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(54) **Auxiliary device**

(57) An auxiliary device for opening a circuit breaker associated therewith following a remote opening command, comprising an insulating enclosure which contains fixed contacts and a corresponding moving contact, connection terminals, a fixed magnet on which a coil is wound and a moving magnet which can be coupled electromagnetically to the fixed magnet, comprising:

- actuation means which are operatively connected to and actuated by the moving magnet;
- means for coupling to the circuit breaker which are operatively associated to the actuation means;
- a kinematic chain operatively connected to the means for coupling to the circuit breaker;
- means for interacting with the moving contact, which are operatively connected to the kinematic chain;
- means for providing a local visual indication of the open state of the circuit breaker following said remote opening command, actuated by the actuation means.

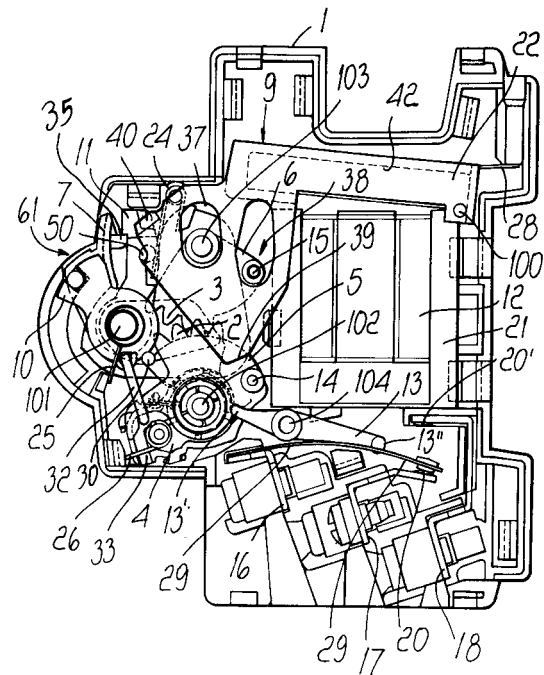


Fig. 1

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Description

[0001] The present invention relates to an auxiliary actuation device for opening a low-voltage circuit breaker associated therewith following a remotely issued opening command. More particularly, the present invention relates to an auxiliary device known in the art as a shunt tripping relay which has improved shape and characteristics.

[0002] Conventional magnetothermal or residual-current circuit breakers for low-voltage electrical applications are generally coupled to suitable auxiliary devices.

[0003] These devices are conventionally of two kinds, respectively the actuating type and the actuated type, depending on whether they act on the circuit breaker and actuate an action thereof or perform an action as a consequence of an actuation received from the circuit breaker. For example, an actuating auxiliary device can be constituted by a shunt tripping relay which, following an intervention command received from an operator, mechanically forces the opening of the associated circuit breaker. By virtue of the received actuation, the circuit breaker changes state, changing from a condition in which the contacts are closed to one in which the contacts are open, and by means of appropriate lever systems it triggers a kinematic mechanism inside a device for signaling the state of the circuit breaker associated therewith, which accordingly constitutes an actuated device. In turn, the actuated device provides operators with a signal which corresponds to the current state of the circuit breaker. As regards the coupling between the circuit breaker and the auxiliary devices, one of the solutions generally used entails placing all the accessories on a same side of the circuit breaker relative to a front view of said circuit breaker. In this case, the mechanical connection between the circuit breaker and the accessories is achieved by using a shaft which is shaped so as to have multiple protrusions and transmits the movements among the various components, according to a solution which is particularly disadvantageous from the point of view of production as well as from the point of view of functionality. The shaft that is used in fact requires accurate machining in order to form the protrusions and the dimensions required to take into account the different stress levels and the considerable clearances involved. This leads to an increase in production costs and possibly to a reduction in the precision and overall reliability of the assembly constituted by the circuit breakers and the auxiliary devices.

[0004] Another solution that is used for coupling the circuit breaker and the auxiliary device is to distribute the devices on both sides of the circuit breaker; in particular, relative to a front view of the circuit breaker, the actuating auxiliary devices according to the present invention are always fitted on the same side of the circuit breaker, for example on the left, while the actuated ones are fitted on the other side, on the right.

[0005] This coupling solution is particularly advanta-

geous with respect to the one described earlier both because it considerably facilitates users in practical applications and because it allows to use a shaft with a smaller number of protrusions, which is accordingly simpler and cheaper to machine; the mechanical stresses that occur are more balanced and clearance is reduced.

[0006] However, the drawback of this embodiment is that magnetothermal and residual-current low-voltage circuit breakers have moving contacts which are mechanically mutually different and can be arranged differently inside the circuit breakers according to specific applications and/or to the applicable national standards. For example, with specific reference to a magnetothermal circuit breaker of the two-pole type, the moving contacts comprise phase contacts and neutral contacts which are mechanically different from each other and can be located either on the right side or on the left side of said circuit breaker relative to a front view thereof. Accordingly, since the shunt tripping relay is an actuating auxiliary device, it is generally always fitted on the same side of the circuit breaker, for example on the left; in the current state of the art, this leads to the need to produce multiple separate series of auxiliary devices according to the constructive structure of the circuit breaker to which they will be coupled, increasing constructive complexity and production costs. Moreover, when an actuating auxiliary device is coupled to a circuit breaker, the kinematic mechanisms for opening the contacts of the circuit breaker can be affected negatively by the corresponding kinematic systems of the auxiliary device; in particular, the opening speed of the circuit breaker might be reduced, accordingly leading to malfunctions or even to breakage of the circuit breaker.

[0007] A further drawback is that if a remote operator sends a command to open the circuit breaker, in the current state of the art conventional actuating auxiliary devices are not provided with means for local visual indication means which protrude outside the device and allow easy and immediate identification of the tripped circuit breaker; this also prevents resetting the auxiliary device without directly acting on the open circuit breaker.

[0008] The aim of the present invention is to provide an auxiliary device for opening a circuit breaker associated therewith following a remotely issued opening command wherein the coupling to the circuit breaker occurs fully independently of the arrangement of the contacts inside it, with a considerable benefit from the point of view of production.

[0009] Within the scope of this aim, an object of the present invention is to provide an auxiliary device for opening a circuit breaker associated therewith following a remotely issued opening command in which the coupling to the circuit breaker does not affect the kinematic mechanisms of said circuit breaker, thus preserving its design characteristics, particularly in terms of speed of contact opening in case of triggering due for example to a fault. Another object of the present invention is to provide an auxiliary device for opening a circuit breaker as-

sociated therewith following a remotely issued opening command in which there is provided a local visual indication of the open state of the circuit breaker due to said remote command.

[0010] Another object of the present invention is to provide an auxiliary device for opening a circuit breaker associated therewith following a remotely issued opening command in which it is possible to reset the auxiliary device without a direct intervention on said circuit breaker.

[0011] Another object of the present invention is to provide an auxiliary device for opening a circuit breaker associated therewith following a remotely issued opening command which is highly reliable, relatively easy to manufacture and at competitive costs.

[0012] This aim, these objects and others which will become apparent hereinafter are achieved by an auxiliary device for opening a circuit breaker associated therewith following a remote opening command, comprising an insulating enclosure which contains fixed contacts and a corresponding moving contact, connection terminals, a fixed magnet on which a coil is wound and a moving magnet which can be coupled electromagnetically to said fixed magnet, characterized in that it comprises:

- actuation means which are operatively connected to and actuated by the moving magnet;
- means for coupling to the circuit breaker which are operatively associated to said actuation means;
- a kinematic chain operatively connected to said means for coupling to the circuit breaker;
- means for interacting with the moving contact, which are operatively connected to said kinematic chain;
- means for providing a local visual indication of the open state of the circuit breaker following said remote opening command, actuated by said actuation means.

[0013] The device thus conceived ensures a coupling to the circuit breaker associated therewith which is entirely independent of the mechanical structure of the circuit breaker and of the arrangement of the contacts inside it. Moreover, the coupling does not affect at all the performance of the circuit breaker, particularly as regards the opening speed of the contacts during triggering due for example to a fault.

[0014] Further characteristics and advantages of the present invention will become apparent from the following detailed description of preferred but not exclusive embodiments of the auxiliary device according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a schematic side view of the auxiliary device according to the present invention in a position which corresponds to the position in which the

associated circuit breaker is closed;

Figure 2 is a schematic side view of the auxiliary device in a position which corresponds to the position in which the associated circuit breaker is open due to direct intervention of an operator on said circuit breaker;

Figure 3 is a schematic side view of the auxiliary device in a position which corresponds to the position in which the associated circuit breaker is open due to a remote intervention command issued by a remotely located operator;

Figure 4 is a perspective view of a reset and indication lever used in the device according to the present invention;

Figure 5 is a perspective view of an engagement lever used in the device according to the present invention;

Figure 6 is a perspective view of an actuation lever used in the device according to the present invention.

[0015] With reference to the above figures, the auxiliary actuation device according to the invention comprises an insulating enclosure 1 inside which there are fixed contacts 20 and 20' which operatively couple to a moving contact 29 (changeover contact), for example of the laminar type. Said contacts are electrically connected to connection terminals, respectively an upper terminal 16, a central terminal 17 and a lower terminal 18. For the sake of clarity in illustration, the figures show only one upper terminal 16, but the device according to the present invention actually uses a second upper terminal 16. As a consequence of an opening of the circuit breaker and of the switching of the moving contact 29 between the two fixed contacts 20 and 20', the four-terminal configuration allows, by means of a suitable electric circuit, to visually indicate to a remotely located operator the change of state of the circuit breaker; this indication can be easily achieved by means of two lamps of mutually different colors which indicate an open or closed state of the circuit breaker.

[0016] Inside the enclosure 1 there is also provided an electromagnetic part which comprises a fixed magnet 21 on which a coil 12 is wound and a moving magnet 22 which is pivoted in a point 100 and with which a spring 28 is associated; the coil 12 is operatively associated to a power supply circuit. As shown in Figure 1, in normal operating conditions, i.e., when the associated circuit breaker is closed, the coil 12 is not supplied with electric power and the moving magnet 22 is spaced from the fixed magnet 21. In order to open the circuit breaker due to a remote command, issued for example by an operator who acts on a button, the coil 12 is excited by current pulses which facilitate the generation of a magnetic field of suitable intensity. By means of this magnetic field, the moving magnet 22 is attracted by the fixed magnet 21 and by overcoming the resistance of the spring 28 it performs a movement which is equal to the

existing gap, as shown in Figure 3.

[0017] Advantageously, the movement of the moving magnet 22 toward the fixed magnet 21 actuates a suitable kinematic mechanism which opens the circuit breaker in a manner described in detail hereinafter.

[0018] The device according to the invention comprises means for coupling to the circuit breaker which comprise a triggering lever 5, a coupling lever 6 and a transmission lever 10 whose function and connections are described hereinafter.

[0019] Actuation means actuated by the moving magnet comprise an actuation lever 9.

[0020] The device also comprises means for interacting with the moving contact 29, which comprise an interaction lever 13, and a kinematic chain which comprises a second actuation lever 9 and a U-shaped element 32 for the purposes which will be described hereinafter. Finally, means are provided for the local visual indication of the open state of the circuit breaker due to a remote opening command; such means comprise a reset and indication lever 7 and an engagement lever 11.

[0021] In particular, the transmission lever 10 is pivoted to a point 101 of the enclosure 1 which is operatively connected to the circuit breaker and with which a return spring 25 is associated; the engagement lever 11 is also arranged on the same pivoting point 101, while the reset and indication lever 7 is pivoted in a point 103 of the enclosure 1.

[0022] The transmission lever 10 is detachably connected, by means of the U-shaped element 32, to the actuation lever 4 and to the tripping lever 5, which are pivoted to a point 102 of the enclosure 1; an actuation spring 26, whose function is described in greater detail hereinafter, acts on the lever 4. As shown in Figure 1, in a position of the device that corresponds to the one in which the circuit breaker is closed, the actuation lever 4 has a raised portion 19 at which one end 13' of the interaction lever 13 is laterally adjacent. The lever 13 is freely pivoted to a point 104 of the enclosure 1 and has an end 13" which abuts against the lamina of the moving contact 29. In this manner, by means of the action applied by the protrusion 19 to the end 13', the lever 13 prevents the movement of the lamina 29.

[0023] As shown in Figure 6, the lamina 4 also has a pivot 30 which can interact with the surface of a slot 31 of the lever 7 and a groove 33 in which the U-shaped element 32 can slide. The tripping lever 5 comprises a pivot 14 for coupling to the tripping mechanism of the circuit breaker and has the particularity that it is provided with a toothed sector 2 whose function is described hereinafter.

[0024] As shown in Figure 4, the reset and indication lever 7 has, in addition to the slot 31, a first raised portion 34, on which a first end of a spring 24 acts, and a second raised portion 35, which interacts against a shaped wall 36 of the engagement lever 11. The engagement lever 11, shown in detail in Figure 5, also has a pivot 50 on which the second end of the spring 24 acts. In practice,

in the position shown in Figure 1, the spring 24 pushes on one side against the raised portion 34, forcing the lever 7 to turn clockwise, and against the pivot 50 at the other side, forcing the lever 11 to turn counterclockwise. Accordingly, the levers 7 and 11 move against each other, facilitating contact between the raised portion 35 and the shaped wall 36 and remaining engaged in the inactive position shown in Figure 1.

[0025] The lever 9 is pivoted to a point 100 of the enclosure 1 and it is associated with a return spring 28. The lever 9 is composed of two parts: a first part is shaped so as to form a seat 42 for geometric coupling to the moving magnet 22 and a second part protrudes from the first one, two slots 37 and 38 being formed thereon. Moreover, the second part is shaped so as to have an oblique flat portion 39, which can interact with the pivot 14 of the lever 5, and a wing 40 which protrudes substantially perpendicular to the median plane of the lever 9 and is suitable to interact with the pivot 50 of the lever 11.

[0026] Advantageously, the device according to the invention comprises an additional coupling lever 6, pivoted to the point 103, which has a pivot 15 for optional coupling to the kinematic mechanism of the associated circuit breaker, and a toothed sector 3 which is operatively coupled to the toothed sector 2 of the tripping lever 5. In practice, once the kinematic mechanism of the device is actuated, the two toothed sectors 2 and 3 mutually mesh, rotating with respect to each other in opposite directions.

[0027] This constructive solution allows to provide a coupling of the auxiliary device to the circuit breaker which is fully independent of the arrangement of the contacts inside it. If the position of the poles in the circuit breaker changes, the coupling between the auxiliary device and the circuit breaker can be provided either on the pivot 14 or on the pivot 15; moreover, the change in the direction of rotation of the mechanism of the circuit breaker according to the arrangement of the poles is rendered irrelevant in terms of the functionality of the coupling between the circuit breaker and the device by the presence of the two mutually contrarotating toothed sectors 2 and 3.

[0028] It should be observed that with this solution the movement of the kinematic system inside the device does not affect at all the corresponding movement in the circuit breaker, since the pivot 15 can move without hindrance inside the slot 38; accordingly, if the circuit breaker trips due for example to a fault, the performance of said circuit breaker in terms of opening speed are not altered in any way.

[0029] Another innovative aspect of the actuation device according to the invention is provided by the fact that the lever 7 has a shaped protrusion 60 which, when the circuit breaker opens due to a command issued remotely by a remote operator by means of a pushbutton or a control panel, protrudes from a corresponding opening 61 formed in the enclosure 1 and therefore al-

lows local visual indication of the tripping of the associated circuit breaker. Moreover, once the protrusion 60 has protruded from the enclosure, it directly provides a button on which an operator can, for any requirement, act directly and restore the auxiliary device without having to act on the associated circuit breaker, which accordingly remains open. The lever 7 therefore simultaneously provides local indication of an open circuit breaker and resetting of said auxiliary device. In further embodiments, not illustrated by figures, said protrusion might be associated with other levers of the kinematic mechanism of the device.

[0030] The operation of the device according to the invention is now described starting from the operating condition shown in Figure 1, which corresponds to a position in which the associated circuit breaker is closed.

[0031] When the circuit breaker is opened due to manual intervention of an operator who acts directly on its actuation knob, the kinematic mechanism of the circuit breaker transmits the motion to the transmission lever 10, which turns in the direction indicated by the arrow 105, pulling the U-shaped element 32 and reaching, at the end of its motion, the position shown in Figure 2. The lever 4, under the action of the U-shaped element 32, rotates about its own pivoting axis 102, in the direction indicated by the arrow 106, and reaches the position shown in Figure 2. At the same time, the levers 5 and 6 also rotate in mutually opposite directions, causing the meshing of the two toothed sectors 2 and 3. In turn, the lever 13, once its end 13' has disengaged, releases the lamina 29, which by means of its elastic loading facilitates the switching of the moving contact from the first fixed contact 20 to the second fixed contact 20'.

[0032] The remaining part of the mechanism is substantially not affected by the movement. If instead an indirect command is issued remotely by an operator on a pushbutton or on a control panel, the coil 12 is excited by a current pulse which produces a magnetic field whose intensity is adequate to facilitate the attraction of the moving magnet 22 toward the fixed magnet 21. In this situation, the moving magnet 22 is capable of crossing the existing gap and by rotating it couples electromagnetically to the fixed magnet 21. Said movement is transmitted to the lever 9, which also rotates about its pivoting axis 100. Through this rotation, the oblique flat portion 39 pushes against the pivot 14 of the lever 5, forcing it to rotate in the direction indicated by the arrow 107. The toothed sector 2 meshes with the toothed sector 3 of the lever 6, causing the movement of the pivot 15 in the slot 38: in this manner, the circuit breaker receives motion either directly by means of the pivot 14 or indirectly from the lever 6 by means of the pivot 15 and the meshing of the two toothed sectors 2 and 3; moreover, by means of this rotation the tripping lever 5 disengages the U-shaped element 32, which becomes able to slide freely in the groove 33 of the lever 4. Advantageously, the actuation lever 4, no longer locked by the U-shaped element 32, rotates under the action of

the thrust of the spring 26 in the direction indicated by the arrow 106 and simultaneously facilitates a faster rotation of the lever 5. This simultaneous rotation is achieved by means of a spring, not shown, which is interposed between the levers 4 and 5 and couples their movement; said spring is conveniently inserted in a seat 80 of the lever 4. Therefore, in this manner the potential energy accumulated earlier by the spring 26 is utilized; once said energy has been released, it provides the force required to ensure the prompt movement of the mechanism and the consequent correct intervention of the circuit breaker. This ensures the advantage of being able to minimize the dimensions of the electromagnetic part (moving magnet 22, fixed magnet 21 and coil 12) with a consequent saving in terms of materials, dimensions and costs.

[0033] At the same time, the lever 13, once the end 13' has disengaged, releases the moving contact 29, which moves from the fixed contact 20 to the fixed contact 20'; this changeover deenergizes the coil 12 and prevents its damage due to excessive power supply. The moving contact therefore advantageously acts as a contact for automatically de-energizing the coil; moreover, when the moving contact changes position, the four-terminal configuration allows to visually indicate to a remote operator that the circuit breaker is open, as described earlier. Moreover, during rotation the wing 40 of the lever 9 interacts with the pivot 50, pushing it toward the inside of the device and disengaging the shaped wall 36 from the engagement with the raised portion 35. In this manner, the lever 7, pushed by the action of the spring 24 on the raised portion 34, rotates about the pivoting axis 103 and the shaped protrusion 60 protrudes from the enclosure 1 through an opening 61, providing a local visual indication that the circuit breaker has tripped. At the end of the actuation, the transmission lever 10, following the movement of the associated circuit breaker, reaches the position shown in Figure 3, in which the U-shaped element 32 re-engages the levers 4 and 5.

[0034] In this condition, an operator can therefore reset the auxiliary device simply by acting on the protrusion 60, without acting on the circuit breaker, which remains open; by pushing the protrusion 60 downward, the lever 7 in fact rotates and allows reengagement between the raised portion 35 and the shaped wall 36, pushed by the spring 24, which acts on a raised portion 70 of said lever 11. Once the magnetic field generated earlier by the excitation of the coil has ceased, the lever 9 returns to its initial position by virtue of the action of the spring 28.

[0035] The device can also be reset by acting on the control knob of the circuit breaker. In this case, the movement is transmitted from the circuit breaker to the transmission lever 10 which pushes the lever 4 by means of the U-shaped element 32; the pivot 30, during the movement of the lever 4, acts against the surface of the slot 31 of the lever 7 and pulls it downward, causing

it to rotate. By virtue of this rotation, the raised portion 35 couples to the shaped wall 36, as described earlier. Moreover, the protrusion 19 engages the end 13' of the lever 13 which, by rotating about its pivoting axis 104, acts on the lamina of the moving contact 29 and returns it onto the fixed contact 20.

[0036] In practice it has been found that the auxiliary actuation device according to the invention fully achieves the intended aim, since it allows to provide a coupling with the circuit breaker independently of the mechanical structure of the circuit breaker and of the arrangement of the contacts inside it without affecting its performance in any way; moreover, thanks to the adoption of the above-described particular constructive refinements, it is possible to locally and directly identify the opening of the circuit breaker, with consequent reset of said device without acting on the circuit breaker.

[0037] It should also be observed that all the innovative functions and the inventive aspects of the device can be achieved by using commonly commercially available elements and materials with extremely modest costs; the mechanism thus conceived allows also to optimize the dimensions of the electromagnetic part constituted by the magnets and by the coil, providing a further economic benefit.

[0038] The auxiliary device thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; all the details may also be replaced with other technically equivalent elements.

[0039] In practice, the materials employed, as well as the dimensions, may be any according to requirements and to the state of the art.

Claims

1. An auxiliary device for opening a circuit breaker associated therewith following a remote opening command, comprising an insulating enclosure which contains fixed contacts and a corresponding moving contact, connection terminals, a fixed magnet on which a coil is wound and a moving magnet which can be coupled electromagnetically to said fixed magnet, characterized in that it comprises:
 - actuation means which are operatively connected to and actuated by the moving magnet;
 - means for coupling to the circuit breaker which are operatively associated to said actuation means;
 - a kinematic chain operatively connected to said means for coupling to the circuit breaker;
 - means for interacting with the moving contact, which are operatively connected to said kinematic chain;
 - means for providing a local visual indication of the open state of the circuit breaker following

said remote opening command, actuated by said actuation means.

2. The auxiliary device according to claim 1, characterized in that said means for coupling to the circuit breaker comprise a coupling lever and a tripping lever which are operatively connected to each other, each lever comprising a pivot for coupling to the circuit breaker.
3. The auxiliary device according to claim 2, characterized in that the coupling and tripping levers are mutually operatively connected by means of two toothed sectors which are associated therewith and mutually mesh, rotating with respect to each other in mutually opposite directions.
4. The auxiliary device according to one or more of the preceding claims, characterized in that said means for coupling to the circuit breaker further comprise a transmission lever which is operatively connected to the circuit breaker and with which a return spring is associated.
5. The auxiliary device according to claim 1, characterized in that said actuation means comprise a first actuation lever which has a seat for geometric coupling to the moving magnet, a return spring being associated with said first actuation lever.
6. The auxiliary device according to one or more of the preceding claims, characterized in that said first actuation lever has a shaped edge which forms at least one surface which is suitable to interact with the pivot of said tripping lever, and a slot in which the pivot of said coupling lever slides freely.
7. The auxiliary device according to claim 1, characterized in that said means for interacting with the moving contact comprise an interaction lever which is freely pivoted to the enclosure and is provided with a first end which can interact directly with the moving contact.
8. The auxiliary device according to one or more of the preceding claims, characterized in that said kinematic chain comprises a second actuation lever provided with a protrusion which can interact with a second end of the interaction lever, a spring being associated with said second actuation lever and being suitable to provide an amount of energy for the opening of the circuit breaker.
9. The auxiliary device according to one or more of the preceding claims, characterized in that the second actuation lever has a seat in which a spring is inserted, said spring being suitable to operatively couple the tripping lever and said second actuation

lever.

10. The auxiliary device according to one or more of the preceding claims, characterized in that the second actuation lever has a groove in which a U-shaped element slides, said U-shaped element being suitable to detachably connect said second actuation lever and said tripping lever to the transmission lever. 5
11. The auxiliary device according to one or more of the preceding claims, characterized in that said means for the local visual indication of the open state of the circuit breaker due to a remote opening command comprise a reset and indication lever and an engagement lever which respectively have a first raised portion and a shaped wall which can be geometrically coupled to each other. 10 15
12. The auxiliary device according to claim 11, characterized in that the reset and indication lever has a protrusion which can protrude from an opening of the enclosure following the opening of the circuit breaker due to a remote opening command. 20 25
13. The auxiliary device according to one or more of the preceding claims, characterized in that said reset and indication lever has a second raised portion on which a first end of a spring acts and a slot which can interact with a pivot which is formed on the surface of the second actuation lever. 30
14. The auxiliary device according to one or more of the preceding claims, characterized in that the engagement lever has a pivot and a seat which are suitable to interact with the second end of the spring which is connected to said second raised portion, a wing also acting on said pivot, said wing being formed on the surface of the first actuation lever. 35 40
15. The auxiliary device according to one or more of the preceding claims, characterized in that it comprises four connection terminals. 45 50 55

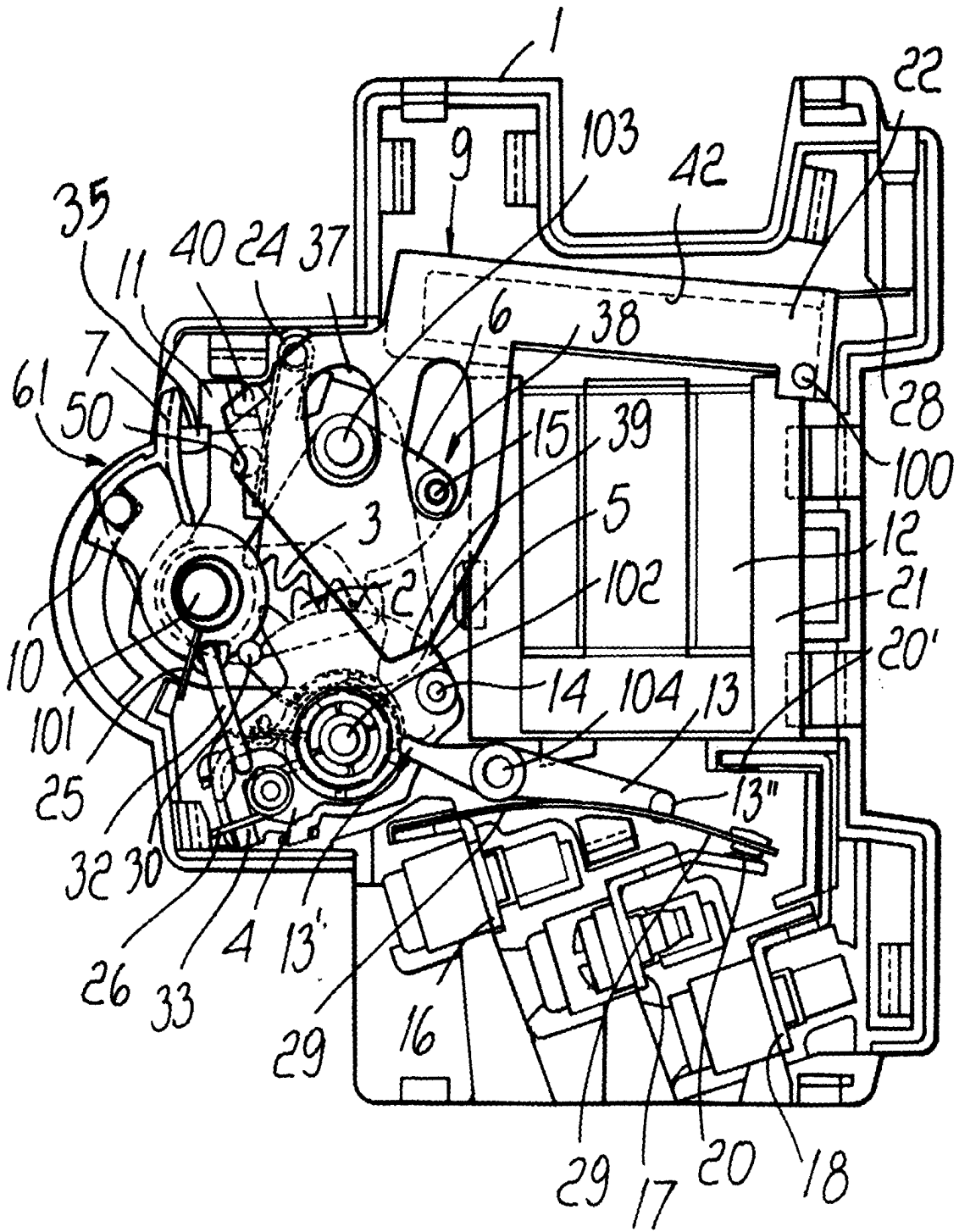


Fig. 1

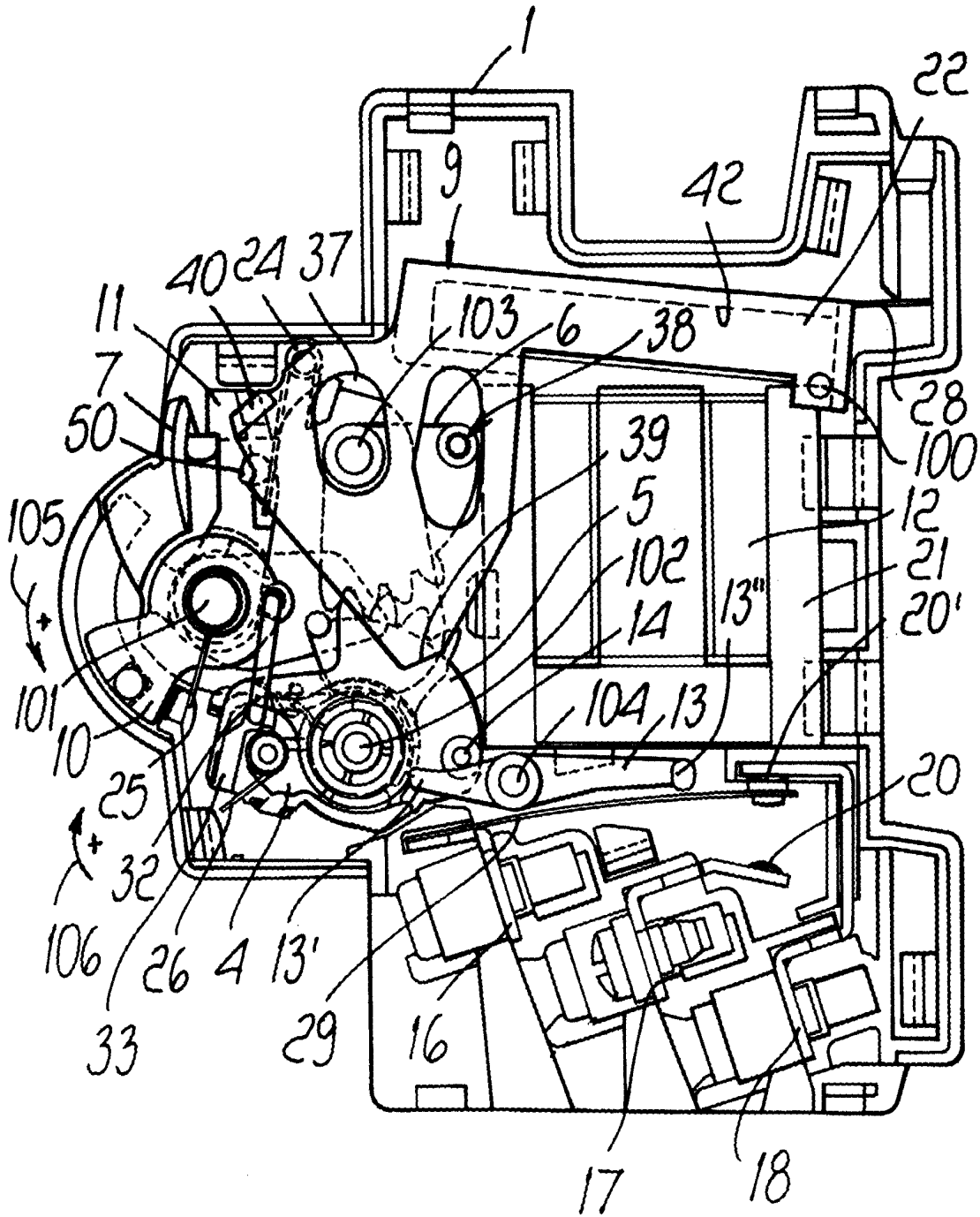


FIG. 2

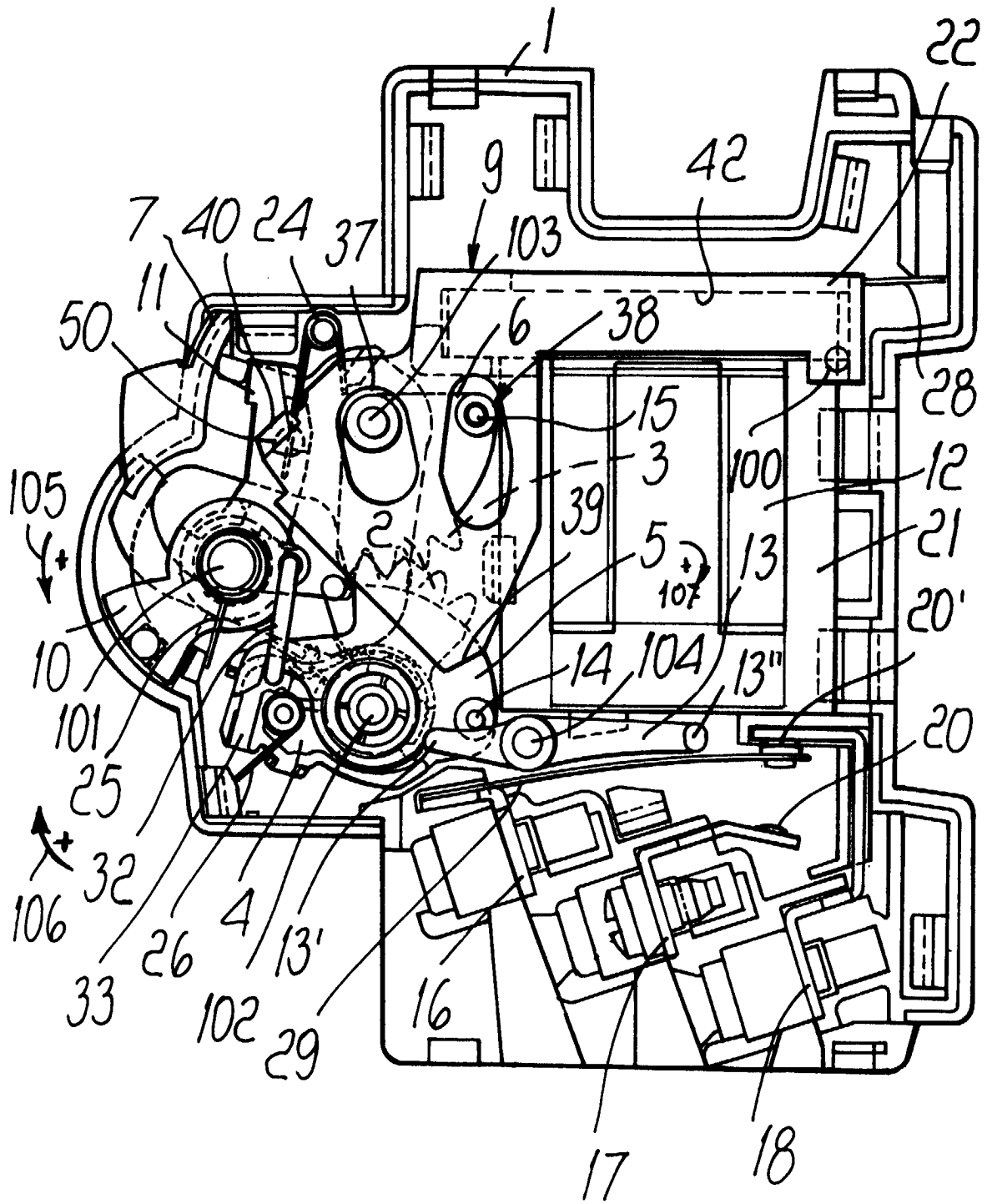


Fig. 3

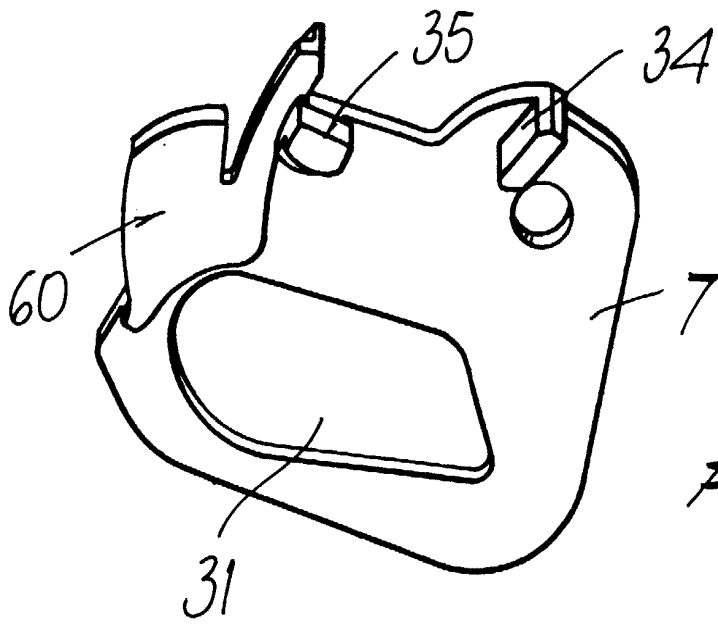


Fig. 4

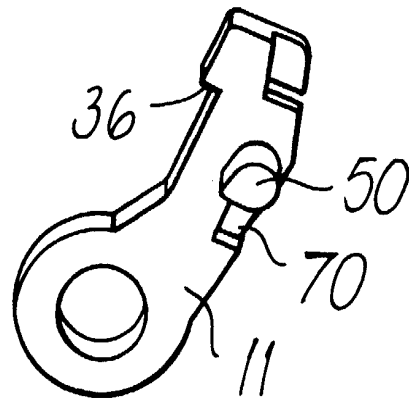


Fig. 5

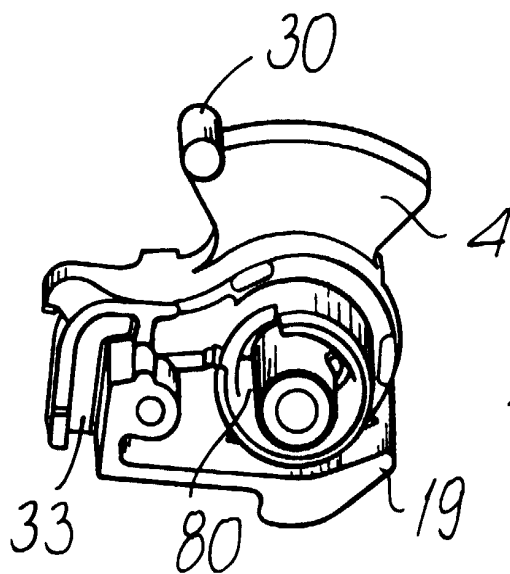


Fig. 6