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Switching mechanism for a circuit breaker

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(56) Related Art
EP 1096528
GB 2267606
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A B S T R A C T

A switching mechanism (15) for a circuit breaker which comprises two break gaps to be jointly switched, which break gaps each comprise a movable contact (8, 8') which is fixed on a switching bridge (9, 9'), with
a support (17) being provided which is held swivelably about a rotary axis (16) of a mechanism which is fixed to the housing and
comprises a partition (18) which extends normal to the rotary axis (16) of the mechanism and on whose two side surfaces there are each attached a cylinder (19, 19'), a bearing stop (26, 26') which is concentric to the rotary axis (16) of the mechanism, as well as a leg support (25, 25'), on which cylinders (19, 19') the switching bridges (9, 9') are placed with their bores (20, 20') and leg springs (21, 21') with their windings (22, 22'), so that the longitudinal axes of the cylinders (19, 19') form rotary axes (36) of the switching bridges, with the first legs (23, 23') of the leg springs resting on the switching bridges (9, 9') and the second legs (24, 24') on the leg supports (25, 25'), as a result of which the switching bridges (9, 9') are permanently loaded in the direction of the bearing stops (26, 26') which are provided with mutually different thicknesses, with
a pin (27) being formed on the upper end of the partition (18) which is opposite of the cylinders (19, 19'), on which pin the first end of the helical compression spring (28) is placed and whose second end rests on the housing, with
furthermore a latch support (29) being provided which is placed with its bore (30) on the bearing stop (26) and is provided with a shoulder (31) in the zone of the upper end of the partition (18) on which a projection (37) of a latch (33) can engage, which latch (33) is rotatably held at the upper end of the partition (18) about a rotary axis (32) of the latch and a bracket (34) is provided which couples the latch (33) with an actuating lever (35), characterized in that
the rotary axes (36) of the switching bridges are disposed offset with respect the rotary axis (16) of the mechanism in the direction of the movable contacts (8, 8').

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COMPLETE SPECIFICATION
STANDARD PATENT

Application Number:

Lodged:

Invention Title: **SWITCHING MECHANISM FOR A CIRCUIT BREAKER**

The following statement is a full description of this invention, including the best method of performing it known to :- us

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The invention relates to a switching mechanism for a circuit breaker which comprises two break gaps to be jointly switched, which break gaps each comprise a movable contact which is fixed on a switching bridge, with a support being provided which is held swivelably about a mechanical rotary axis which is fixed to the housing and comprises a partition which extends normal to the mechanical rotary axis and on whose two side surfaces there are each attached a cylinder, a bearing stop and a leg support, on which cylinders the switching bridges are placed with their bores and leg springs with their windings, so that the longitudinal axes of the cylinders form rotary axes of the switching bridge, with the first legs of the leg springs resting on the switching bridges and the second legs on the leg supports, as a result of which the switching bridges are permanently loaded in the direction of the bearing stops which are provided with mutually different thicknesses, with a pin being formed on the upper end of the partition which is opposite of the cylinders, on which pin the first end of the helical compression spring is placed and whose second end rests on the housing, with furthermore a latch support being provided which is placed with its bore on the bearing stop and is provided with a shoulder in the zone of the upper end of the partition on which a projection of a latch can engage, which latch is rotatably held at the upper end of the partition about a rotary axis of the latch and a bracket is provided which couples the latch with an actuating lever.

A switching mechanism of this kind has become known through **EP-B1-696 041**. This granted patent teaches and expressly states in its claim 1 that the mechanical rotary axis is aligned coaxially to the rotary axis of the switching bridge.

Switching tests were performed with circuit breakers whose switching mechanisms which were provided with the constructional arrangement as illustrated in **EP-B1-696 041**, especially a mechanical rotary axis coaxial to the rotary axis of the switching bridge. It was noticed that during the cut-off, the two movable contacts are not lifted off simultaneously, but temporally offset from the fixed contacts allocated to the same. This time-offset lift-off of the two movable contacts is also specifically referred to in column 2, lines 14 and 15 of **EP-B1-696 041.**

Notice must be taken that a respective two-pole switching device is connected in the incoming circuit to a single-pole a.c. circuit, with the first break gap being switched to the supply conductor (=phase conductor) and the second break gap in the outgoing conductor (=neutral conductor) of said circuit. Both break gaps are therefore flowed through by the same current and must interrupt the same current in the case of a short-circuit.

If, as is taught in **EP-B1-696 041** (cf. column 2, lines 14, 15 of said document) or as is actually provided in a switching mechanism as designed according to **EP-B1-696 041**, the two movable contacts are lifted off mutually temporally offset from the fixed contacts, an arc is produced only between the contact elements of the first break gap during the first phase of the opening process in which the first movable contact has already lifted off and the second movable contact still rests on the fixed contact associated to the same.

Since this arc is flowed through by a short-circuit current, a very large energy quantity is released in the same which in the contact elements of the first break gap is converted into respectively large heat quantities.

The strong heating of the contact elements leads to a relatively high amount of wear and tear of these contact elements (contact erosion). This contact erosion leads to a low service life of the first break gap and thus naturally to the entire switching device. If an economically viable life of the first break gap and thus the entire switching device is to be achieved, the contact elements of the first break gap have to be provided with a respectively large volume in order to compensate the contact erosion.

Large-volume contact elements consequently have larger dimensions which in the end lead to an enlargement of the entire switching device.

It is the object of the present invention to provide a switching mechanism of the kind mentioned above which allows a particularly rapidly progressing interruption of the short-circuit currents with the smallest possible volume of the contact elements of the two break gaps, and thus with small dimensions of the switching device, and with a high service life of these break gaps.

This is achieved in accordance with the invention in that the rotary axes of the switching bridges are disposed offset with respect the mechanical rotary axis in the direction of the movable contacts.

It is achieved by the offset arrangement of the rotary axes that the two movable contact elements are lifted off simultaneously from the fixed contact elements assigned to the same. This simultaneous opening leads to the consequence that the short-circuit current to be cut off is interrupted already at the beginning of the cut-off process at two places simultaneously. Arcs are formed in both break gaps, as a result of which the energy of the short-circuit current can be released in two arcs.

The energy released within each arc is thus only half the energy released in a single arc of a switching mechanism according to **EP-B1-696 041** and emitted to the contact elements. This leads to a considerably lower contact erosion and thus a higher service life of all contact elements and thus the entire switching device.

During the separation of an alternating current by spacing two contact elements, said spacing movement of the contact elements occurs slowly as compared with the frequency of the alternating current (50 Hz). During the opening movement of the contact elements, the alternating current passes through a number of periods during which it also becomes zero, with the arc extinguishing. A new ignition of the arc after such a zero-passage-induced extinction can only occur when the voltage driving the short-circuit current exceeds the re-ignition voltage of the arc. The re-ignition voltage of two arcs connected in series is considerably higher than the re-ignition voltage of a single arc, so that as a result of the simultaneous opening of the two break gaps which is achieved in accordance with the invention, the short-circuit current can be finally interrupted at an earlier point than if only one of the two breaks gaps is opened at first as in **EP-B1-696 041.**

In this way the entire heat produced in a cut-off process in the switching device can be reduced, as a result of which the entire switching device can be designed with less temperature-resistance and especially with smaller dimensions.

A second factor which is relevant for the rapid final extinction of an arc driven by an alternating voltage is the quickest possible drawing to a large length of the running path of the arc. Since the arrangement of the switching mechanism in accordance with the invention produces a simultaneous severing of the short circuit at two places and thus the formation of two arcs disposed in series, the entire running path of the arc is twice as long right from the start as during the opening of the circuit at only one place. During the opening movement of the movable contact elements, two arc running paths are drawn open, as a result of which the entire arc running path to be bridged by the current to be cut off is drawn open twice as fast as in a switching mechanism according to **EP-B1-696 041**, where at first only one arc is formed.

The movable contacts must be swiveled during the opening movement by such an angle as compared with the fixed contacts that in the OFF position the movable contacts are disposed at a distance from the fixed contacts so as to ensure a disruptive-discharge-free interruption.

If the rotary axis of the switching bridge is arranged coaxially to the mechanical rotary axis as in **EP-B1-696 041**, then this entails that switching bridges extend over the entire distance between the movable contacts and the mechanical rotary axis. If, on the other hand, the rotary axes of the switching bridges are arranged in the manner in accordance with the invention in the direction towards the movable contacts offset with respect to the mechanical rotary axis, the switching bridges are provided with a considerably shorter arrangement.

As a result of the shorter arrangement of the switching bridges, the same are provided with a smaller mass, thus reducing the mass moment of inertia of the entire switching mechanism. This reduced mass moment of inertia leads to the consequence that the switching mechanism can be brought particularly rapidly from the ON to the OFF position.

In summary, the offset in accordance with the invention of the rotary axis of the switching bridges with respect to the mechanical rotary axis in the direction towards the movable contacts leads in three respects to a faster cut-off of the short-circuit current entailing less contact erosion and a lower heat development:

- As a result of the simultaneous formation of two arcs disposed in series, the energy produced by the short-circuit current is divided among the two break gaps, thus leading in the two break gaps to a relatively low load on the contact elements, i.e. a lower contact erosion.

- As a result of the simultaneous formation of two arcs, the entire running path of the arc to be bridged by the short-circuit current is larger than compared with an only single-pole interruption and is drawn up twice as fast compared with an only single-pole interruption. The re-ignition voltage is thus higher and rises during the opening movement twice as fast as in the case of an only single-pole interruption.

- The smaller mass moment of inertia of the entire mechanism, which can be achieved by the smaller switching bridges, allows a faster movement of the same.

A further effect which is obtained from the offset of the rotary axes of the switching bridge as compared with the rotary axis of the mechanism is that there is a cleaning of the sections of the movable and fixed contacts which rest on one another in the ON position:
During the swiveling of the support and the switching bridges thus fixed on the same to the ON position, the movable contacts come to rest on the fixed contacts.

As soon as a movable touches the assigned fixed contact in the course of this turn-on movement, any further swiveling of the respective movable contact which occurs synchronously with the support is prevented.

In the course of the further progressing swiveling of the contact bridge, the same is swiveled against the pressure of the leg spring about the rotary axis of the switching bridge against the swiveling direction of the support. The end of the switching bridge which is opposite of the movable contact is lifted off from the bearing stop (cf. fig. 2).

During this swiveling of the switching bridge, the movable contact is displaced tangentially with respect to the fixed contact, with the surfaces of the fixed and movable contact which rest on one another rubbing against each other. Any impurities disposed on said surfaces are removed during this mutual rubbing, thus always securing a particularly low-resistance transfer from the fixed to the movable contact.

The displaced arrangement of the mechanical rotary axis with respect to the rotary axis of the switching bridge is already known in connection with a single-pole circuit breaker from **AT-B-404 648** (cf. its claim 1): The switching mechanism shown in this document is provided, as in the switching mechanism in accordance with the invention, with a supporting bracket 4 on which a switching bridge 5, a latch support 6 and a latch 3 are rotatably held. The entire mechanism is swivelably held about a rotary axis 11 of the mechanism which is fixed to the housing. The latch support 6 is also swivelable about the rotary axis 11 with respect to the supporting latch 4. The switching bridge 5 is swivelable about the rotary axis 12 with respect to supporting latch 4, with said rotary axis 12 being distanced from the rotary axis 11 of the mechanism, as a result of which the rotary axes 12 and 11 are arranged offset from one another.

Since **AT-B-404 648** merely describes single-pole switches, it cannot provide any information concerning the application of the principle of offsetting the rotary axis of the switching bridge with respect to the rotary axis of the mechanism in two-pole switches. Moreover, the necessity can never arise in single-pole switches to lift off two movable contact elements simultaneously from fixed contact elements.

AT-B-404 648 can therefore not provide any incentive to offset the rotary axes of the switching bridge with respect to the rotary axis of the mechanism of said two-pole switching device in order to achieve this advantageous effect in a two-pole switching device.

It may be provided in a further development of the invention that the bearing stops are arranged as mutually spaced components which are different from the leg supports. The forces exerted by the leg springs on the switching bridges can thus be set easily by changing the distance of the leg supports from the bearing stops.

It may further be provided that the rotary axis of the latch is disposed at a distance from the bearing stops and the leg supports.

The latch can thus be fixed so as to be connected to the support independent from the other components of the switching mechanism and with low technical effort.

It has proven to be advantageous to shape a further cylindrical element on the support and a further leg spring is provided whose first end is fixed on the shaped element and whose free leg is supported on the section of the latch support.

This further leg spring is used to move the shoulder of the latch support in the direction towards the latch, as a result of which the latch can latch into the shoulder of the latch support after a release. This allows a reactivation of the switching mechanism with the help of the actuating lever.

The invention is now described in closer detail by reference to the enclosed drawings which show a particularly preferred embodiment.

Fig. 1 shows a two-pole circuit breaker in an oblique view;

Fig. 2 shows the phase conductor break gap of a circuit breaker equipped with the switching mechanism 15 in accordance with the invention in the activated state in a plan view;

Fig. 3 shows the phase conductor break gap of the circuit breaker of fig. 2 in the same representation in the deactivated state in a plan view;

Fig. 4 shows an exploded view of the switching mechanism 15 in accordance with the invention;

Figs. 5 and 6 show the support 17 of a switching mechanism 15 in accordance with the invention with inserted switching bridges 9, 9' in an oblique view, each from a different viewing angle, and

Fig. 7 shows the representation of figs. 5, 6 when viewed in the direction of the rotary axis 16 of the mechanism.

Fig. 1 shows the housing of a circuit breaker which is provided with two break gaps, namely one for the phase conductor L of a single-phase a.c. circuit and one for the associated neutral conductor N.

Each of said break gaps comprises a terminal 2 for the supply conductor and a terminal 3 for the outgoing lead (cf. fig. 3). A conductor bar 4 is connected to the first terminal 2, which conductor bar is connected to the first winding end of a striker armature trip element 5. The second winding end of the striker armature trip element 5 is connected with a further conductor bar 6 which carries a fixed contact 7.

The movable contact 8, which in the activated state rests on the fixed contact 7, is located on a switching bridge 9. Said switching bridge 9 is in connection with the free end of a bimetal strip 11 via a flexible stranded conductor 10. The second end of said bimetal strip 11, which is held immovably with respect to the housing, is connected via a conductor bar 12 with the second terminal 3. Said conductor bar 12 is connected with an arcing horn 13, which in combination with the conductor bar 6, forms a spark running path following the contacts 7, 8, in the end zone of which there is disposed a spark extinction chamber 14 consisting of a plurality of mutually parallel extinction plates.

Arcs are extinguished in said extinction chamber 14 which arise between the same during the opening of the contacts 7,8 at a time different from the zero passage and run into the extinction chamber 14 along the conductor bar 6 and the arcing horn 13.

Striker armature trip element 5 and bimetal strip 11 are flowed through by the current of the phase conductor connected to said break gap and are used for monitoring the level of said current. Both components act upon a switching mechanism 15 in the case of an impermissible level of said current and can thus initiate a cut-out of the circuit breaker, i.e. a lift-off of the movable contact 8 from the fixed contact 7, which cut-out is performed by the switching mechanism 15.

The striker armature mechanism 15 is used in the usual way to detect a briefly occurring (short-circuit) current which exceeds the nominal value by several times and the bimetal trip element 11 to detect an (overload) current which applies over a prolonged period and is only slightly over the nominal value.

The break gap of the neutral conductor N, which is not shown in the figures in closer detail, is arranged like the discussed phase conductor break gap, but it is not provided with any striker armature trip element and no bimetal strip. The current that flows through it is thus not monitored. The switching bridge 9' of the neutral conductor break gap is moved jointly with the switching bridge 9 of the phase conductor break gap, so that the neutral conductor break gap is always simultaneously switched with the phase conductor break gap.

The housing of the circuit breaker is only provided with one modular spacing (18 mm) despite the fact that two complete break gaps are housed in the same.

The present invention relates to the constructional arrangement of the switching mechanism 15. It comprises at first the two switching bridges 9, 9' of the two break gaps of the circuit breaker which each bear a movable contact 8, 8'.

Furthermore, the switching mechanism 15 comprises three main components, namely the support 17, the latch support 29 and the latch 33 (cf. fig. 4).

Support 17 is held in the housing swivelably about a rotary axis 16 of the mechanism which is fixed to the housing. This is realized in the form that a pin is fixed in the housing and the support 17 is provided with a bore which corresponds to the outside diameter of said pin and with which it is placed over said pin. The support 17 is provided with a partition 18 which extends normally to the rotary axis 16 of the mechanism and on whose two side surfaces a number of components are attached, namely cylinder 19, 19', bearing stops 26, 26' and leg supports 25, 25'.

Cylinders 19, 19' are used for the rotatable bearing of the switching bridges 9, 9' on support 17, and therefore form the rotary axes 36 of the switching bridges. The switching bridges 9, 9' are provided with bores 20, 20' whose diameters correspond to the outside diameters of the cylinders 19. The switching bridges 9, 9' are placed with these bores 20, 20' on the cylinder 19 (cf. figs. 5, 6).

The bearing stops 26, 26' are preferably also provided with a cylindrical shape and are also attached at a distance from the cylinders 19, 19' and concentrically to the rotary axis 16 of the mechanism to the partition 18. The rotary axes 36 of the switching bridges are thus disposed in an offset manner in the direction of the movable contacts 8, 8' with respect to the rotary axis 16 of the mechanism.

The switching bridges 9, 9' are permanently loaded by the leg springs 21, 21' in the direction of the bearing stops 26, 26' and are elastically pressed with their ends 90, 90' which are opposite of the movable contacts 8, 8' against said bearing stops 26, 26'. For this purpose said leg springs 21, 21' are placed with their windings 22, 22' on the cylinder 19, 19'. Its first legs 23, 23' rest in the zone of the movable contacts 8, 8' on the switching bridges 9, 9' and its second legs 24, 24' rest on the leg supports 25, 25' (cf. fig. 3).

The switching bridges 9, 9' are provided with precisely the same dimensions, i.e. they are designed congruently. Although the bearing stops 26, 26' are disposed in alignment with each other and concentrically to the rotary axis 16 of the mechanism, their thicknesses or diameters differ from one another in the respect that the diameter of the bearing stop 26' which is assigned to the neutral conductor break gap is smaller than the diameter of the bearing stop 26 which is assigned to the phase conductor break gap (cf. fig. 6). The result is that the two movable contacts 8, 8', when viewing the switching mechanism 15 in the direction towards the rotary axis 16 of the mechanism, are mutually angularly offset by the amount a (cf. fig. 7) in the state when lifted off from the fixed contacts 7, 7'.

This angular offset will lead to the consequence that during the transition of the switching mechanism from its opened state as shown in fig. 3, to the closed state as shown in fig. 2, only the neutral conductor break gap is closed first. The phase conductor break gap, however, is closed only slightly later. This lead-in of the neutral conductor break gap must be provided mandatorily according to standards applicable on circuit breakers.

The following components of the switching mechanism 15 are necessary to move the support 17 and the switching bridges 9, 9' which are fixed to the same:

The latch support designated with reference numeral 29 is provided with a bore 30 with which it is placed on bearing stop 26 and is thus held rotatably on support 17.

In the zone of the upper end of the partition 18, said latch support 29 is provided with a shoulder 31 on which a latch 33 can engage.

Said latch 33 is a U-shaped component which is preferably bent from a thin sheet and which is provided in its legs with bores 38 for receiving a compression rivet 39. A bore 40 is also introduced in the upper end of the partition 18 of support 17, through which bore the compression rivet 39 is passed. The latch 33 is thus rotatably held about a rotary axis 32 of the latch at the upper end of the partition 18.

The latch 33 is provided at its end opposite of the bores 38 with a projection 37 which can rest on shoulders 31. If, as is shown in figs. 2 and 3, the latch 33 is latched to the latch support 29 in such a way, the three main components of the switching mechanism 15 (support 17, latch support 29 and latch 33) are mutually connected in a positive-locking way and the switching mechanism 15 can be moved with the help of the actuating lever 35 which is coupled by way of a bracket 34 with the latch 33, i.e. it can be swiveled from its ON position (fig. 2) to its OFF position (fig. 3) and vice-versa.

During the swiveling to the ON position, the movable contacts 8, 8' come to rest (in a temporally offset way) on the fixed contacts 7, 7'. Since from this time any further swiveling of the movable contacts 8, 8' which occurs synchronously with the support 17 is prevented, the contact bridges 9, 9' are swiveled against the swiveling direction of the support against the pressure of the leg springs 21, 21' and thereby lifted off by the bearing stops 26, 26' (fig. 2).

The movable contacts 8, 8' are displaced radially with respect to the fixed contacts 7, 7', with the contact surfaces of the fixed contacts 7, 7' and the movable contacts 8, 8' being rubbed against each other and any impurities located there being removed.

If any impermissible fault current occurs which must be cut off accordingly, the respective fault current detection component (striker armature trip element 5 or bimetal strip 11) acts upon the section 41 of the latch support 29 which is disposed below the bore 30: The striker armature 50 of the striker armature trip element 5 strikes directly on said section 41; the free end of the bimetal strip 11 which is moved in the case of impermissible heating by an impermissibly high constant current in the direction towards the second terminal 3 entrains a draw bracket 42 which is connected by way of a tubular rivet 43 with the section 41.

In both cases, the latch support 29 is slightly swiveled counter-clockwise about the rotary axis 16 of the mechanism, as a result of which the shoulder 31 is brought out of engagement with the latch projection 37. As a result, the positive-locking connection between latch 33, support 17 and latch support 29 and these three components with the actuating lever 35 is released, so that the support 17 and, in conjunction with the same, the switching bridges 9, 9' can be swiveled to the OFF position.

This swiveling is performed by a helical compression spring 28 whose first end rests on a pin 27 which is fastened to the end of the partition 18 of support 17 which is opposite of the cylinders 19, 19'. The second end of said helical compression spring 28 rests on the housing.

The first end of a further leg spring 45 is fixed on a further cylindrical shaping 44 of support 17. Its free leg 46 acts on the section 41 of the latch support 29, as a result of which the latch support 29 is pretensioned clockwise by the leg spring 45. Said pretension ensures that once the latching of the latch projection 37 and shoulder 31 has been released, the latch support 29 is swiveled counter-clockwise and thus the shoulder 31 is moved towards latch 33. Once the actuating lever 35 has been brought to the OFF position (which occurs automatically by a spring built into the same), the latch projection 37 can come to rest on the shoulder 31 again.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

Claims

1. A switching mechanism (15) for a circuit breaker which comprises two break gaps to be jointly switched, which break gaps each comprise a movable contact (8, 8') which is fixed on a switching bridge (9, 9'), with
a support (17) being provided which is held swivelably about a rotary axis (16) of a mechanism which is fixed to the housing and
comprises a partition (18) which extends normal to the rotary axis (16) of the mechanism and on whose two side surfaces there are each attached a cylinder (19, 19'), a bearing stop (26, 26') which is concentric to the rotary axis (16) of the mechanism, as well as a leg support (25, 25'), on which cylinders (19, 19') the switching bridges (9, 9') are placed with their bores (20, 20') and leg springs (21, 21') with their windings (22, 22'), so that the longitudinal axes of the cylinders (19, 19') form rotary axes (36) of the switching bridges, with the first legs (23, 23') of the leg springs resting on the switching bridges (9, 9') and the second legs (24, 24') on the leg supports (25, 25'), as a result of which the switching bridges (9, 9') are permanently loaded in the direction of the bearing stops (26, 26') which are provided with mutually different thicknesses, with
a pin (27) being formed on the upper end of the partition (18) which is opposite of the cylinders (19, 19'), on which pin the first end of the helical compression spring (28) is placed and whose second end rests on the housing, with
furthermore a latch support (29) being provided which is placed with its bore (30) on the bearing stop (26) and is provided with a shoulder (31) in the zone of the upper end of the partition (18) on which a projection (37) of a latch (33) can engage, which latch (33) is rotatably held at the upper end of the partition (18) about a rotary axis (32) of the latch and a bracket (34) is provided which couples the latch (33) with an actuating lever (35), characterized in that
the rotary axes (36) of the switching bridges are disposed offset with respect the rotary axis (16) of the mechanism in the direction of the movable contacts (8, 8').

2. A switching mechanism as claimed in claim 1, characterized in that the bearing stops (26, 26') are arranged as mutually spaced components which are different from the leg supports (25, 25').

3. A switching mechanism as claimed in claim 1 or 2, characterized in that the rotary axis (32) of the latch is disposed spaced from the bearing stops (26, 26') and the leg supports (25, 25').

4. A switching mechanism as claimed in one of the claims 1 to 3, characterized in that a further cylindrical element (44) is formed on the support (17) and a further leg spring (45) is provided whose first end is fixed on the shaped element (44) and whose free leg (46) rests on the section (41) of the latch support (29).

DATED this 24th day of September 2001.

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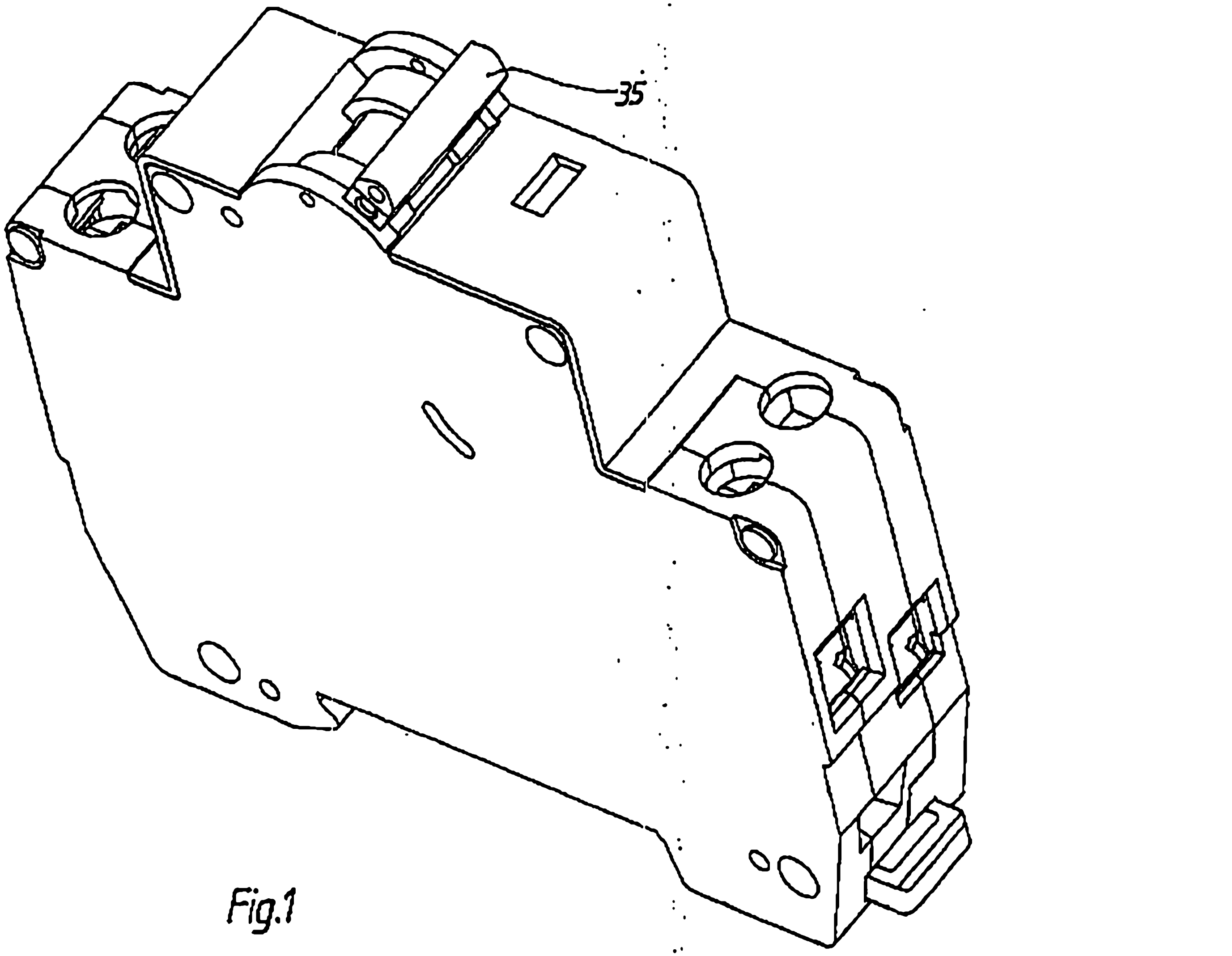

Fig.1

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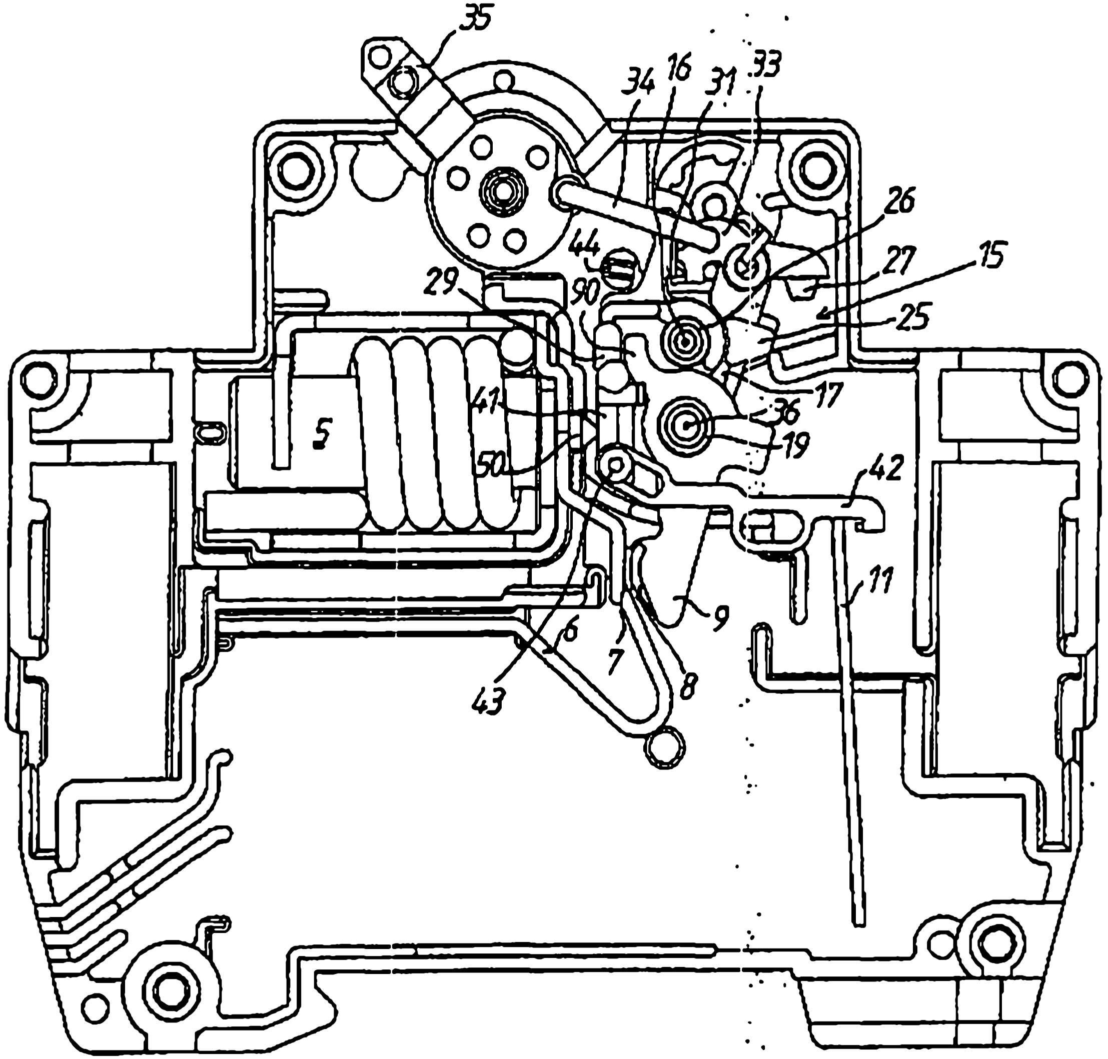

Fig.2

24 9 01 76076

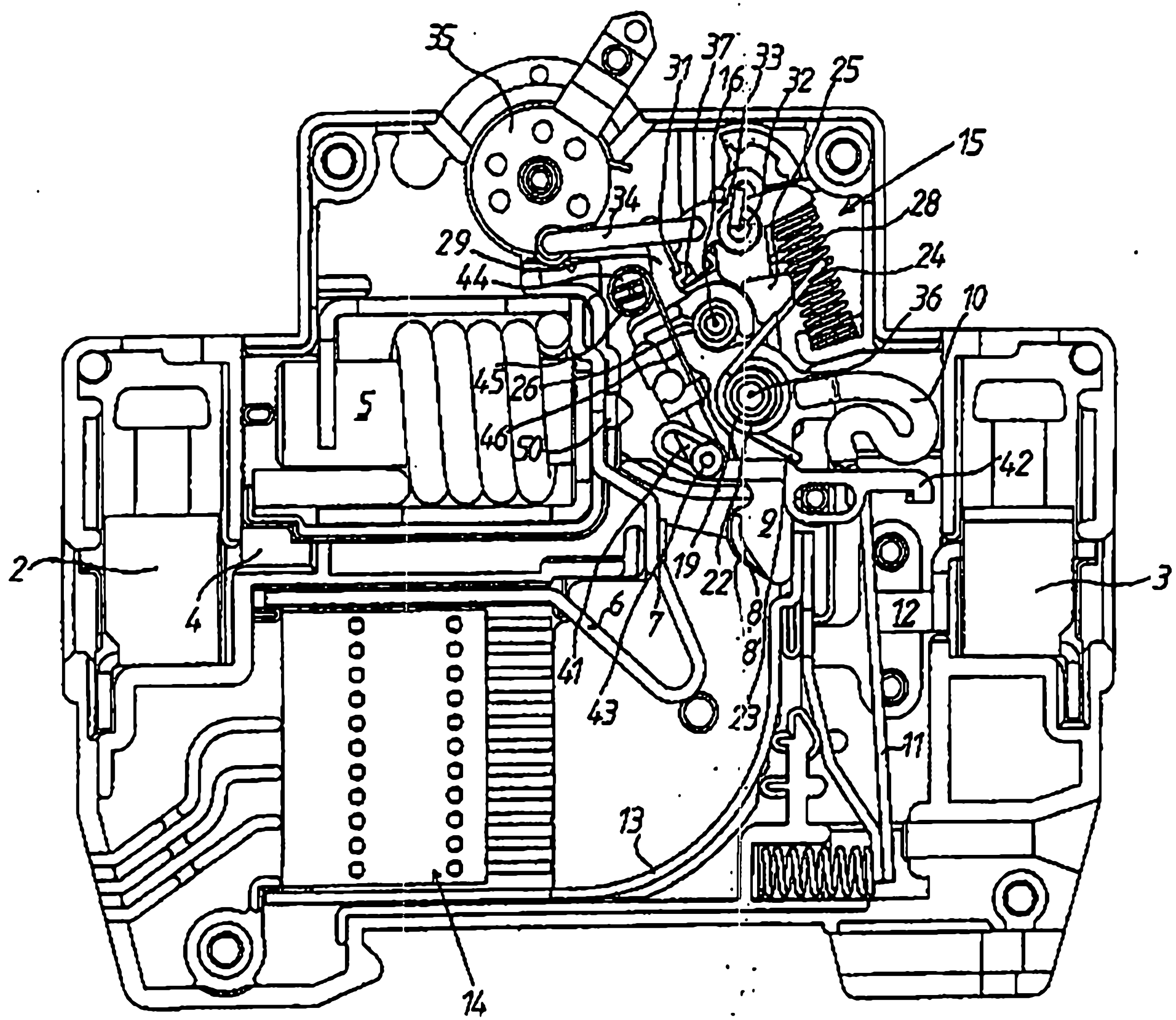

Fig.3

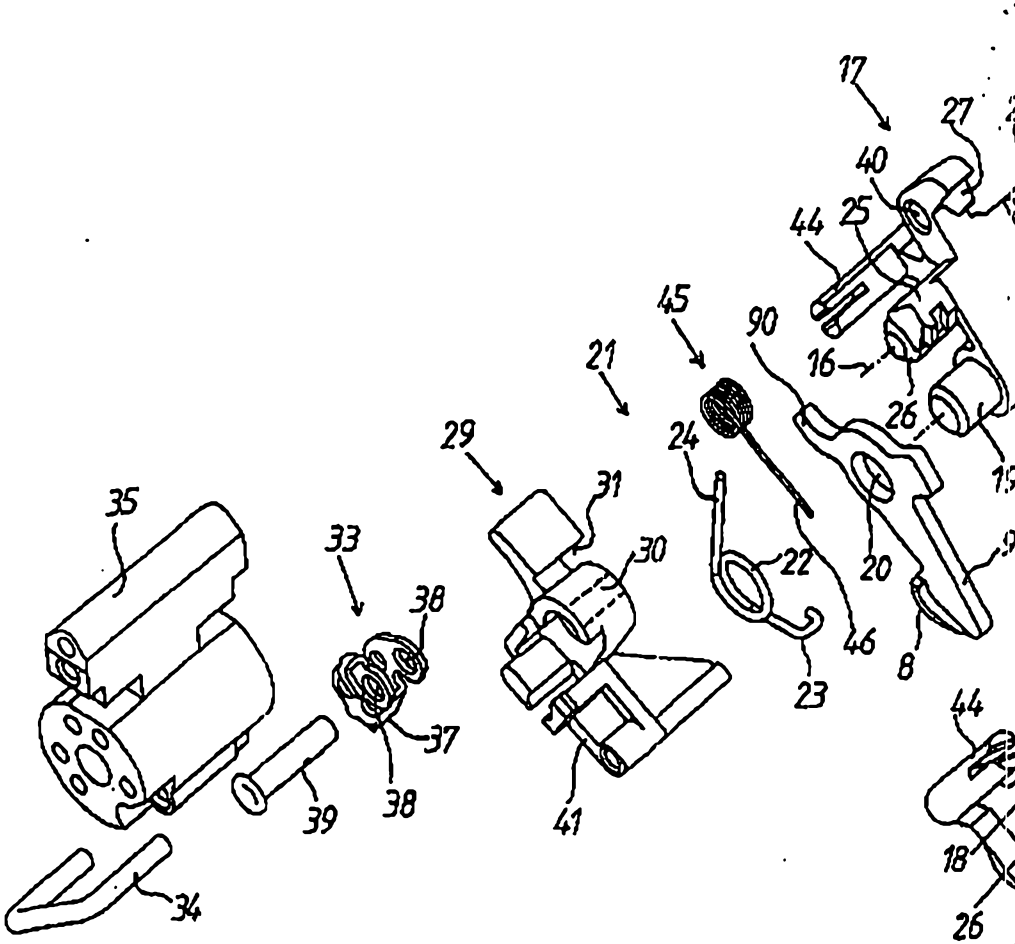
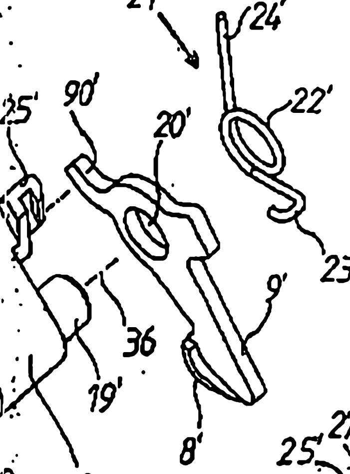

Fig.4

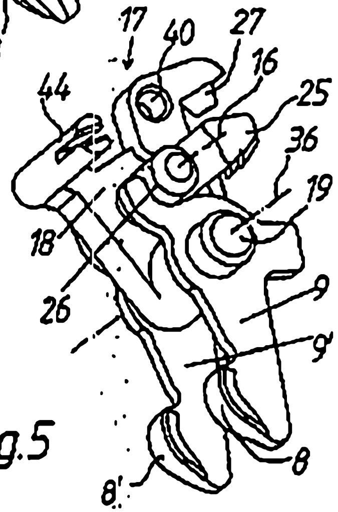

Fig.5

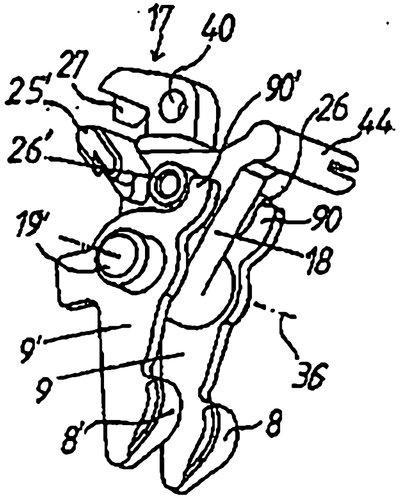

Fig.6

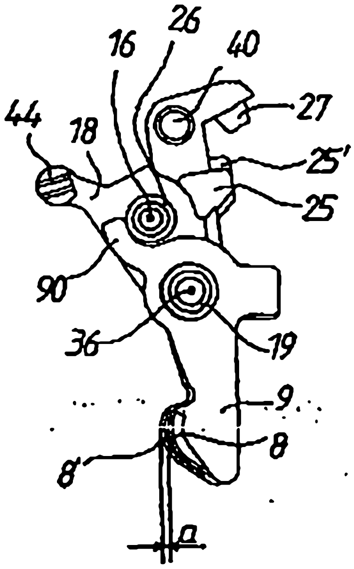

Fig.7