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(71) Applicant: **ABB Service S.r.l**
20124 Milano (IT)

(72) Inventors:
- **Colombo, Gabriele**
  20011 Corbetta (MI) (IT)
- **Antoniazzi, Aleberto**
  20080 zibido San Giacomo (MI) (IT)
- **Readaelli, Claudio**
  20030 Seveso (MI) (IT)
- **Valagussa, Sergio**
  20050 Ronco Briantino (MI) (IT)

(74) Representative: **Zanoli, Enrico et al**
Zanoli & Giavarini S.r.l.,
Viale Bianca Maria, 35
20122 Milano (IT)

(54) A device for low-voltage circuit breakers

(57) A device for low-voltage circuit breakers comprising a kinematic chain designed for transmission of motion to an external kinematic structure. Said kinematic chain comprises first elements (10) for manoeuvring, second elements (20) for engagement/release, and third elements (30) for actuation, substantially contained within two containment side pieces (100, 200). The kinematic chain further comprises means (40) for transmission of motion located on the outside of the two side pieces and connected to said actuating means (30).

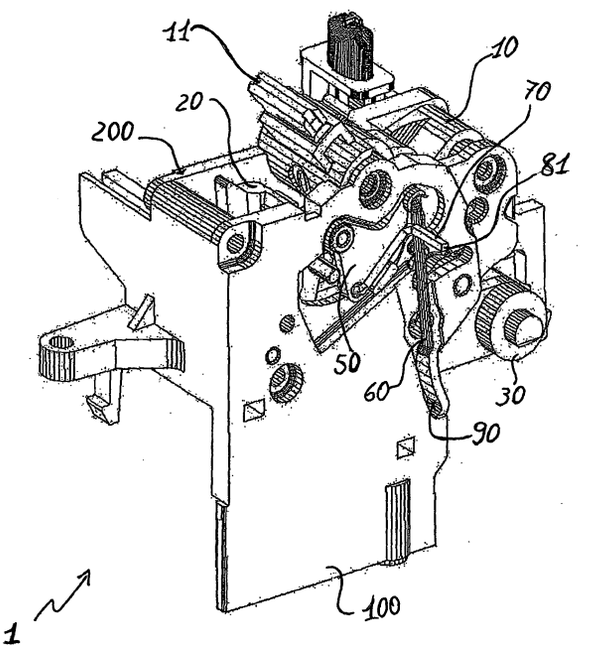

Fig. 1

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Description

[0001] The present invention relates to a device to be used in protection apparatuses for low-voltage electrical networks, which may be, for example, residual-current units appropriately coupled to a circuit-breaking unit.

[0002] It is known that, in low-voltage electrical systems, devices such as the ones mentioned above or the like are commonly used to interrupt the current flow in the electrical circuit in which they are employed when a residual current higher than a pre-set threshold value occurs. The purpose of such apparatuses is principally that of guaranteeing an adequate protection of the electrical system and of the loads applied thereto against the small dispersions that usually precede short-circuits. A further, and even more important, purpose is to protect persons from the so-called direct contacts, i.e., accidental contacts with a conductor carrying electric current, specifically with a phase of the circuit, which may be a stripped wire, a broken socket, etc., but also from indirect contacts, i.e., contacts with a conductive body that is normally insulated, such as the casing of an electrical household appliance, which, on account of a fault or failure or a random event, happens to come into contact with a phase of the circuit and is hence at a dangerous voltage.

[0003] Existing protection devices of a residual-current type envisage the use of a kinematic chain comprising essentially a first series of lever mechanisms dedicated to moving a contact-bearing shaft, and a second series of lever mechanisms dedicated, instead, to interfacing the first series of lever mechanisms with an actuation device generally constituted by a relay. The latter may be directly activated via current-sensor means designed to detect the presence of currents of a residual type.

[0004] Through an external actuation knob, the first series of lever mechanisms that enables rotation of the contact-bearing shaft and the consequent passage of current inside the circuit is actuated. When currents of a residual type arise, detected by the sensor means, the relay actuates the second series of lever mechanisms, which acts directly on the first series releasing the latter from the position reached previously and thus enabling return of the contact-bearing shaft into the initial position. In this way, the interruption of the current flow inside the circuit is guaranteed.

[0005] Kinematic chains of the above sort, albeit quite satisfactory from the standpoint of operation, currently present the drawback of rendering the electrical-protection apparatus in which they are inserted far from flexible in regard to a possible coupling with another protection device.

[0006] Very often, in fact, an apparatus containing only the residual-current part is coupled, for example, to an appropriate circuit-breaking unit located inside another apparatus. To enable this coupling between two distinct apparatuses, the kinematic chains usually employed must often be largely redesigned and adapted to the various needs. With reference to the aforementioned example, the kinematic chain normally used must envisage further and different transmission elements which enable actuation of the interruption unit according to what is detected by the sensors constituting the residual-current part.

[0007] The above aspect represents a considerable disadvantage above all in regard to industrialization and assembly. In addition to having to provide and design two different configurations of the kinematic chain, according to the use, also the assembly lines must be completely re-arranged above all in the case of extensive automation of the process, which is, on the other hand, evidently fundamental for reasons that are obvious and go without saying.

[0008] The above lack of flexibility inherent in current kinematic chains used hence leads, as a somewhat disadvantageous consequence, to a considerable increase in the production costs and hence to an obvious competitive disadvantage.

[0009] On the basis of the above considerations, the main task of the present invention is to provide a kinematic chain to be used in the production of protection devices for low-voltage electrical networks which will enable the drawbacks mentioned above to be overcome.

[0010] In the context of the above task, the main purpose of the present invention is to provide a kinematic chain designed to transmit motion to an external kinematic structure.

[0011] A further purpose of the present invention is to provide a kinematic chain which will comprise components that can easily be assembled together and can easily be assembled to the other components constituting the protection apparatus for electrical networks.

[0012] Not the least important purpose of the present invention is to provide a containment structure for current-sensor means that will present high reliability, relative ease of manufacture and competitive costs.

[0013] The aforesaid tasks, as well as the above and other related purposes that will appear more clearly from what follows, are achieved by a kinematic chain for protection devices of a residual-current type comprising:

- first elements for manoeuvring;
- second elements for engagement/release, connected to a residual-current protection relay;
- third elements for actuation; and
- fourth elements for transmission of motion.

[0014] The kinematic chain according to the invention is characterized in that said third elements for actuation comprise a first shaft connected to a system of mobile contacts or to a device for providing mechanical resistance. Said fourth elements for transmission of motion comprise at least one first motion-transmission lever and, in the case where the first shaft is connected to the mechanical-resistance device, further comprise at least

one second transmission lever and one third transmission lever. The second transmission lever is connected to the first lever and to said transmission shaft. The third lever is connected to said first lever and to a further low-voltage device.

[0015] The main advantage of the invention is represented by the presence of transmission means specifically dedicated to transmission and in any case present whatever the functionality required of the kinematic chain itself.

[0016] Further characteristics and advantages of the invention will emerge more clearly from the description of preferred but non-exclusive embodiments of the containment structure according to the invention, illustrated by way of indicative and non-limiting example in the attached drawings, in which:

- Figure 1 is a perspective side elevation of an embodiment of the kinematic chain according to the invention;
- Figures 2 is a perspective side elevation of the system for assembly of the first motion-transmission lever to the rest of the kinematic chain according to the invention; and
- Figures 3 is a perspective side elevation of the system for assembly of the second motion-transmission lever to the rest of the kinematic chain according to the invention.

[0017] With reference to the aforesaid figures, the kinematic chain 1 according to the invention comprises first elements 10 for manoeuvring, second elements 20 for engagement/release, third elements 30 for actuation, and fourth elements for transmission of motion. The first elements 10 for manoeuvring may comprise, for example, a knob 11 which enables movement of a first series of lever mechanisms that act on said third elements 30 for actuation. The second elements 20 for engagement/release are actuated by the protection relay, which, in turn, is controlled by sensor means that detect the presence of currents of a residual type. Said second elements 20 for engagement/release make it possible to act on said first elements 10 for manoeuvring, in order to cause the action of the latter on said actuating elements 30, which move said fourth elements 40 for transmission of motion, to cease.

[0018] The kinematic chain according to the invention is characterized in that the aforesaid third elements 30 for actuation comprise a first shaft connected to a system of mobile contacts or else to a mechanical-resistance device having the purpose of reproducing the conditions of operation that are usually characteristic of the system of mobile contacts. The fourth elements for transmission of motion in any case comprise a first motion-transmission lever 50 and, in the case where said first shaft is connected to the aforesaid mechanical-resistance device, further comprise a second transmission lever 60 and a third transmission lever 70. The second motion-transmission lever 60 is connected to the first transmission lever 50 and to the first transmission shaft, whilst the third transmission lever is connected, instead, to said first lever and to a further low-voltage device.

[0019] The mechanical-resistance device indicated above comprises elastic means chosen so as to reproduce the same parameters of motion and force that are usually supplied by the system of mobile contacts. In this way, the first elements 10 for manoeuvring, albeit acting on a structure that is substantially different from the usual one, act producing the same effect of rotation on the first shaft. According to a preferred embodiment of the invention, these elastic means comprise a spring positioned in such a way that it is substantially concentric to the first shaft.

[0020] With reference to Figure 1, according to the invention, the first elements 10 for manoeuvring, the second elements 20 for engagement/release, and the third elements 30 for actuation are substantially contained within a first containment side piece 100 and a second containment side piece 200 which can be coupled together, for example, via the use of blocking pins. The fourth elements for transmission of motion are, instead, located on the outside of the two side pieces and, in particular, are associated on the outside of the first side piece 100 and of the second side piece 200.

[0021] In addition, according to the invention, the first transmission lever 50 is associated to one of the two side pieces 100 via a first turning pair and, according to a preferred embodiment, said first lever 50 is positioned within a first seat 80 made on the outside on the side piece itself. In this way, the lateral encumbrance is limited so that no problem is created in the assembly step for the insertion of the side pieces 100 and 200 within the corresponding containment box of the protection device.

[0022] Again with reference to Figure 1, the first seat 80, according to the invention, has dimensions such as to enable a well pre-defined rotation of the first transmission lever 50. As indicated above, moreover, the rotation of the first lever 50 is obtained via a turning pair comprising a first pin 52 and a first seat 53 made on the first transmission lever 50 and on said first seat 80.

[0023] Figure 2 clearly indicates the above embodiment of said first pair, and also shows the axis of rotation of said pair, which advantageously coincides precisely with the direction of insertion of the first transmission lever 50 in the corresponding seat 80, a direction of insertion that is substantially orthogonal to the containment side pieces.

[0024] Figure 3 illustrates, instead, the insertion, within the kinematic chain, of a second transmission lever 60 with which a transmission element very similar to a U bolt is indicated, which is used in the fabrication of the manoeuvring means 10. This second transmission lever 60 is advantageously connected to the first transmission lever 50 and to said first shaft through a second turning

pair and a third turning pair, respectively. In particular, the second turning pair comprises a second pin that is made, for example, on one first end 61 of the second transmission lever 60 and can be inserted in a third seat 62 made on the first transmission lever 50. Likewise, also the third pair comprises a third pin, which is made advantageously on said second end 65 of said second transmission lever 50 and can be inserted in a fourth seat made on the first shaft, in a position eccentric with respect to the axis of rotation of the latter.

[0025] On the side piece 100 that houses the first transmission lever 50 there is also made a shaped opening 90, which has the purpose of guiding the movement of the second transmission lever as indicated hereinafter in the description. This opening 90 enables translation of the second transmission lever in a plane substantially coincident with that of the side piece, and, at the same time, a rotation about an axis that is substantially orthogonal to the side piece itself.

[0026] With reference to Figure 1, the third transmission lever 70, according to the invention, is connected to the first transmission lever 50 through a fourth turning pair and is connected at a first end 81 to a further protection device. In practice, it represents the final element that enables connection between the kinematic chain contained on the inside of the first protection device and a generic external kinematic structure that can be actuated through the former.

[0027] According to a preferred embodiment of the invention, said fourth turning pair comprises a fourth pin, made advantageously on one second end of said third transmission lever 70, and a fifth seat 83 made on the first transmission lever 50.

[0028] With reference to Figure 2, the first transmission lever 50 also comprises a projection 96, which is exploited to impose on the transmission lever 70 a rotation that is pre-defined as regards amplitude and direction, leaving freedom of movement to the lever itself for a possible rotation in a direction opposite to said direction.

[0029] Operation of the fourth elements 40 for transmission of motion described thus far may be readily understood from Figure 1. Following upon motion of the first shaft, generated by the detection of residual currents by said sensor means, the second transmission lever 60 moves according to the guide profile of the shaped opening 90 made on the side piece 100. Through the second turning pair, also the first transmission lever 50 is hence set in rotation and rotates, within the first seat 80, about the first pair. The movement of the first transmission lever sets in rotation the third transmission lever thus enabling actuation of the external kinematic structure.

[0030] According to the invention, the positioning of the external transmission elements enables the same containment side pieces, the same first elements for manoeuvring, and the same second elements for engagement/release to be used both in the case where the apparatus is used by itself and in the case where it is coupled to a second apparatus. This is extremely convenient from the assembly point of view in so far as it enables use of just one assembly line, were necessary introducing simply a station dedicated to positioning of the transmission levers described above.

[0031] The technical solutions adopted for the kinematic chain enable the pre-set tasks and purposes to be fully achieved. In particular, the kinematic chain is pre-arranged for an easy and fast coupling with an external kinematic structure via the use of few components that are easy to manufacture and that can be readily coupled together.

[0032] The kinematic chain for protection devices for electrical networks thus conceived may undergo numerous modifications and variations, all falling within the scope of the inventive idea; in addition, all the items may be replaced by other technically equivalent ones. In practice, the materials used, as well as the dimensions and shapes, may be any whatsoever according to the requirements and the state of the art.

Claims

1. A kinematic chain (1) for low-voltage devices, in particular for protections of a residual-current type, comprising:

   - first elements (10) for manoeuvring;
   - second elements (20) for engagement/release, connected to a residual-current protection relay;
   - third elements (30) for actuation; and
   - fourth elements (40) for transmission of motion;

   said kinematic chain being **characterized in that** said third elements (30) for actuation comprise a first shaft connected to a system of mobile contacts or to a device for providing mechanical resistance, said fourth elements (40) for transmission of motion comprising at least one first motion-transmission lever (50) and, in the case where said first shaft is connected to the mechanical-resistance device, further comprising at least one second transmission lever (60) and one third transmission lever (70), said second transmission lever (60) being connected to said first lever (50) and to said transmission shaft, said third lever (70) being connected to said first lever (50) and to a further low-voltage device.

2. The kinematic chain (1) according to Claim 1, **characterized in that** said elastic means are chosen so as to reproduce the same parameters of motion and force that are usually supplied by said system of mobile contacts.

3. The kinematic chain (1) according to Claim 2, **char-**

acterized in that said elastic means comprise a spring positioned in a way substantially concentric to said first shaft.

4. The kinematic chain (1) according to one or more of the preceding claims, **characterized in that** said first elements (10) for manoeuvring, said second elements (20) for engagement/release, and said third elements (30) for actuation are substantially contained within a first containment side piece (100) and a second containment side piece (200) which can be coupled together, said fourth elements (40) for transmission of motion being on the outside associated to said first containment side piece (100) or to said second containment side piece (200).

5. The kinematic chain (1) according to Claim 4, **characterized in that** said first transmission lever (50) is associated to said first containment side piece (100) or to said second containment side piece (200) via at least one first turning pair.

6. The kinematic chain (1) according to Claim 4 or Claim 5, **characterized in that** said first transmission lever (50) is positioned within a first seat (80) made on the outside of said first containment side piece (100) or of said second containment side piece (200), said first seat (51) having dimensions such as to enable rotation of said first lever (50) through a pre-defined angle.

7. The kinematic chain (1) according to one or more of Claims 4 to 6, **characterized in that** said turning pair comprises a first pin (52) and a first seat (53) made on said first transmission lever (50) and on said first seat (80).

8. The kinematic chain (1) according to Claim 1, **characterized in that** said second transmission lever (60) is advantageously connected to said first transmission lever (50) and to said first shaft through a second turning pair and a third turning pair, respectively.

9. The kinematic chain (1) according to Claim 8, **characterized in that** said second turning pair comprises a second pin that is made on one first end (61) of said second transmission lever (60) and can be inserted in a third seat (62) made on said first transmission lever (50), and **characterized in that** said third pair comprises a third pin, which is made on said second end (65) of said second transmission lever (50) and can be inserted in a fourth seat (66) made on said first shaft.

10. The kinematic chain (1) according to one or more of the preceding claims, **characterized in that** said first side piece (100) or said second side piece (200) to which said first transmission lever (50) is associated comprises an opening (90) shaped so as to guide the movement of said second transmission lever (60).

11. The kinematic chain (1) according to Claim 1, **characterized in that** said third transmission lever (70) is connected to said first transmission lever (50) through a fourth turning pair and is connected to said further protection device through a first end (81).

12. The kinematic chain (1) according to Claim 11, **characterized in that** said fourth turning pair comprises a fourth pin, which is made on one second end (82) of said third transmission lever (70) and can be inserted in a fifth seat (83) made on said first transmission lever (50).

13. The kinematic chain (1) according to one or more of the preceding claims, **characterized in that** said first transmission lever (50) also comprises at least one projection (96) such as to impose on said third transmission lever (70) a rotation that is pre-defined as regards amplitude and direction during the rotation of said first transmission lever (50).

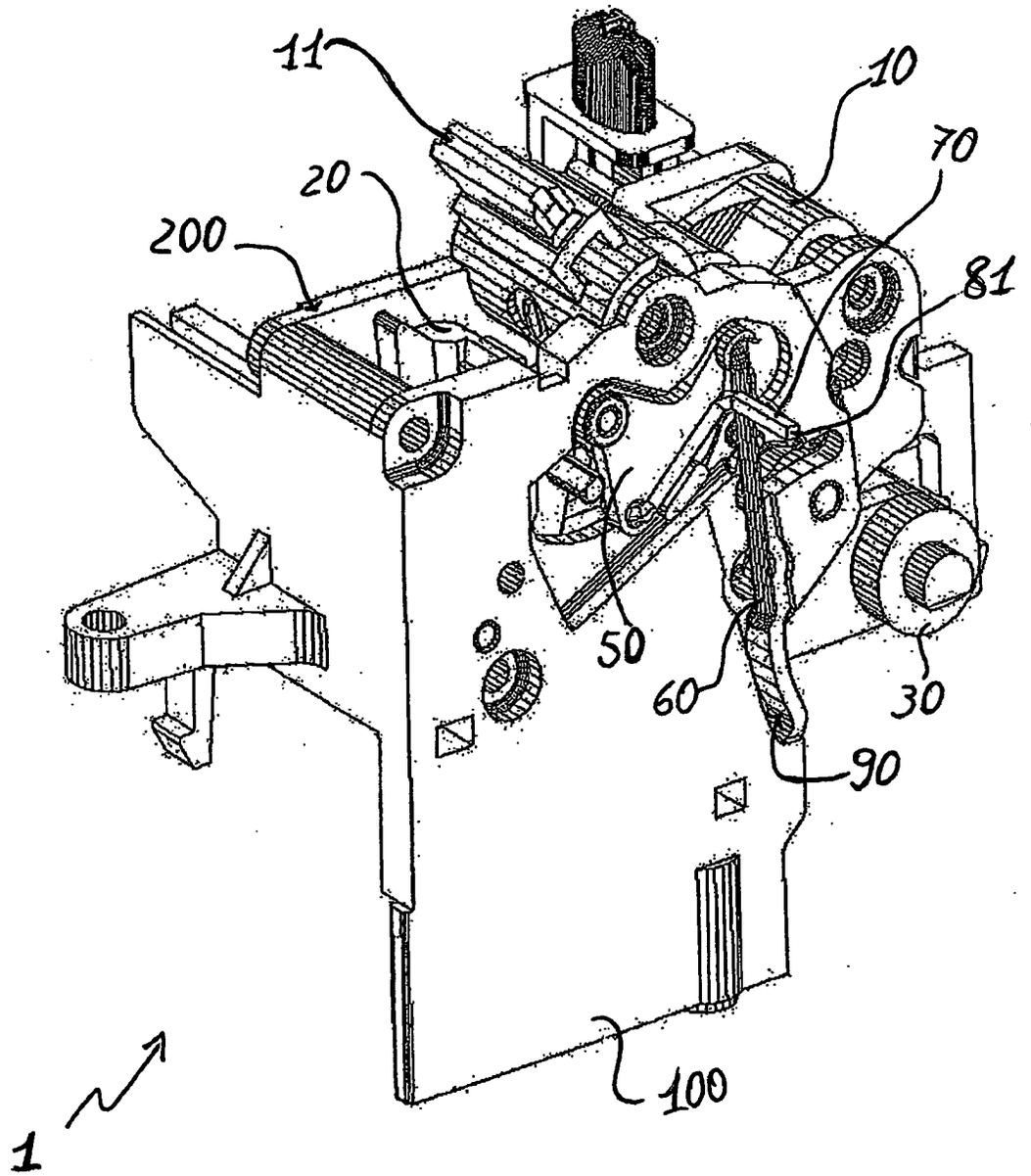

Fig. 1

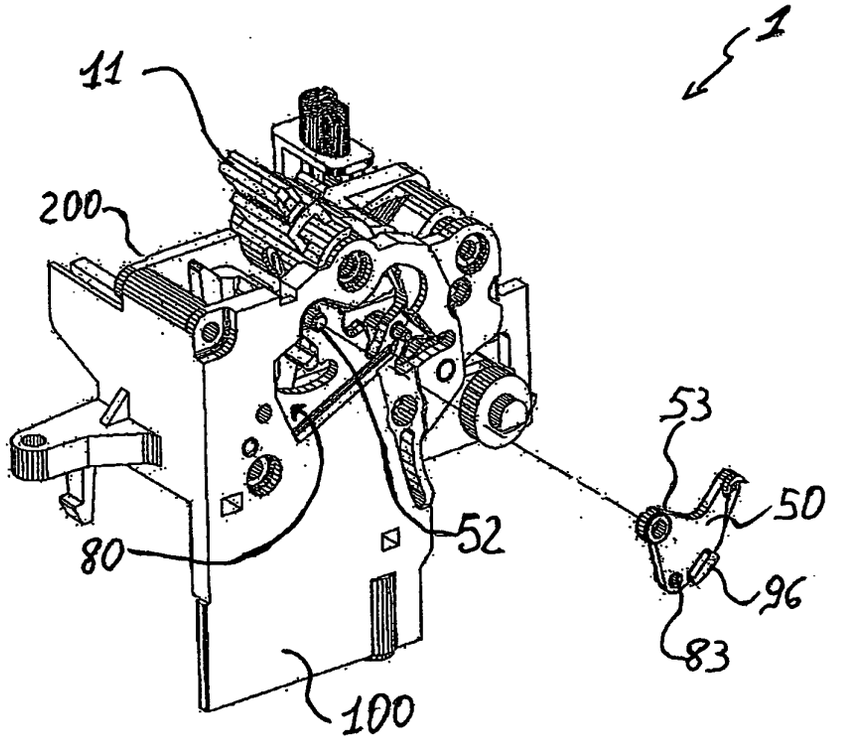

Fig. 2

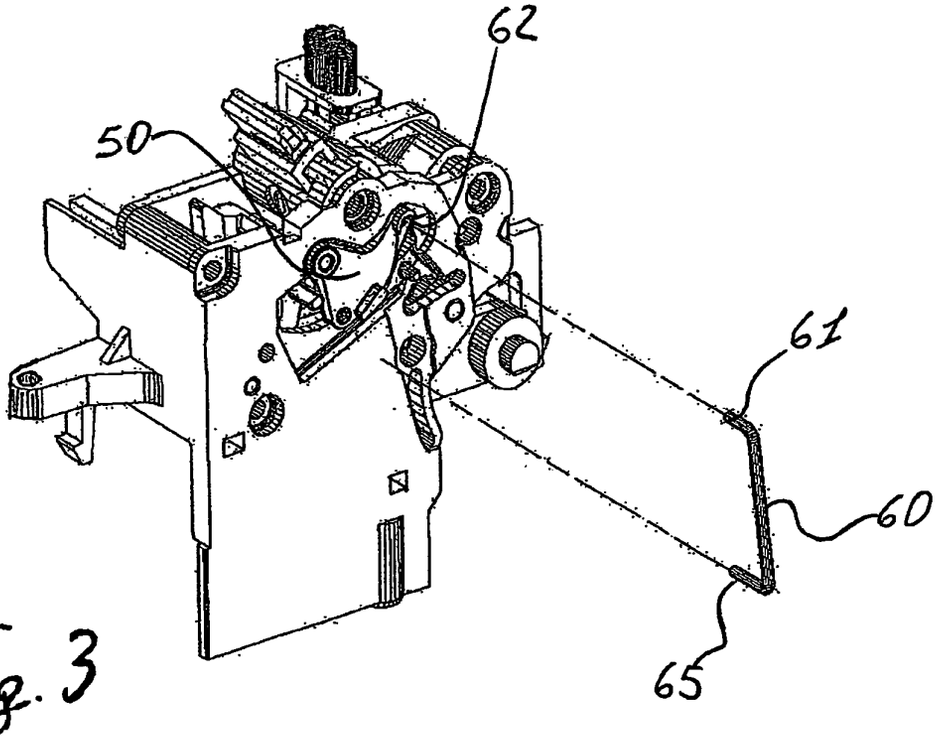

Fig. 3