housing 321.

FIG. 22 is a schematic representation of the differential circuit breaker 330. The figure shows in particular the first external poles 308 'to be electrically welded in step e). In FIGS. 4 and 5 the flashes represent the welding points of the components.

FIG. 23 is a schematic representation of the differential circuit breaker 330. The FIGURE shows in particular the electrical welding of the second external poles 308 "of the primary connections 304 respectively to a conductor 309, 310, 311, 312 of the switching compartments 340, welding effected during step g). Preferably, each conductor 309, 310, 311, 312 is connected to a magnetic coil of the switching compartment.

The subject of the application is also a switching device and a modular differential circuit breaker comprising at least one such switching device.

Such switching devices generally have a mechanism for opening and closing at least one electrical contact between an upstream electrical line and a downstream electrical line. In general, the opening and closing mechanism comprises a breaking chamber comprising a barrel, an arc horn and a subassembly called a Deion.

The switching performance of such switching devices and of modular differential circuit-breaker comprising at least one such switching device are the result of a compromise between different components of the switchgear.

5

Generally, the cut is finalised in the deion, deion comprising plates that split the arc. The said plates are held parallel and without contact between them by a known non-electrically conductive device such as cardboard sheets or plastic plates. The performance of such switching devices is dependent on the number of plates in the deion. The number of plates is usually a number between 7 and 15 plates, more particularly 7 or 11 or 12 or 13 plates.

10

It goes without saying that the more plates the deion sub-assembly contains, the higher the switching performance, but the greater the volume of the deion sub-assembly.

15

The electric arc is created when the contact is opened under load and is guided to the deion sub-assembly by two elements:

20

The arc horn and an arc sheet.

The current trend is to develop more efficient switching devices with an equivalent or reduced volume. This tendency involves increasing the performance of the switching device either at constant volume or by reducing the volume of the product or at least maintaining acceptable performance while reducing the volume of the product.

25

Another important parameter in the switching performance of the switching device is whether or not there is an arc jump between the arc horn and the yoke.

30

At present there are two technologies of yoke for the switching devices known from the prior art:

With electrical arc
Without electrical arc

35

With electrical arc, either the chute is a component welded to the head, or the chute forms an integral part of the head itself. This leads to a slower rise in arc and thus to high thermal stresses.

40

In this configuration, the deion sub-assembly can extend to the head, which makes it possible to increase the number of deion plates, on the other hand the fact that an "arc jump" is present on the course of the electric arc, counteracts the increase in performance generated by the fact that the number of deion plates is increased.

45

The arc jump is actually a discontinuity of the conductor which allows the arc to go to the deion sub-assembly.

Without arc jump, is always the prolongation of the horn that extends under the yoke. This leads to a loss of volume in the breaking chamber and therefore a lower arc voltage and a lower heat dissipation.

5 The object of the application is to propose a switching device and a modular differential circuit breaker comprising at least one such switching device having a sufficiently high switching performance while keeping a breaking chamber that is sufficiently compact.

10 To this end, the application proposes a switching device having a mechanism for opening and closing at least one electrical contact between an upstream electric line and a downstream electrical line. The opening and closing mechanism comprises a breaking chamber comprising a yoke, an arc horn and a subassembly called a deion.

15 Preferably, the arc horn is curved.

Preferably, the yoke has a longitudinal opening. Preferably the arc horn terminates in a planar portion lodged in the longitudinal opening so as to be parallel and aligned therewith.

20 Preferably, the arc horn is housed in the same plane as that of the yoke. The longitudinal opening allows the arc horn to be housed in the same plane as that of the yoke.

25 Preferably, the arc horn is integrated directly into the yoke in a single piece without arc jump.

30 Preferably, the arc horn is arranged on the same plane as the yoke. Preferably, the longitudinal opening in the yoke is emergent, thus enabling the arc horn to be housed integrally in its thickness in the opening of the yoke, since generally this type of component has a constant thickness.

35 Preferably, the opening may also be constituted by a recess for receiving the non-emergent arc horn produced by stamping in the yoke for example.

In that case:

40 Either the arc horn is not totally integrated in the thickness of the yoke (case of component of constant thickness);

Or it is totally integrated in the thickness of the yoke if, for example, the component is not of constant thickness (yoke thicker than the arc horn) or the excrescence generated by stamping in the yoke does not collide with any component of the magnetic sub-assembly.

45 Preferably, the arc horn is partially integrated in the thickness of the yoke.

Preferably, the arc horn is fully integrated in the thickness of the yoke, an excrescence generated by the stamping in the yoke being remote from each component of the magnetic sub-assembly.

5 These characteristics have the effect of causing a volume gain in the breaking chamber in order to maximize the performance of the deion (gain of a plate on the deion). They also make it possible to better dissipate the energy of the electric arc.

Preferably, the yoke and the arc horn are formed in one piece.

10

Preferably, the yoke and the arc horn are formed by a piece of variable thickness.

Preferably, the yoke and the arc horn are formed by a piece of constant thickness.

15

Preferably, the yoke and the arc horn are formed by a curved part.

Preferably, the yoke and the arc horn are formed of an electrically conductive material.

Preferably, the yoke and the arc horn are formed by a metal part.

20

According to one possibility, the yoke may comprise a flat portion, preferably extended at one of its ends by a first curved portion comprising a contact zone constituting a fixed contact of the switching device.

25

According to one possibility, the first curved portion is itself extended by a second portion constituting an arc horn.

Preferably, the arc horn may consist of two portions, a prolonged curved portion of a terminal flat portion.

30

According to one possibility, the yoke may have an opening.

According to one possibility, the arc horn terminates in a planar portion and is preferably curved so that the plane portion is received in the yoke opening so as to be parallel and aligned with it.

35

These features have the advantage that an arc jump can be avoided and the volume of the breaking chamber can be conserved (and therefore of the number of deion plates in the deion sub-assembly).

40

The characteristics and advantages of a switching device and of a modular differential circuit-breaker comprising at least one such switching device proposed by the application will emerge moreover from the description which follows, by way of example, with reference to the drawings in which:

45

FIG. 24 is a schematic representation of a prior art arc switching device of prior art with arc jump;

25 is a schematic representation of a prior art switching device;

FIG. 26 is a schematic representation of a prior art switching device with arc jump;

FIG. 27 is a schematic representation of a prior art switching device without arc jump;

5

FIG. 28 is a schematic representation of a switching device known of the prior art;

FIG. 29 is a schematic representation of a yoke of a switching device proposed by the application;

10

FIG. 30 is a schematic representation of a switching device proposed by the application comprising a yoke shown in FIG. 29.

FIGS. 24 to 26 are schematic representations of a switching device 450 known in the prior art with an arc jump comprising a mechanism for opening and closing at least one electrical contact between an upstream electrical line and a downstream electrical line. The opening and closing mechanism includes a breaking chamber 470 having a yoke 462, an arc horn 461, and a sub-assembly called the deion 490. The arc horn 461 is a component welded to the yoke 462. The sub Assembly 490 extends as far as the yoke 462, which makes it possible to increase the number of deion plates 491. On the other hand, the fact that an "arc jump" is present on the course of the electric arc goes at against the increase in performance generated by the fact that the number of deion plates 491 is increased.

The arc jump is further shown diagrammatically in FIGS. 24 and 26. The arc jump takes place from a first position 451 of the arc to a second position 452 of the arc above a discontinuity 463 of the conductor which allows the arc to go to the deion sub-assembly 490.

FIGS. 27 and 28 are schematic representations of a switching device 450 known from the prior art without arc jump comprising a mechanism for opening and closing at least one electrical contact between an upstream electrical line and a downstream power line. The opening and closing mechanism includes a breaking chamber 470 'having a yoke 462', an arc horn 461 and a sub-assembly called the deion 490'.

35

As shown schematically in FIGS. 27 and 28, the extension of the arc horn 461 extends under the yoke 462'. This leads to a loss of volume in the breaking chamber and therefore a lower arc voltage and a lower heat dissipation.

FIG. 29 is a schematic representation of a yoke 410 of a switching device 400 proposed by the application.

40

FIG. 30 is a schematic representation of the cut-off device 400 comprising the yoke 402.

45

The switching device 400 has a mechanism for opening and closing at least one electrical contact between an upstream electrical line and a downstream electrical line.

The opening and closing mechanism includes a breaking chamber 420 having a yoke 402, an arc horn 401 and a sub-assembly called the deion 440.

5 Preferably, the yoke 402 has a longitudinal opening 411. Preferably, the arc horn 401 is housed in the same plane as that of the yoke 402. The longitudinal opening 411 allows the arc horn 401 to be housed in the same plane as that of the yoke 402.

10 Preferably, the arc horn 401 is integrated directly into the yoke 402 in a single piece without arc jump.

15 Preferably, the arc horn 401 is arranged on the same plane as the yoke 402.

20 These characteristics have the effect of causing a volume gain in the breaking chamber 403 in order to maximise the performance of the deion 440 (gain of a plate on the deion). They also make it possible to better dissipate the energy of the electric arc.

25 According to one possibility, the yoke 402 may comprise a planar portion 404, preferably extended at one of its ends by a first curved portion 405 comprising a contact zone 406 constituting a fixed contact of the switching device.

30 According to one possibility, the first curved portion 405 and the contact zone 406 are themselves extended by a second curved portion 407 constituting the arc horn 401.

35 Preferably, the arc horn 401 may consist of two portions, that is to say the second curved portion 407 and a terminal flat portion 408. Preferably, the second curved portion 407 is extended by terminal flat portion.

40 Preferably, the terminal flat portion 408 is housed in the longitudinal opening 401.

45 According to one possibility, the arc horn 401 terminates in a flat portion and is preferably curved so that the flat portion is received in the opening 411 of the yoke 402 so as to be parallel and aligned with it. Preferably the opening 401 is emergent.

Optionally, the opening 401 may be made by stamping, in this case it is non-emergent and the part covering the opening 401 extends beyond the thickness of the yoke 402 in the opposite direction to that of the breaking chamber by a distance d . Preferably, this distance is equal to the thickness of the yoke 402. Optionally, this distance is less than the thickness of the yoke 402.

FIGS. 24 and 26 each disclose a cut-off device 400 with arc jump. The cut-off device 400 comprises a first position 451 where the arc is before the arc jump and a second position 452 where the arc is after the arc jump.

These features have the advantage that an arc jump can be avoided and the volume of the breaking chamber can be conserved (and therefore of the number of deion plates in the deion sub-assembly).

The last object of the application is a differential circuit breaker which combines at least two of the different objects mentioned above.

5 Of course, the invention is not limited to the embodiments described and shown in the accompanying drawings. Modifications remain possible, in particular from the point of view of the constitution of the various elements or by substitution of technical equivalents, without thereby departing from the field of protection of the invention.

CLAIMS

1. A differential protection device including a differential fault detector comprising a first electrical circuit and a second electrical circuit, the first electrical circuit including a coil,
said differential fault detector further including a toroid which can be traversed with at least one repeat by at least one conductor, the coil being wound around the toroid and connected to the first electrical circuit for applying a first voltage to the first electrical circuit when a magnetic flux is induced in the toroid, wherein
said differential fault detector includes at least one voltage multiplication device connected to the second electrical circuit and capable of applying a second voltage to the second electrical circuit as a function of the first voltage,
said multiplication device includes at least one electrical energy storage device ,
the multiplication device is capable of applying the second voltage to the second circuit such that the second voltage is greater than the first voltage by a multiplicative factor greater than 2.
2. The differential protection device according to claim 1, wherein it has a first width substantially equal to the width of a base module.
3. The differential protection device according to either one of claims 1 and 2, wherein the differential fault detector includes an intermediate electrical circuit connected to the first electrical circuit by means of a conditioning module, capable of supplying a conditioned voltage to the intermediate circuit as a function of the first voltage, the intermediate electrical circuit preferably being connected to the second electrical circuit by means of the voltage multiplication device.
4. The differential protection device according to any one of claims 1 to 3, wherein the electrical energy storage device is an electrical capacitor preferably having a capacitance between 470 nF and 2200 nF.
5. The differential protection device according to any one of claims 1 to 4, wherein the coil includes a number of turns comprised between 800 turns and 1100 turns.
6. The differential protection device according to any one of claims 1 to 5, wherein the voltage multiplication device includes an AC/DC converter capable of converting an alternating voltage applied to the first electrical circuit and/or, if applicable, to the intermediate circuit, into a direct or quasi-direct voltage applied to the second electrical circuit.
7. The differential protection device according to any one of claims 1 to 6, wherein the second voltage is greater than the first voltage by a multiplicative factor of less than or equal to 8.

8. A differential circuit breaker including at least two disconnection devices, wherein it also includes a differential protection device according to any one of claims 1 to 7, the disconnection devices each including at least one conductor traversing the toroid of the differential protection device with at least one repeat.

9. The differential circuit breaker according to claim 8, wherein it includes four disconnection devices, each including a conductor traversing the toroid of the differential protection device respectively with at least one repeat, the differential protection device and the disconnection devices being preferably arranged in such a way that two disconnection devices are respectively arranged on either side of the differential protection device.

10. The differential circuit breaker according to either one of claims 8 or 9, wherein the disconnection device or devices have a second width that is substantially equal to 0.75 times the width of a base module.

11. A method for controlling at least one electrical apparatus device, by means of a differential protection device according to any one of claims 1 to 7, said method including the following successive steps:

- applying a first voltage in a first electrical circuit from a magnetic field by means of a toroid and a coil;
- applying a second voltage in a second electrical circuit as a function of the first voltage by means of a voltage multiplication device, the second voltage being greater than the first voltage by a factor greater than 2 and
- storing energy by means of an energy storage device connected to the second electrical circuit.

12. The control method according to claim 11, wherein it further includes the following step:

- discharging the electrical energy stored in the energy storage device into a third electrical circuit when a third voltage detected in the energy storage device exceeds a predetermined threshold voltage.

13. The control method according to claim 12, wherein it further includes the following step:

- sending a command intended for the electrical apparatus by discharging into the third electrical circuit the electrical energy stored in the energy storage device.

14. The control method according to claim 13, wherein the sending of the command intended for the electrical appliance consists in applying a force to a control unit of the electrical apparatus by means of an actuator.

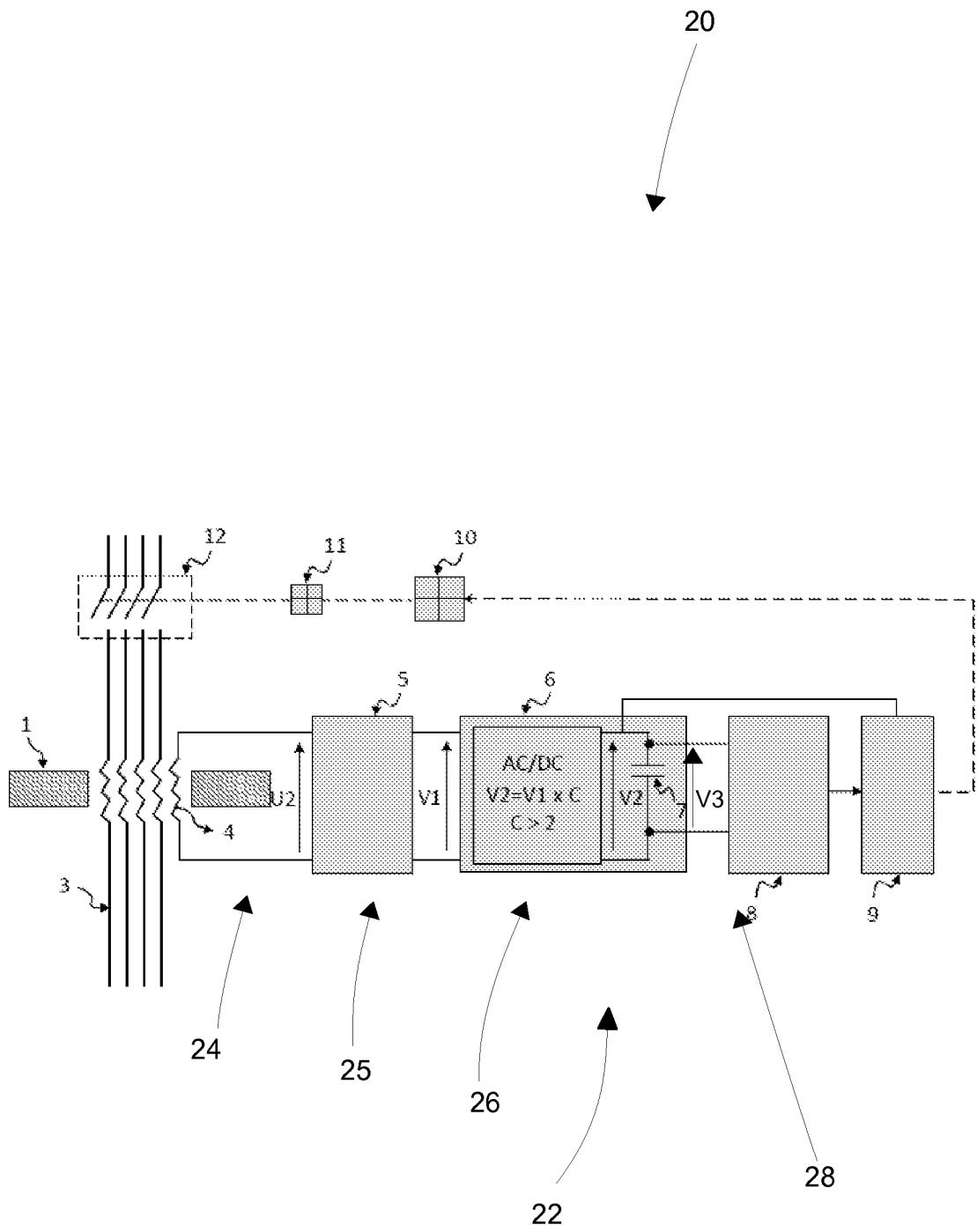
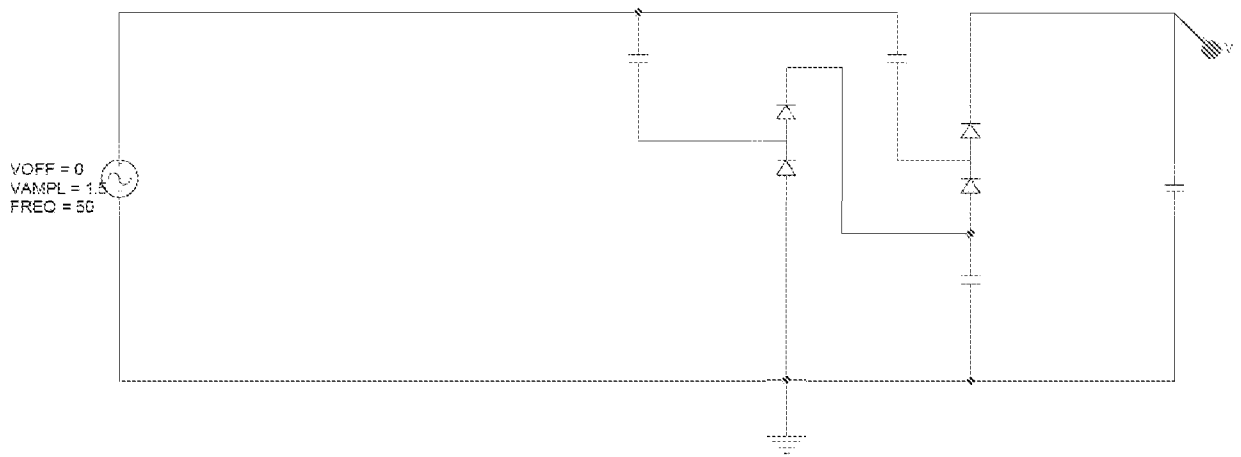


Fig. 1



6

Fig. 3

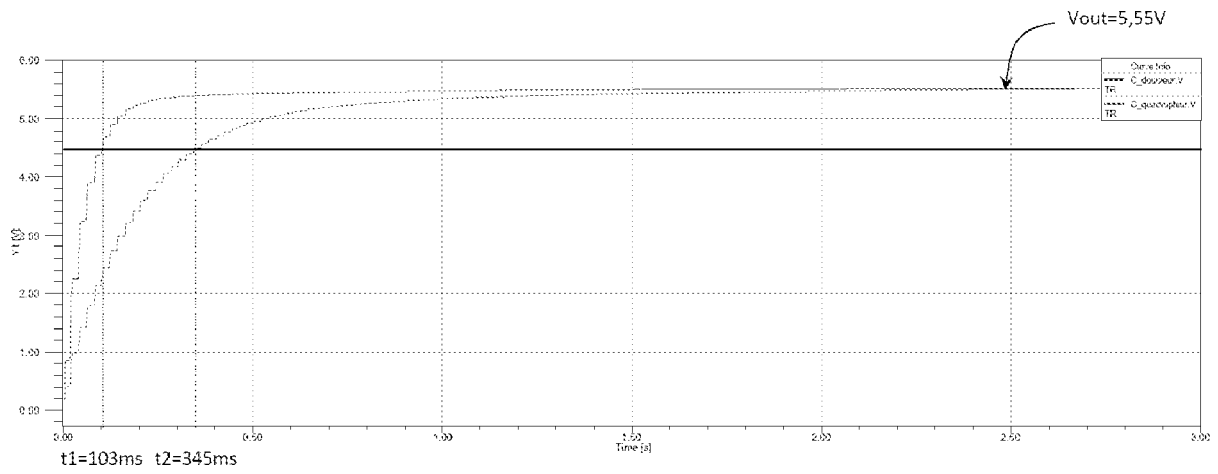


Fig. 4

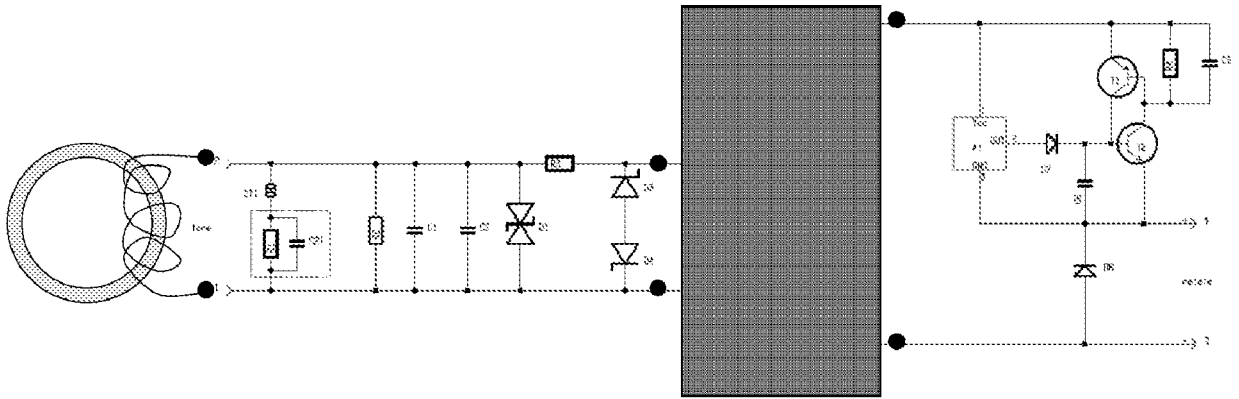


Fig. 5

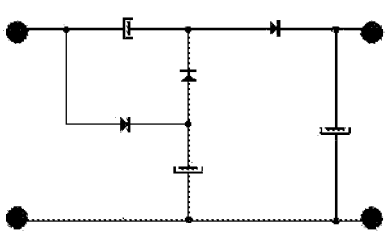


Fig. 5A

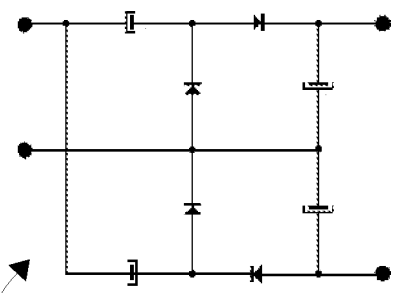
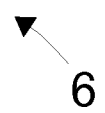


Fig. 5B

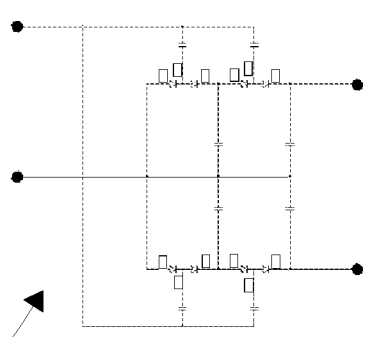


Fig. 5C

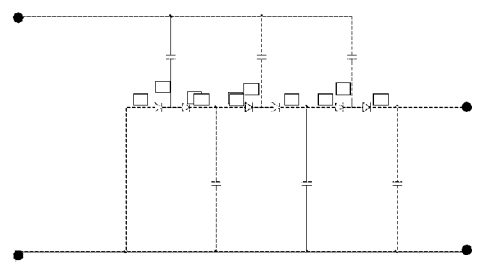


Fig. 5D



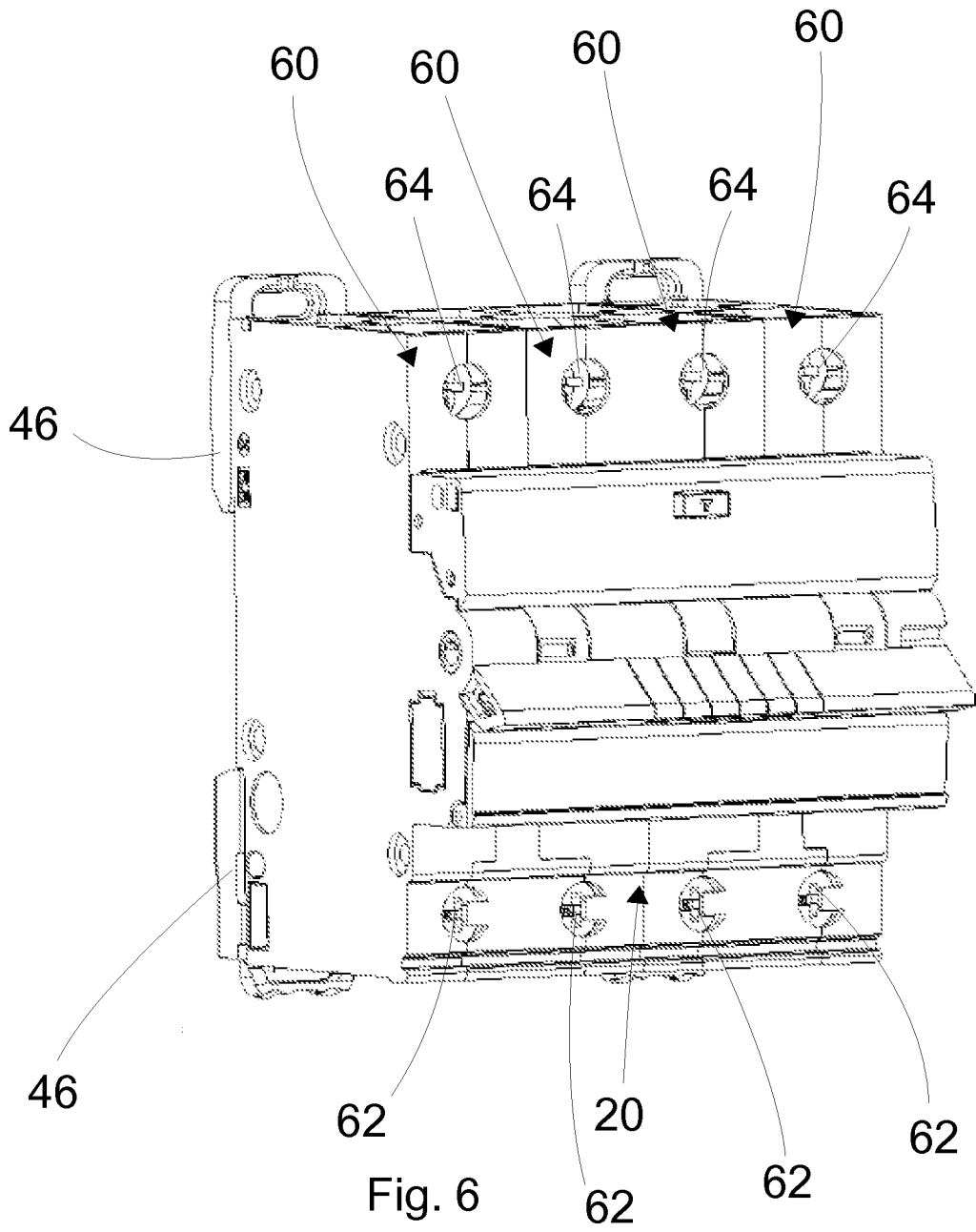


Fig. 6

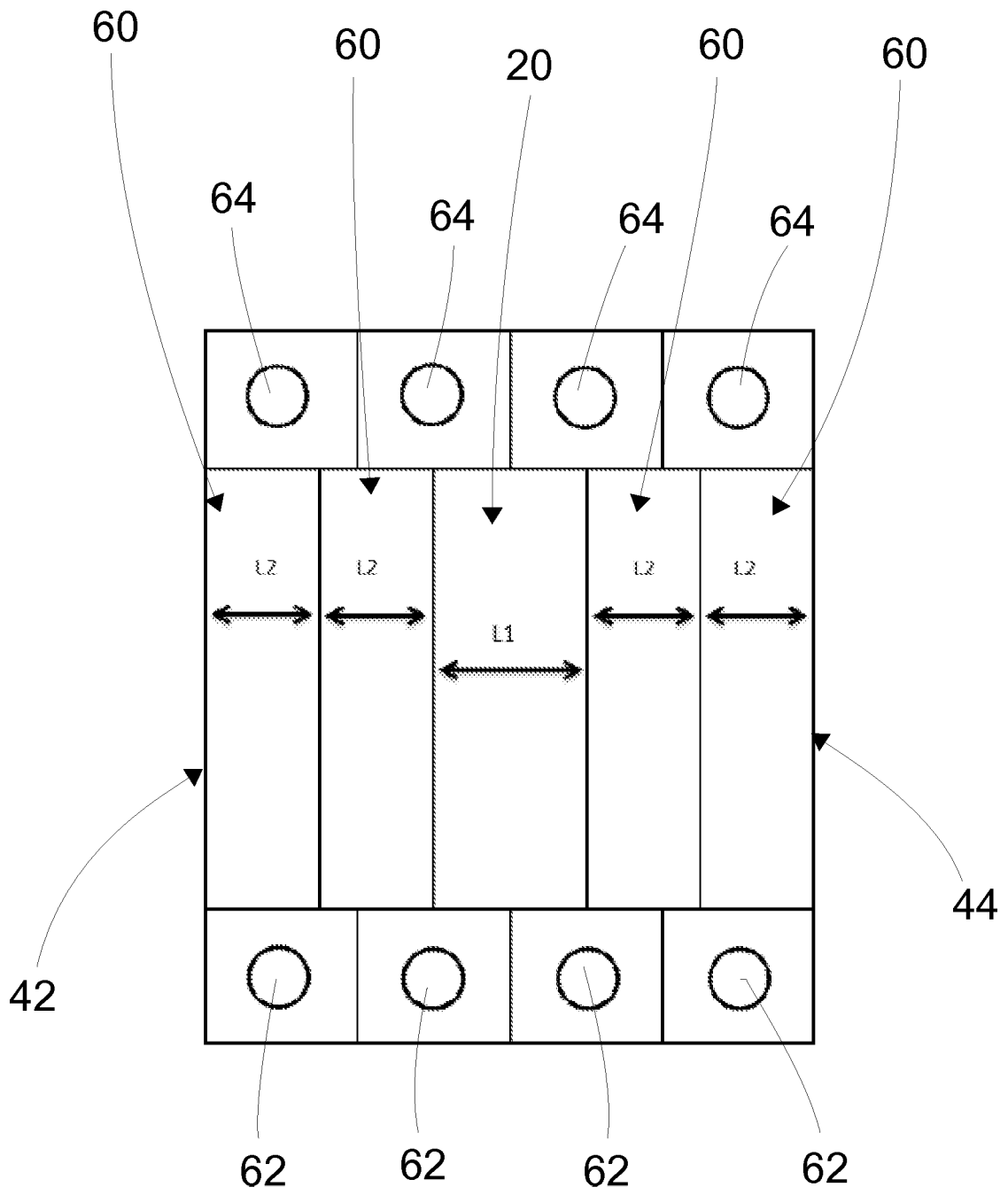


Fig. 7

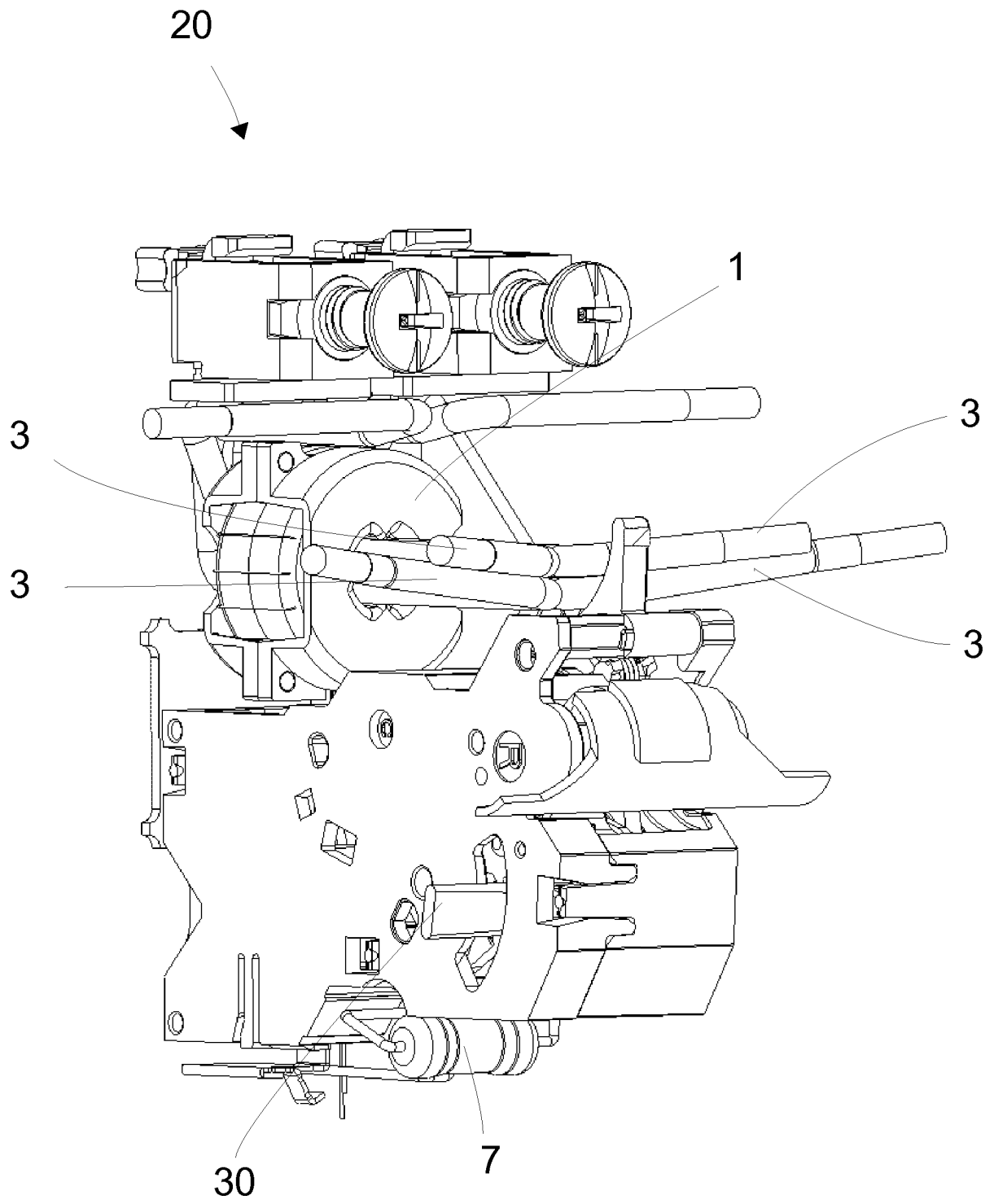


Fig. 8

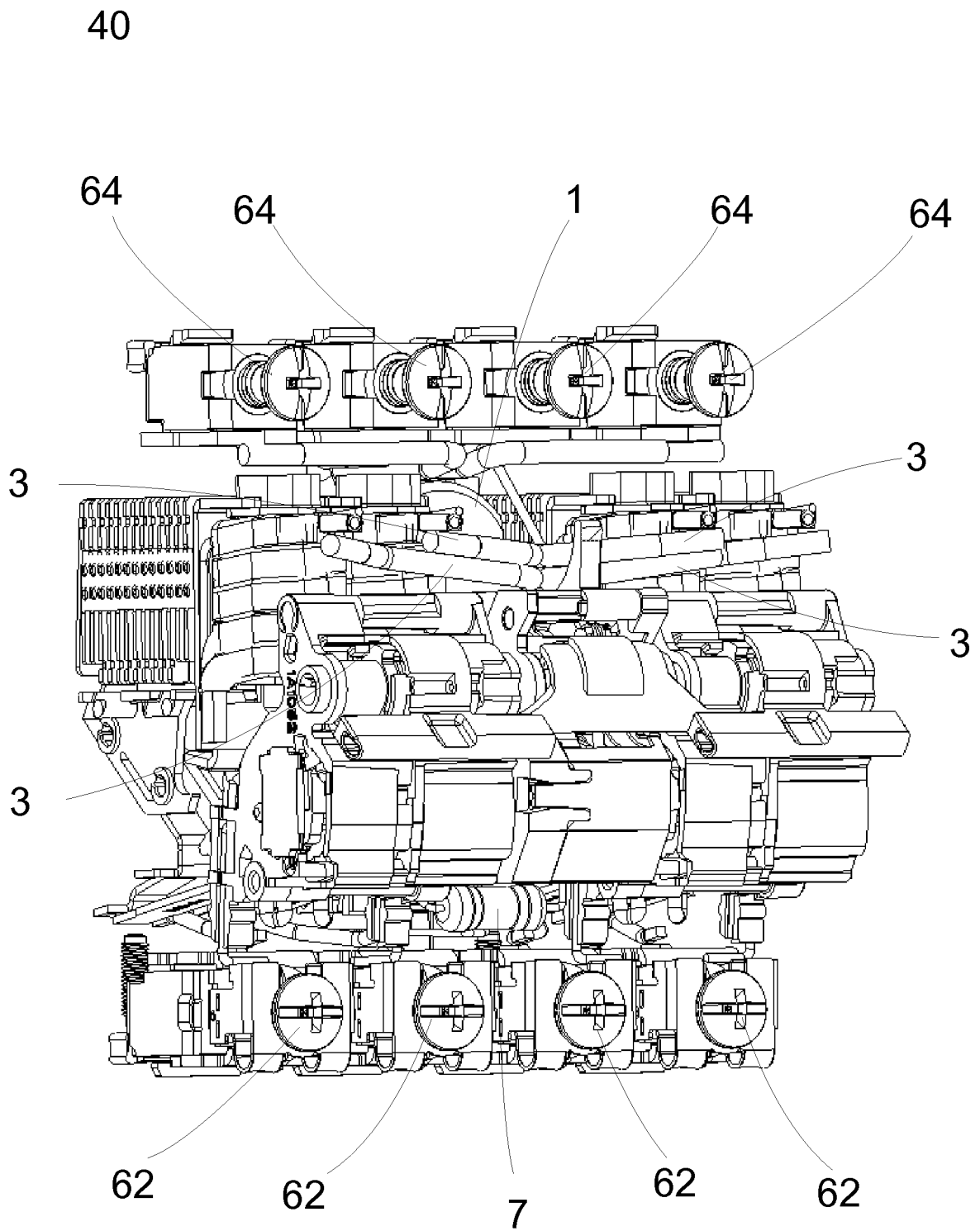


Fig. 9

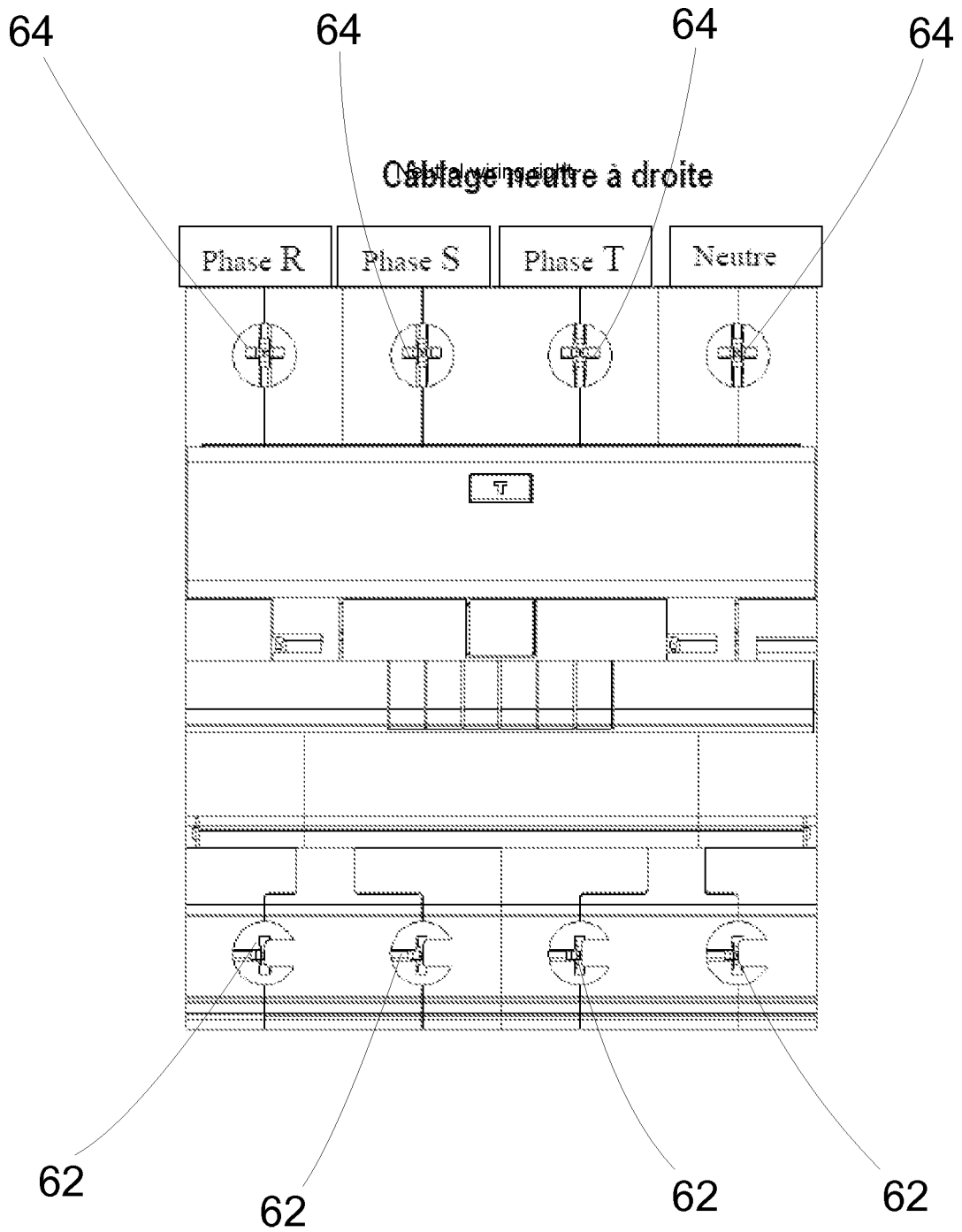


Fig. 10

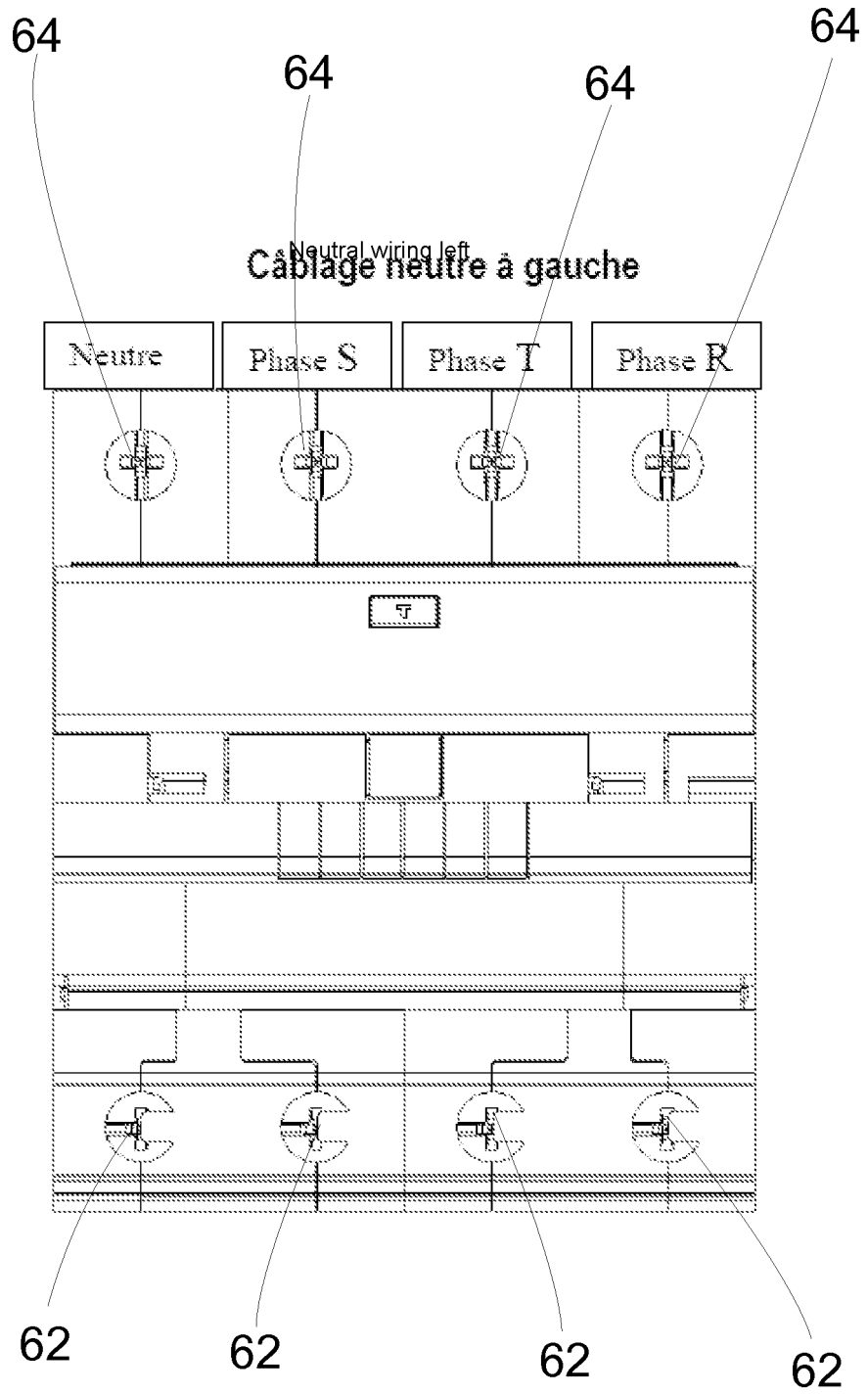


Fig. 11

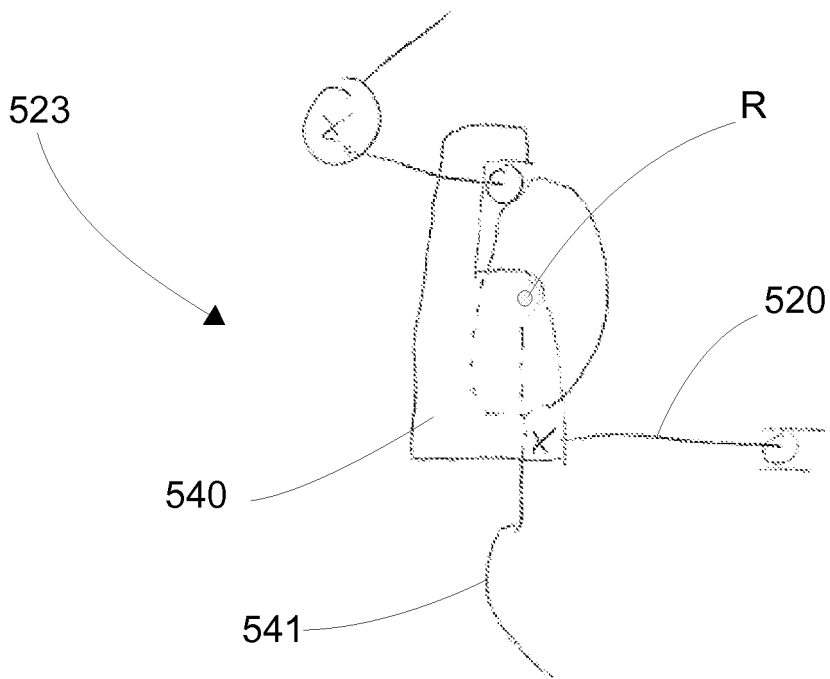


Fig. 12

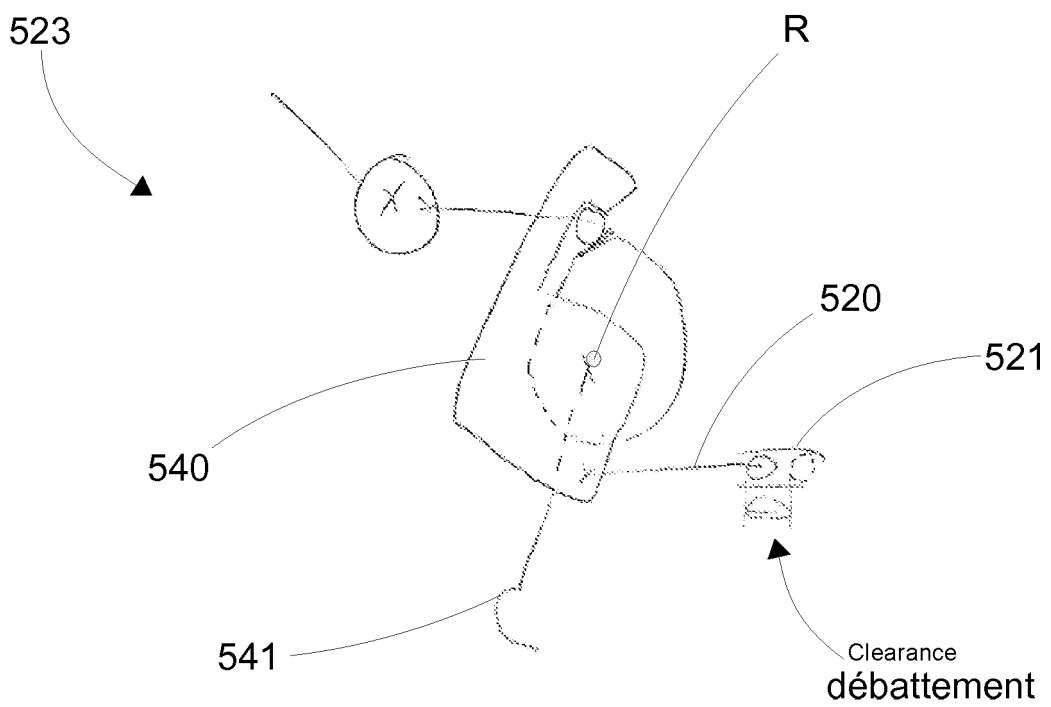


Fig. 12a

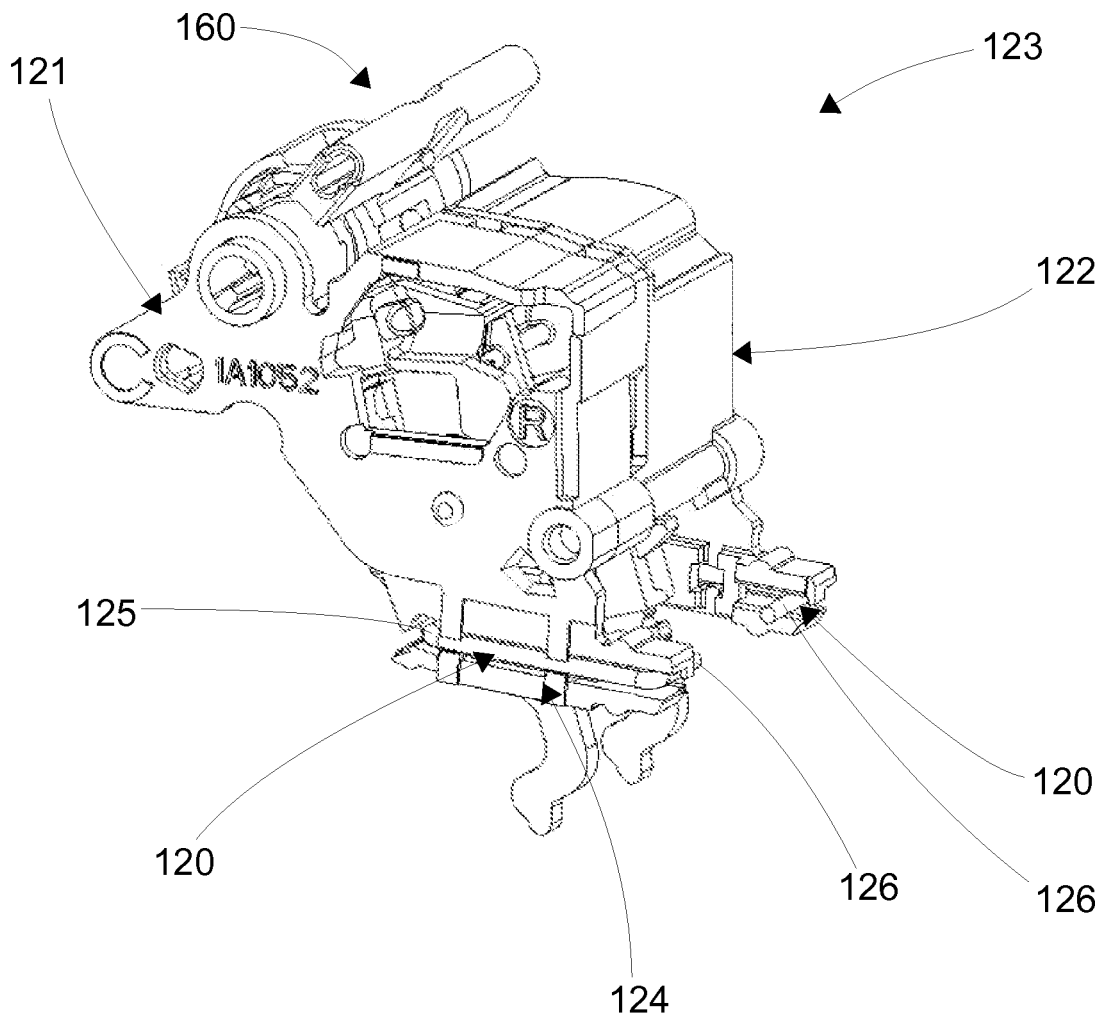


Fig. 13

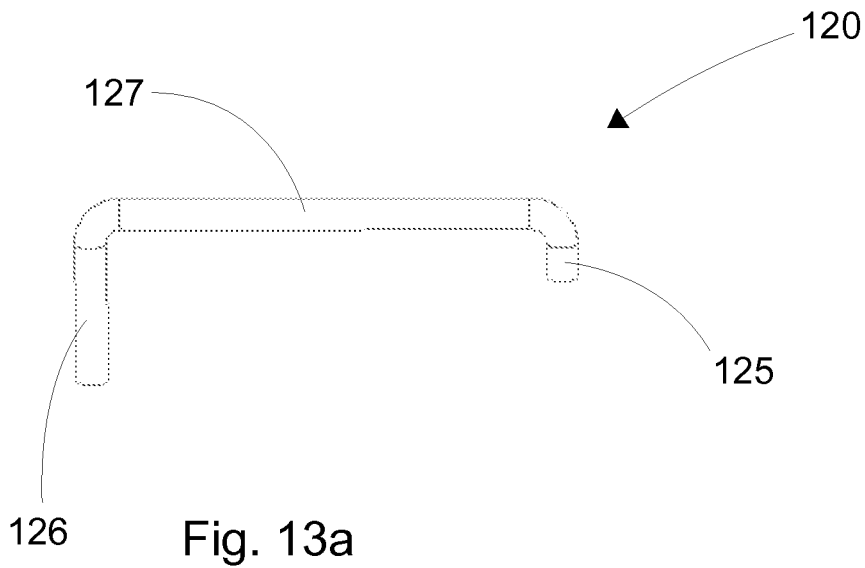
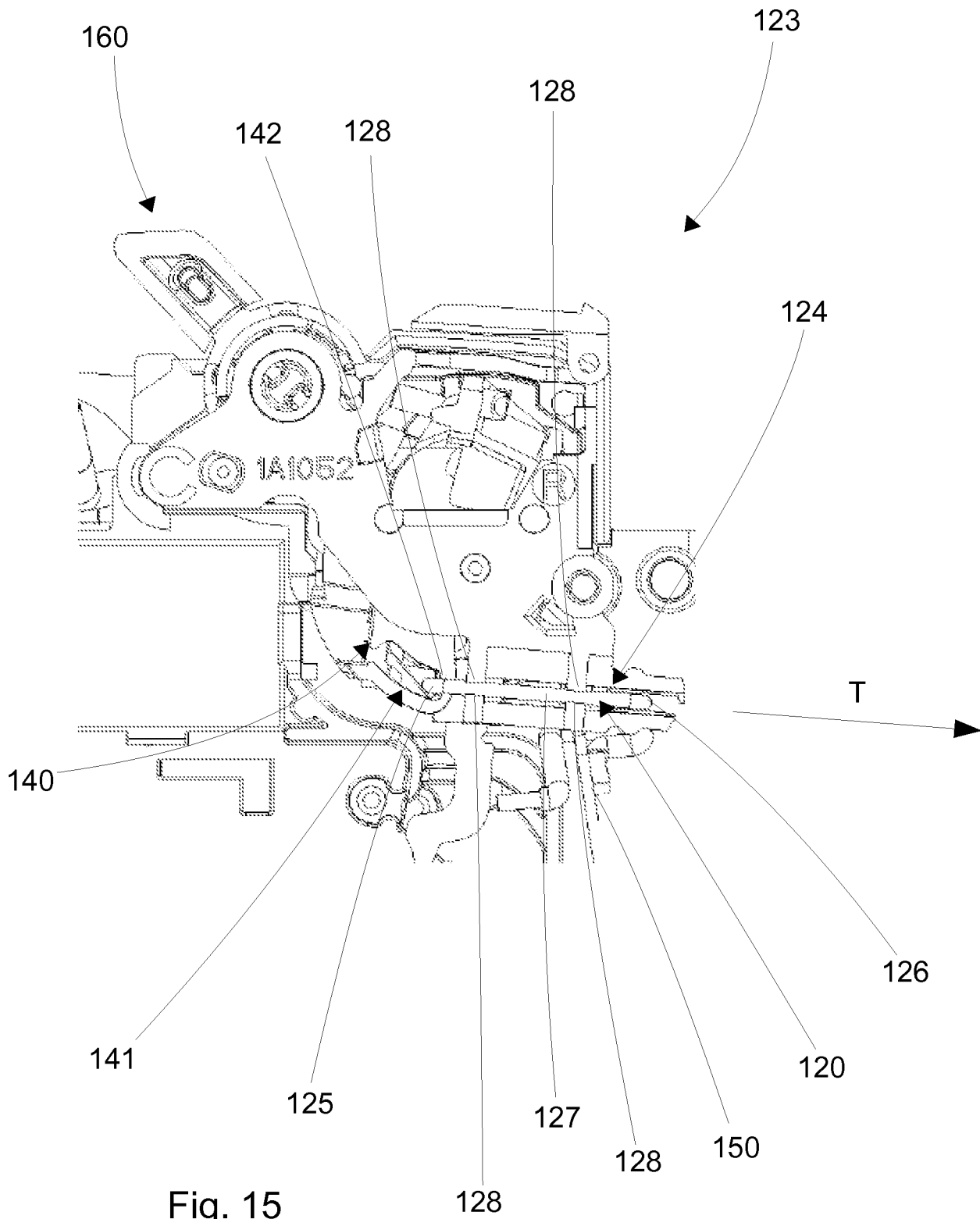
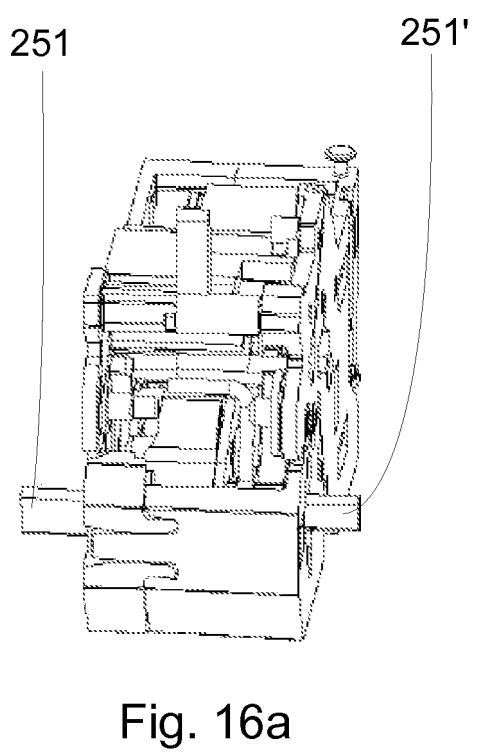
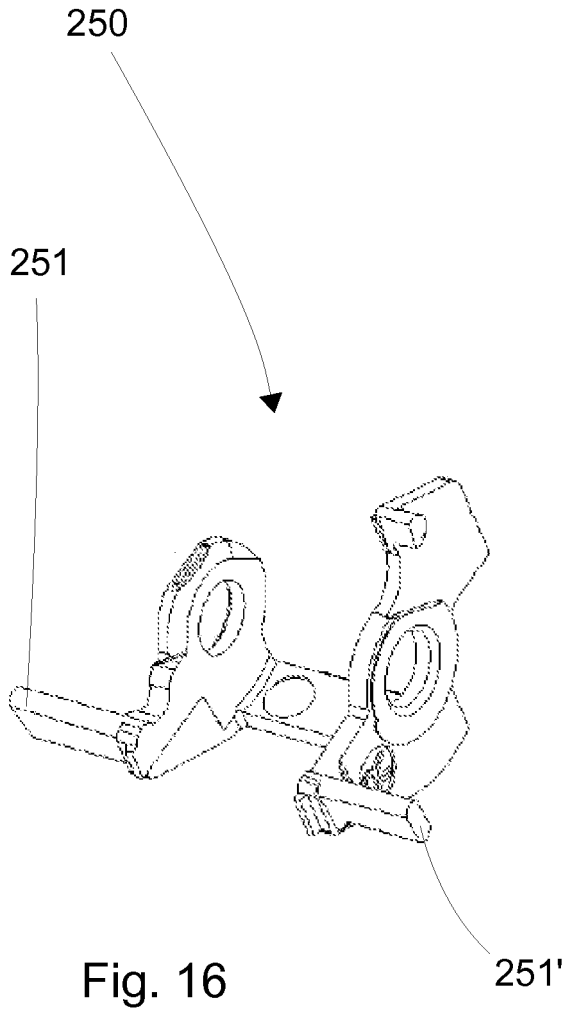


Fig. 13a





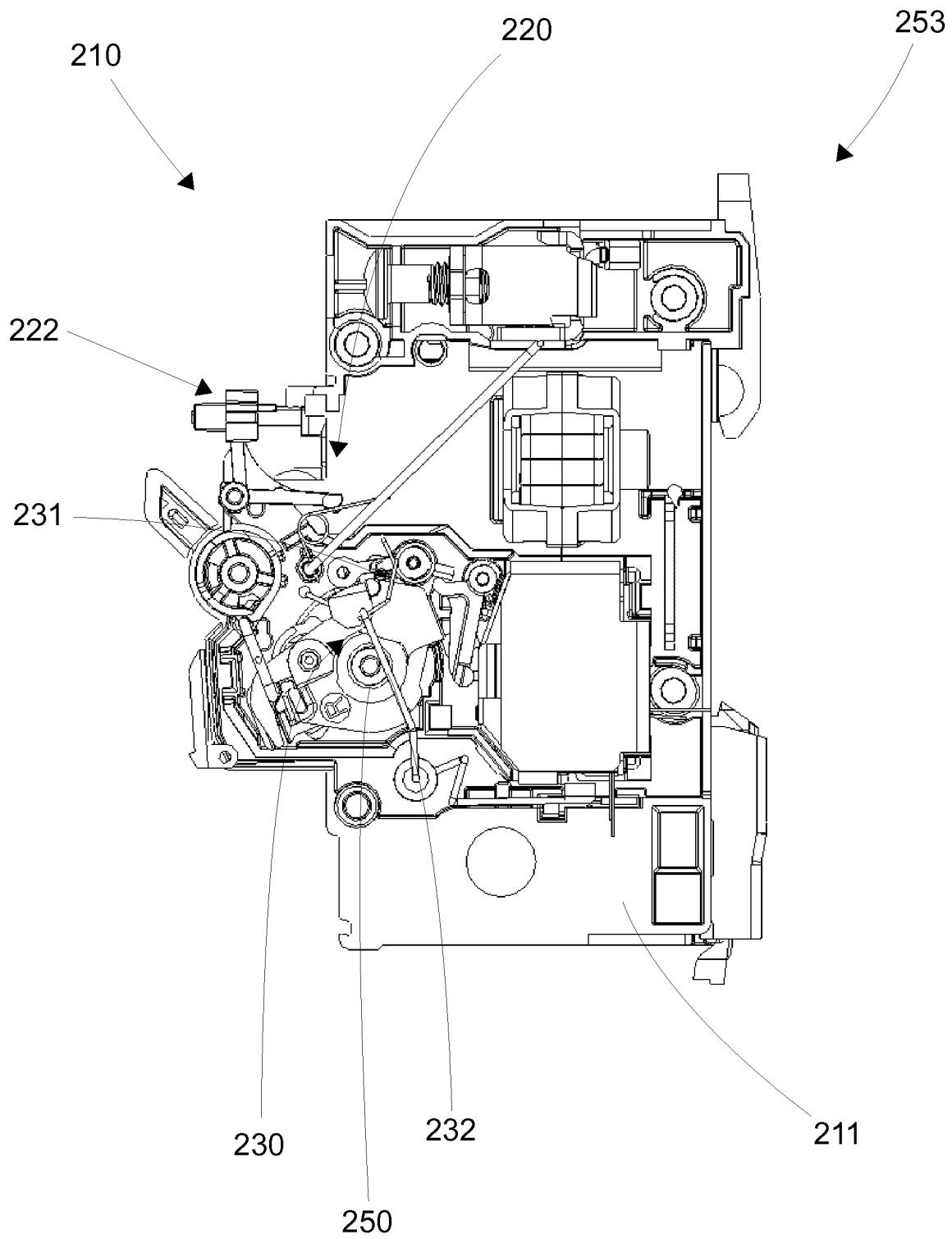


Fig. 17

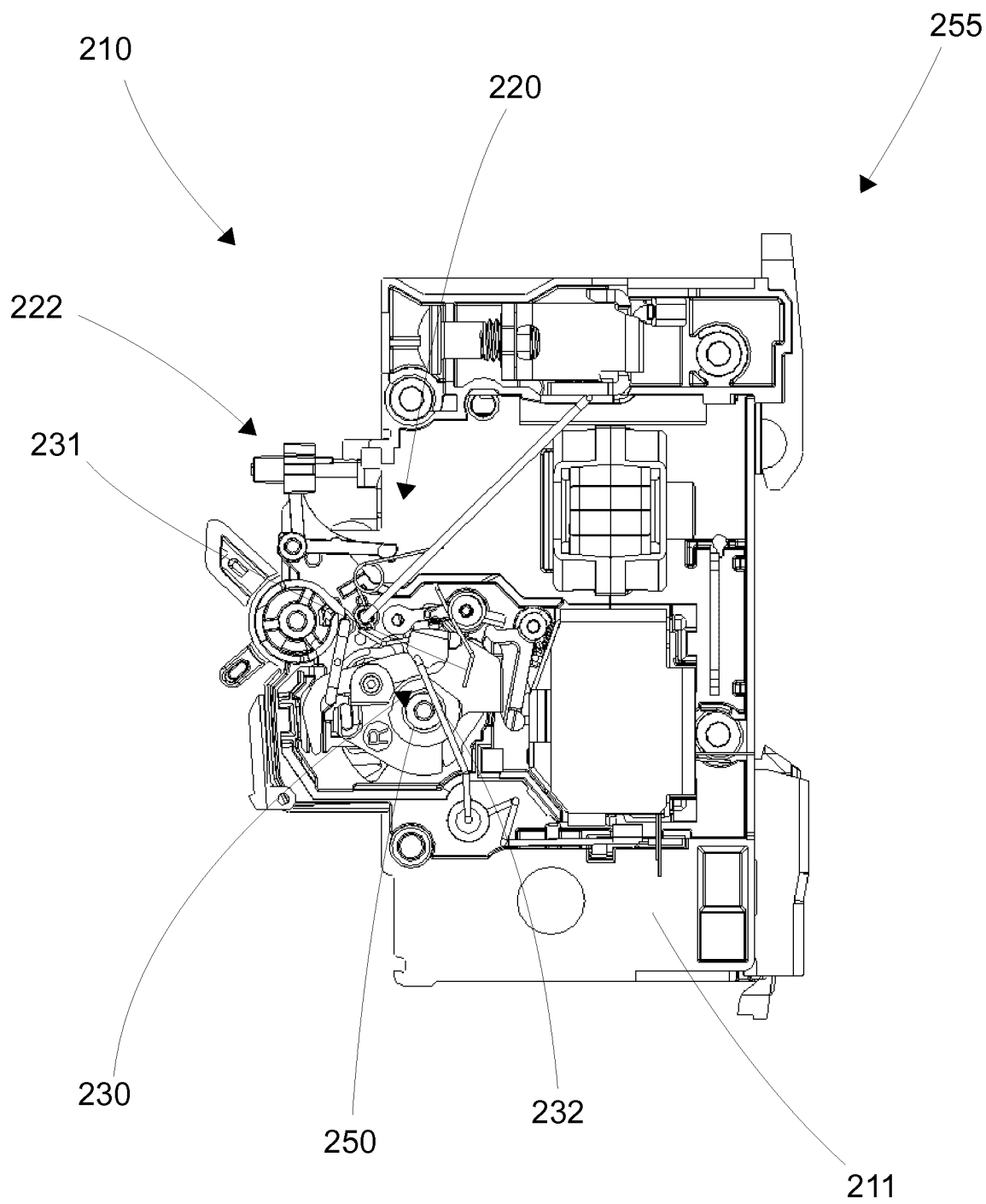


Fig. 18

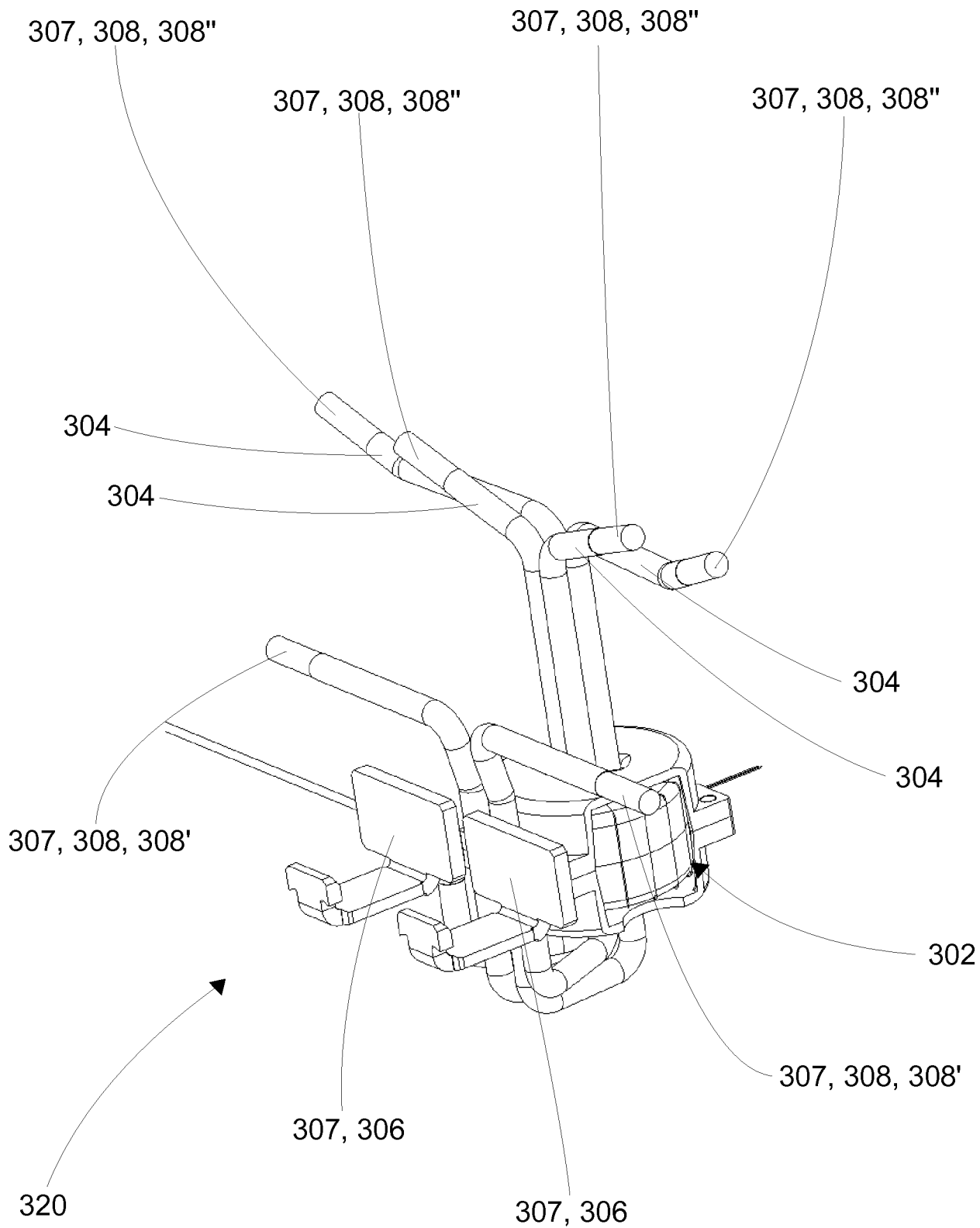


Fig. 19

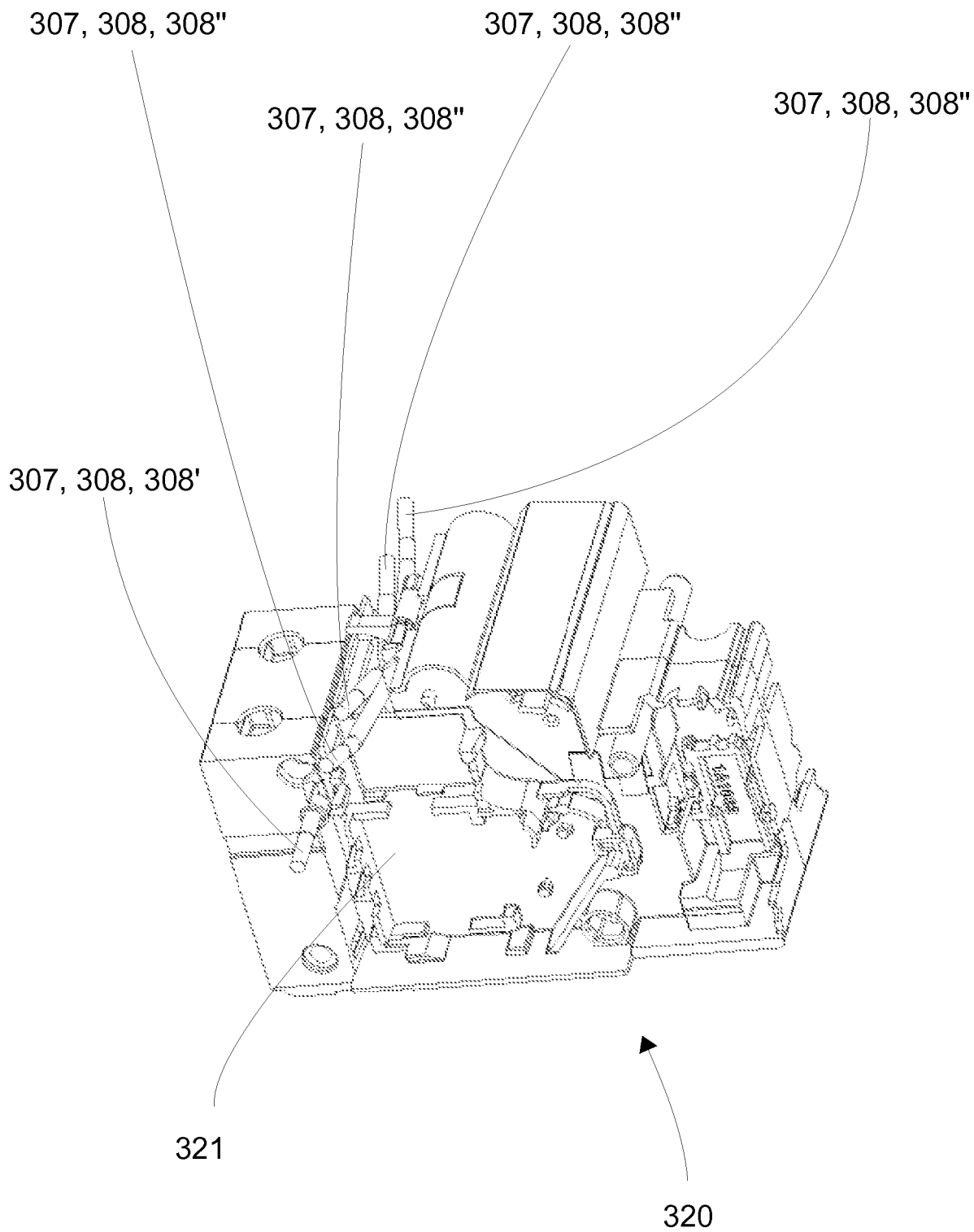


Fig. 20

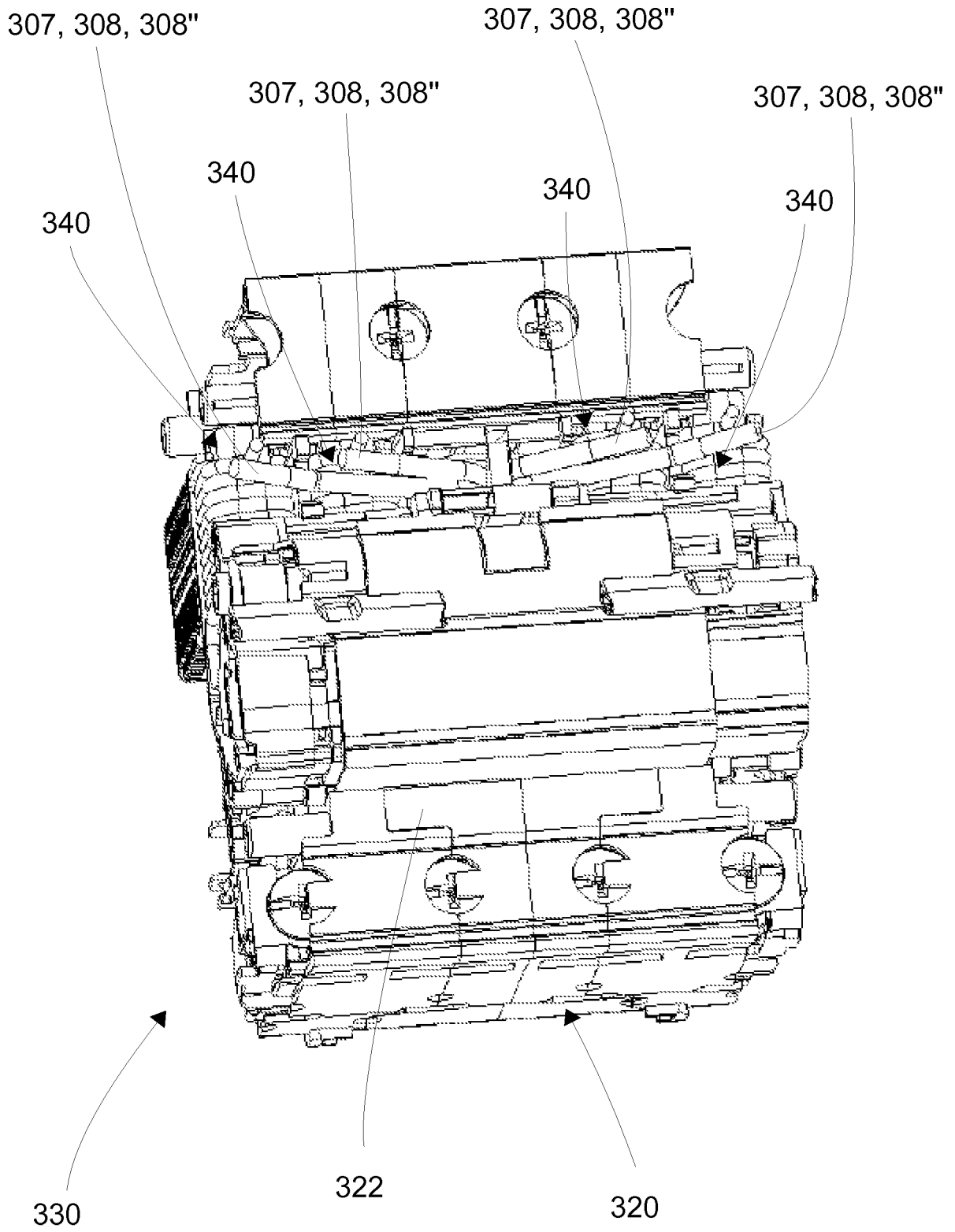


Fig. 21

330

307, 308, 308'

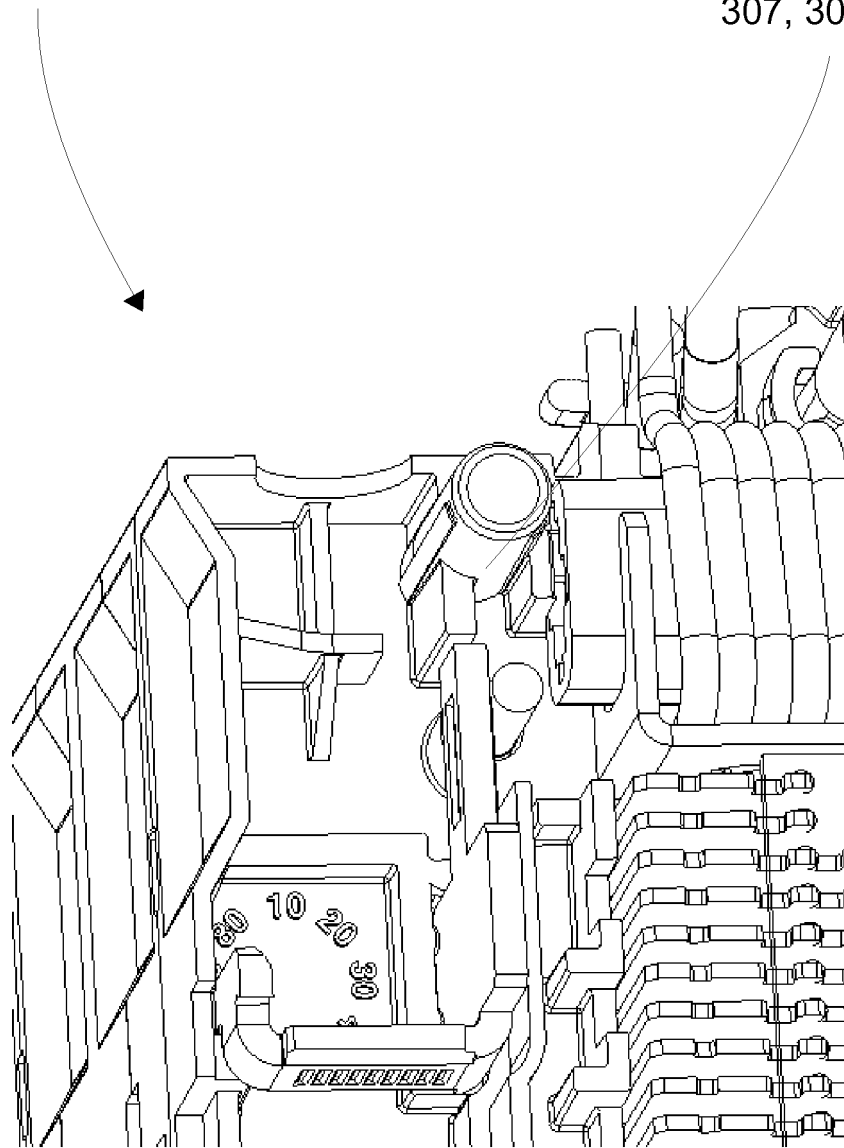


Fig. 22

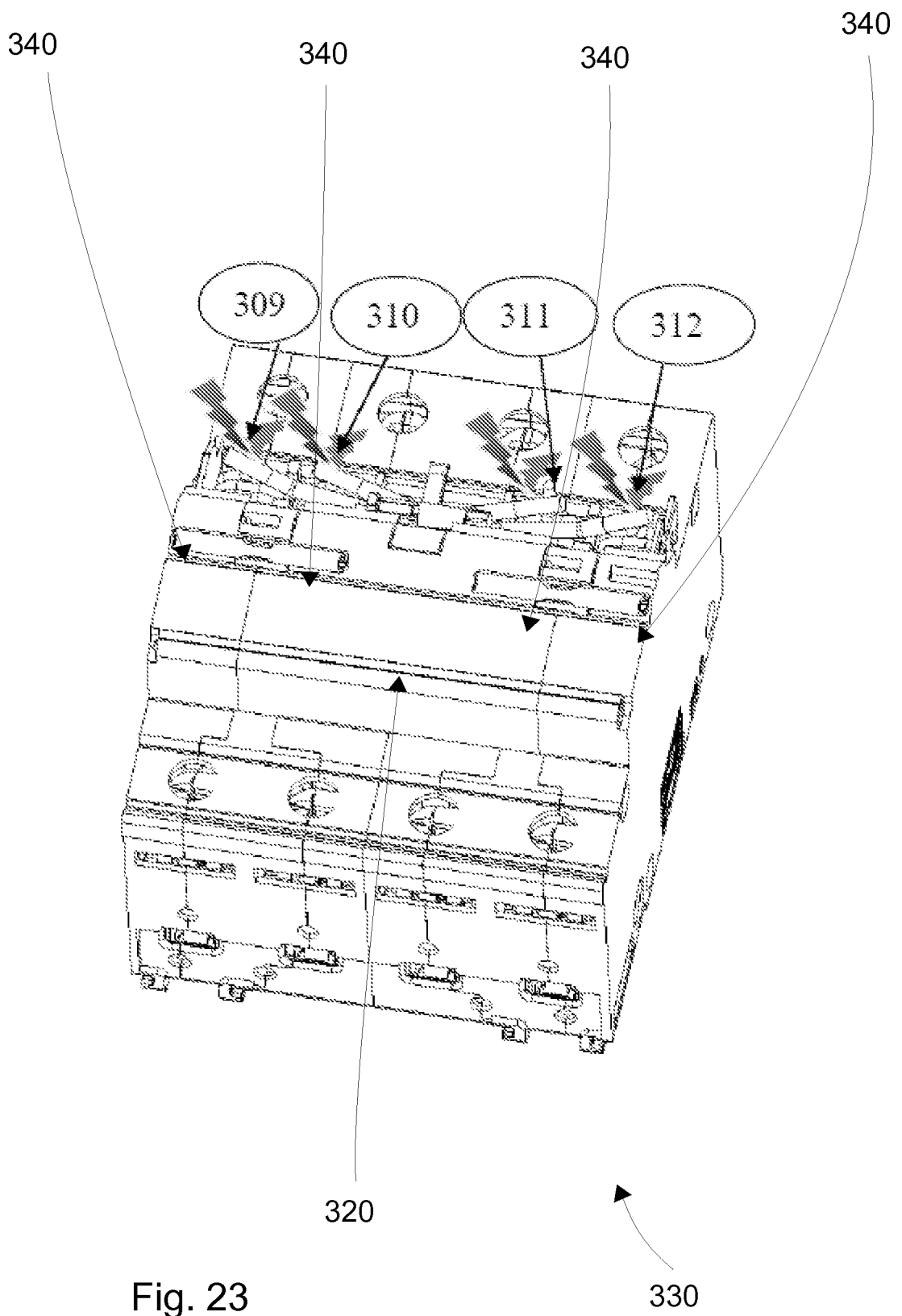


Fig. 23

330

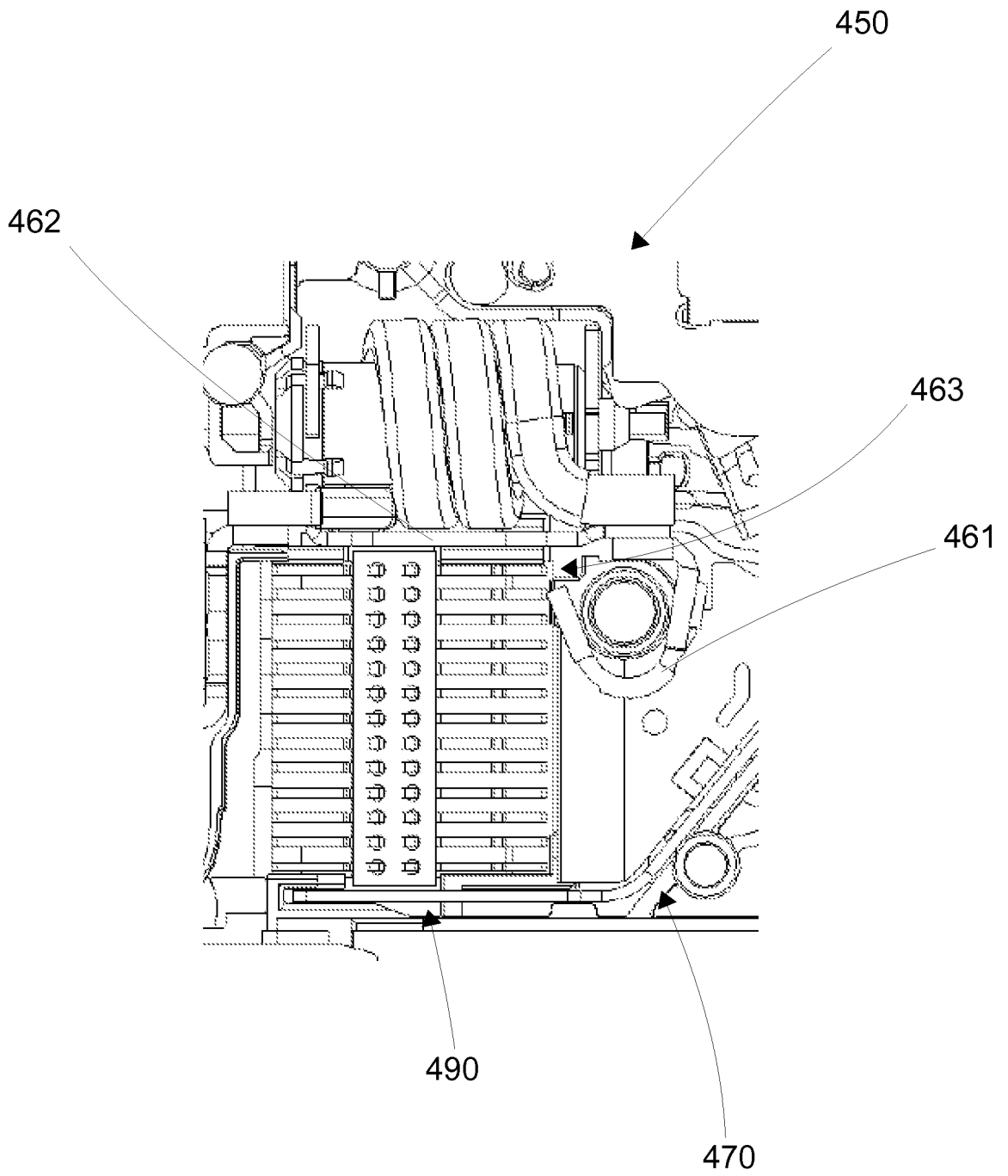


Fig. 25

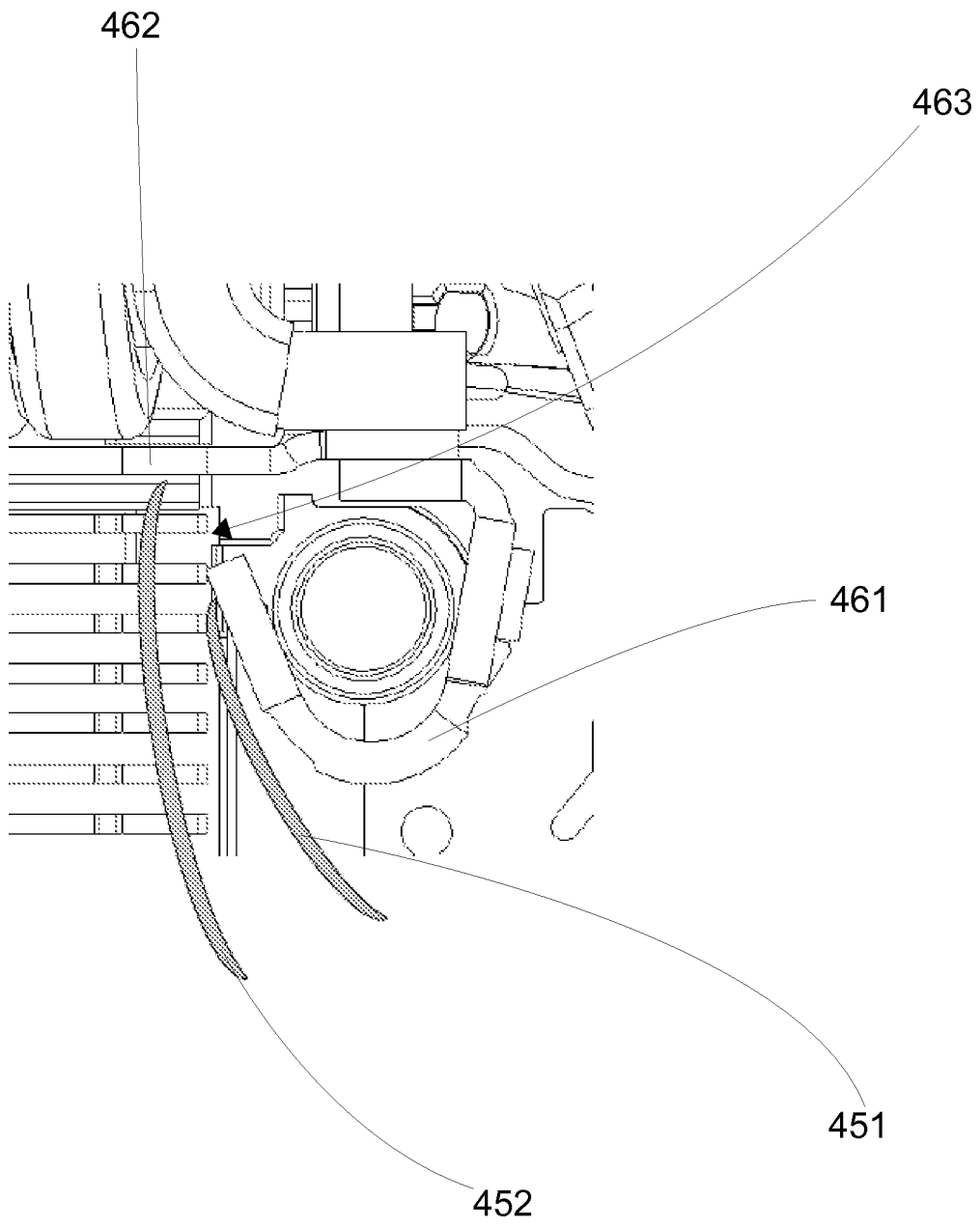


Fig. 26

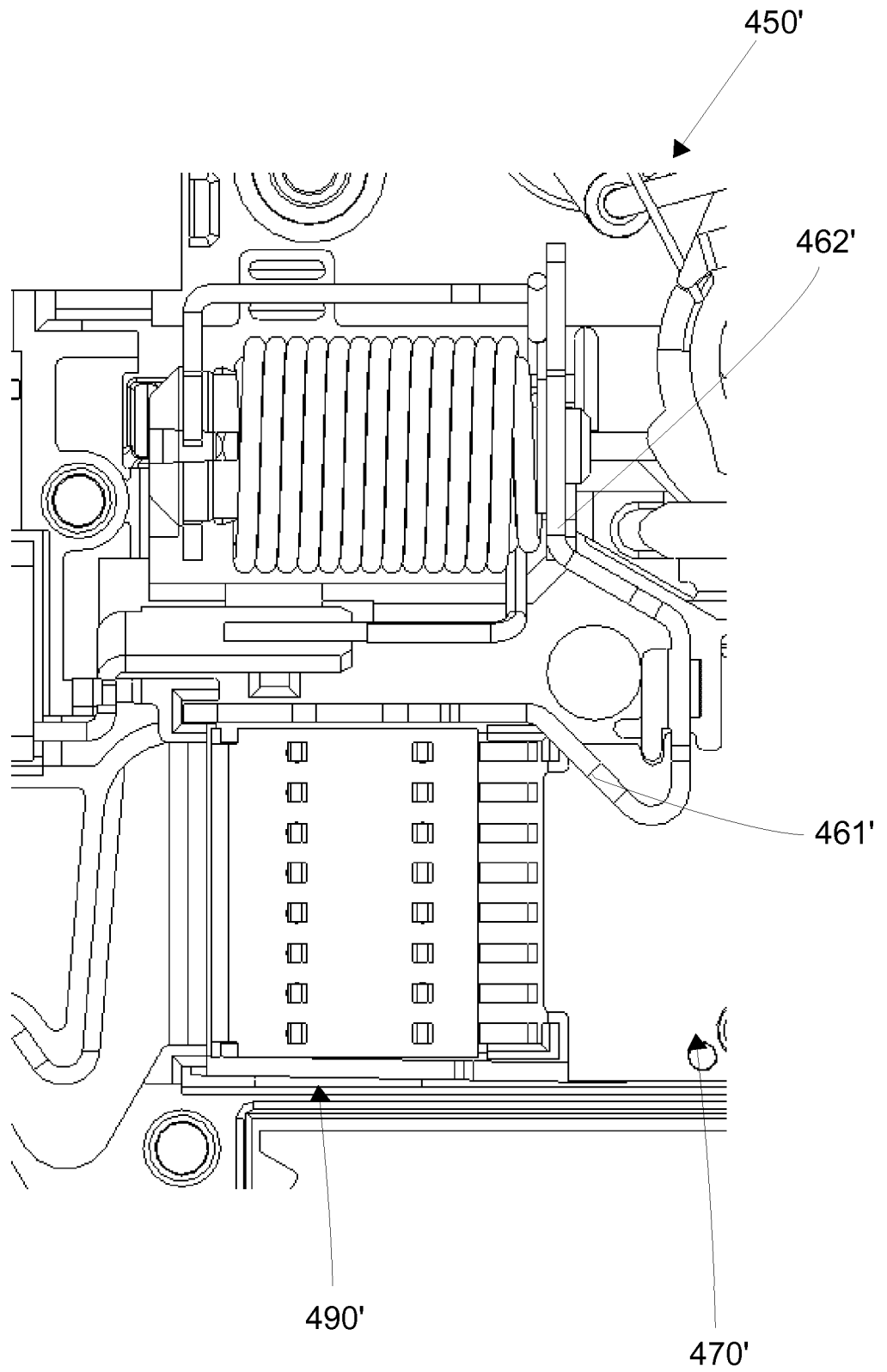


Fig. 27

450'

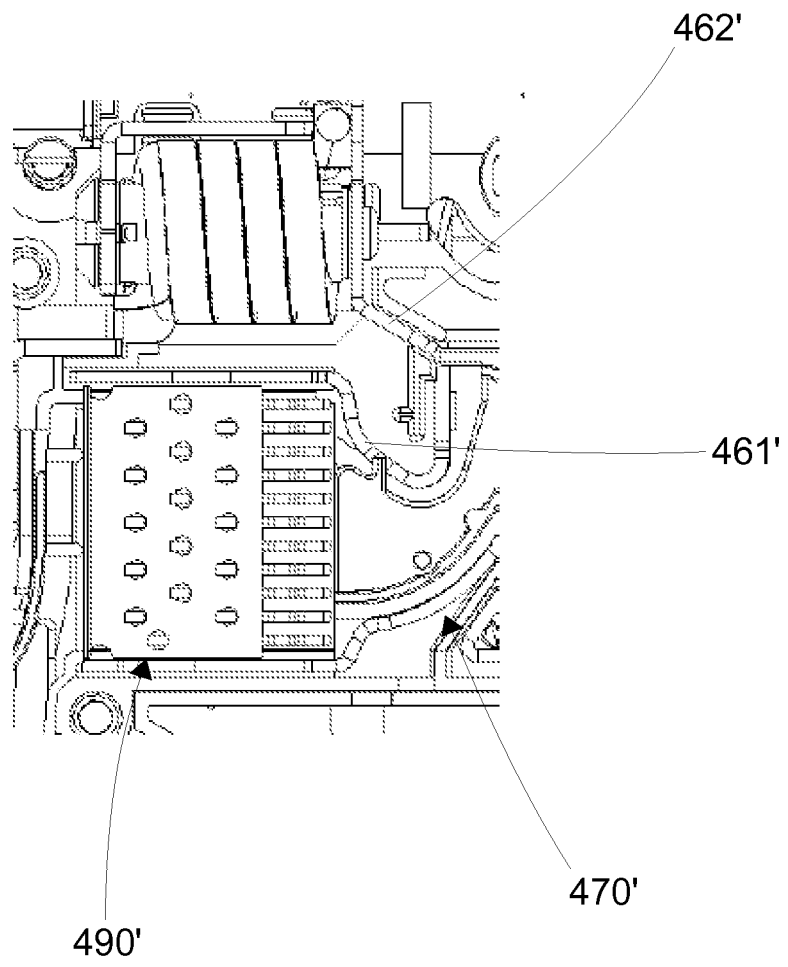


Fig. 28

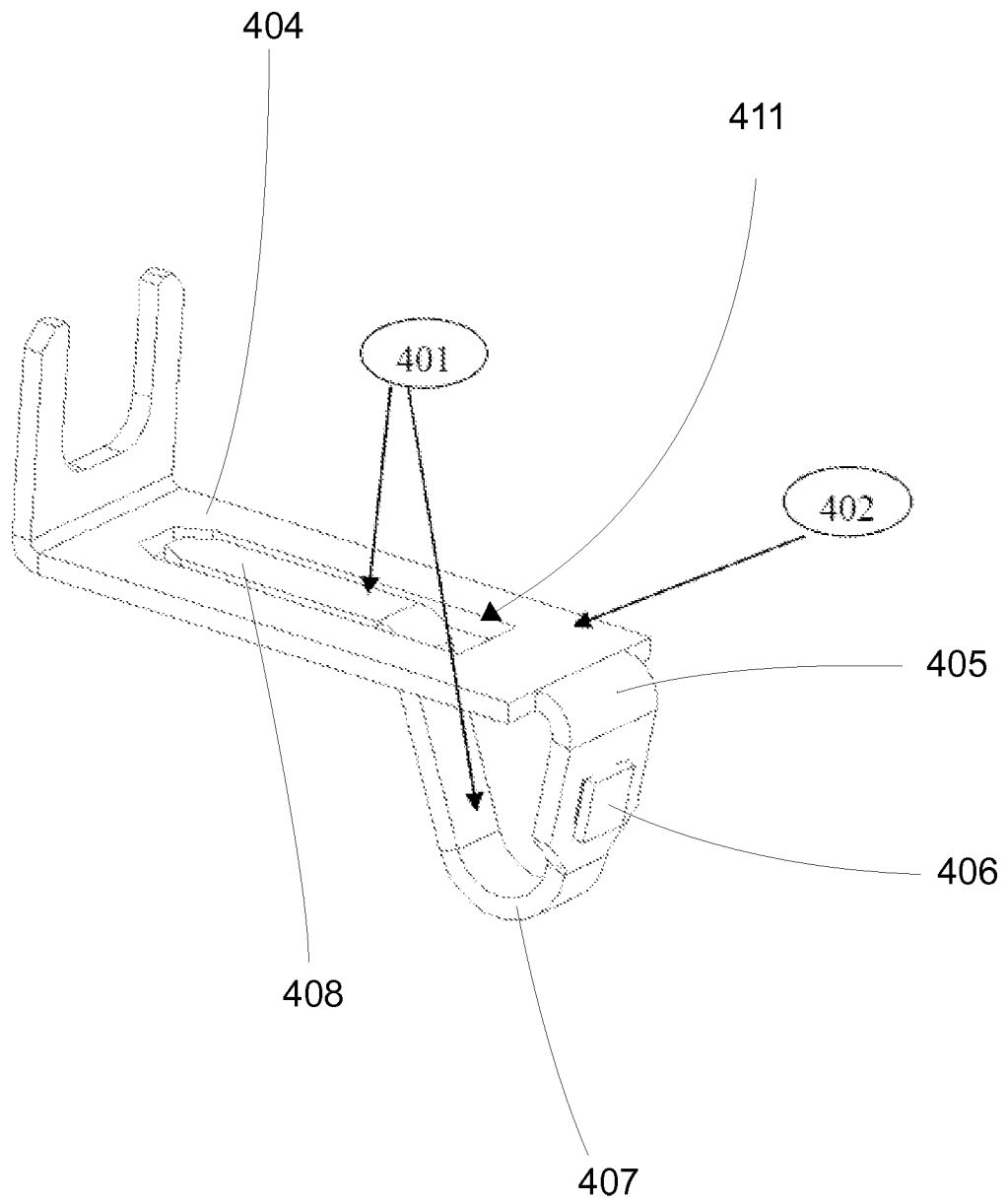


Fig. 29

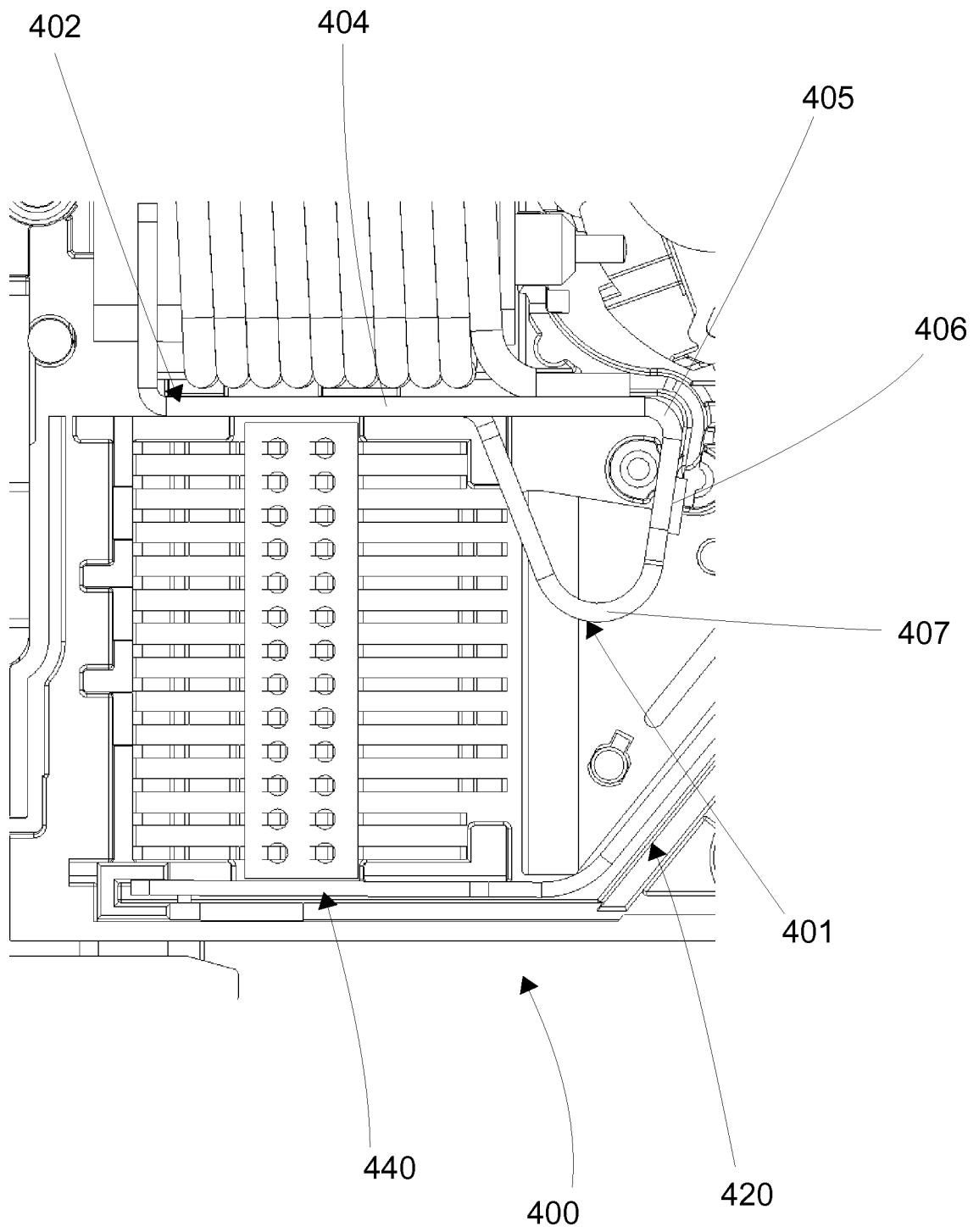


Fig. 30