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(54) Electrical assembly with actuating device for a circuit breaker, comprising malfunction signalling means

(57) Electrical assembly comprising a circuit breaker having an operating element movable between an opening position and a closing position and a safety mechanism for moving the operating element from the closing position into the opening position when a malfunction occurs, an actuating device (103) for moving the operating element between the opening position and the closing position, means (115,116;159,160) for connecting the safety mechanism to the actuating device (103), the actuating device (103) including signalling means (224,228) and means (206,212,216,220) for activating the signalling means (224,228) when there is a non-voluntary movement of the operating element from the closing position into the opening position caused by the safety mechanism.

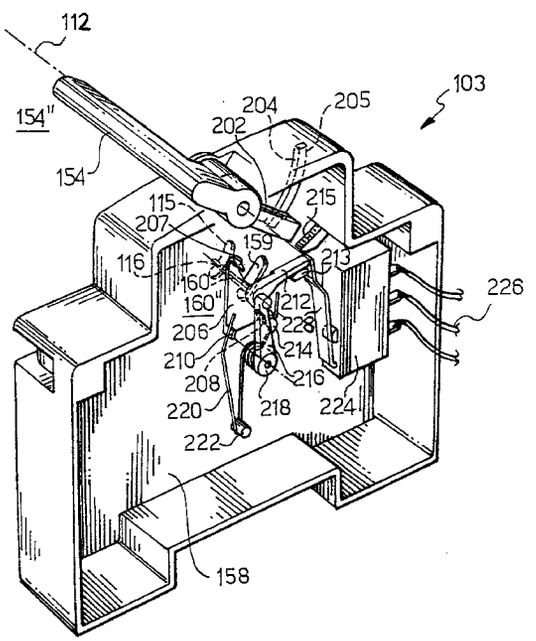

FIG.2a

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Description

The present invention relates to an electrical assembly comprising a circuit breaker and a device for actuating the circuit breaker, and in particular to an electrical assembly according to the preamble of Claim 1.

A circuit breaker is an electrical apparatus which is able to interrupt or establish a flow of current in a circuit by means of special separable contacts; in particular, the contacts are pressed together with a suitable force in a closed circuit breaker condition, while they are separated by an isolating distance in an open circuit breaker condition. These operating conditions are stable, in the sense that the circuit breaker remains in each of them in the absence of external forces.

Actuating devices (or actuators) are commonly used, for example in control systems for industrial plants, to perform switching operations (opening and closing) of the circuit breaker using energy other than manual energy. Typically, actuating devices use an electric motor to move an operating lever of the circuit breaker from an opening position into a closing position, and vice versa, in response to a suitable external command signal.

The circuit breaker includes moreover a safety mechanism which allows the circuit breaker to be opened automatically in a situation where there is a malfunction (or fault) of the circuit in which the circuit breaker is arranged.

A drawback of the known electrical assemblies consists in the fact that the electric circuit breaker opened by this safety mechanism following a malfunction may be closed inadvertently in a manual manner by an operator. The known electrical assemblies in fact do not allow one to distinguish whether the circuit breaker has been opened voluntarily following a normal switching operation (either manually or by means of the actuating device) or whether it has been opened non-voluntarily on account of a malfunction. The closing of the circuit breaker in this situation results in operation of the circuit under incorrect conditions, with a high risk of damage to the circuit breaker and the devices connected.

The object of the present invention is to overcome the aforementioned drawbacks. In order to achieve this object, an electrical assembly as described in Claim 1 is provided.

The electrical assembly according to the present invention allows an operator to be warned of the fact that a malfunction situation has occurred. In this way the circuit breaker can be locked in the opening condition, avoiding the danger of incorrect operations; this also prevents the circuit breaker from being accidentally closed by the actuating device owing to a spurious command signal.

Further characteristic features and advantages of the electrical assembly according to the present invention will emerge from the description, given below, of a preferred embodiment thereof, provided by way of a non-limiting example, with reference to the accompanying figures, in which:

Fig. 1 is a view, with parts separated, of the electrical assembly according to the present invention;
Figs. 2a-2c show a cross-section through the actuating device according to Fig. 1 in different operating conditions.

With reference in particular to Fig. 1, an electrical assembly 100 comprising an actuating device 103 for a circuit breaker 106 is illustrated. Typically, the actuating device 103 is used as a servomotor in a closed-chain control system, even though its use in different applications is not excluded - for example for simple remote operation of the circuit breaker 106.

The circuit breaker 106 comprises an insulating body 107 on the side walls of which one or more pairs of terminals 109 for connecting the circuit breaker 106 to corresponding pairs of electric wires of an external circuit (not shown in the figure) are provided. An operating element 110, typically consisting of a lever, is movable rotatably about an axis 112 between a position 110' (shown in continuous lines) and a position 110" (shown in broken lines) for opening and closing the circuit breaker 106, respectively. The insulating body 107 has, housed inside it, an opening mechanism (not shown in the figure) which, when the operating lever from the closing position 110" reaches an intermediate release position 110"' (shown in broken lines), triggers movement of the operating lever towards the opening position 110'; this mechanism imparts a sudden acceleration to the operating lever 110, pushing it with force towards the opening position 110', so as to avoid the formation of an electric arc between the contacts of the circuit breaker which are about to separate.

A slot 113 which allows access to a hole 114 is formed on a front wall of the insulating body 107. The hole 114 is formed (perpendicular to the front wall of the insulating body 107) in an internal element connected to the operating lever 110. When the operating lever is displaced from the opening position 110' into the closing position 110", the hole 114 moves correspondingly from an opening position 114' (shown in continuous lines) to a closing position 114" (shown in broken lines); when the operating lever is displaced from the closing position 110" to the opening position 110', the hole 114 does not move until the operating lever reaches the release position 110"', following which it moves correspondingly from the closing position 114" to the opening position 114'.

An additional slot 115 (with a slightly curved shape) is provided on a rear surface of the insulating body 107; this slot 115 allows access to a groove 116 (coaxial with the hole 114) having a shape slightly elongated in the direction of the slot 115. The groove 116 is formed (perpendicular to the rear wall of the insulating body 107) in an additional internal element movable integrally with

the element in which the hole 114 is formed, so as to move the groove 116 between an opening position 116' (shown in continuous lines) and a closing position 116" (shown in broken lines) in a similar manner to that described above.

A suitable operating element (not shown in the figure), consisting for example of a pin, is inserted into the hole 114. In the situation where there is a malfunction of the circuit in which the circuit breaker 106 is arranged, a remote protection device (not shown in the figure) acts on this pin so as to displace the hole 114 from the closing position 114" into the opening position 114'. This displacement causes movement of the operating lever 110 towards the release position 110"', causing opening of the circuit breaker 106. The present invention, however, may also be realized using different equivalent safety elements.

The actuating device 103 comprises an insulating body 117 which is provided on one of its lateral flanks with a terminal strip 118 for connecting the actuating device 103 to an electrical power supply network. The terminal strip 118 is also used for applying to the actuating device 103 suitable (opening and closing) command signals which are supplied by a remote control device (not shown in the figure).

The actuating device 103 is provided with a bar 154 (or other equivalent driving means) which is parallel to the axis of rotation 112 and on the bottom surface of which a longitudinal channel 157 is formed, into which channel the operating lever 110 of the circuit breaker 106 is inserted. The operating lever 110 is slidable inside the channel 157 in the direction of the axis 112 so as to allow assembly of the electrical unit 100, while the operating lever 110 and the driving bar 154 move locked together in rotation about the axis 112.

On a front wall 158 of the insulating body 117 there is formed a slot 159 facing the slot 115 formed on the rear wall of the circuit breaker 106. A pin 160 which is inserted into the groove 116 projects from the slot 159, perpendicularly with respect to the insulating body 117; the pin 160 is displaced by the groove 116 (as described in detail below) so as to connect the safety mechanism of the circuit breaker 106 to the actuating device 103. The present invention may, however, also be realized using different equivalent connecting means.

The circuit breaker 106 and the actuating device 103 are connected together, along each side surface of the electrical assembly 100, by means of an L-shaped element 166 (only one of which is shown in the figure). The L-shaped element 166 terminates on the smaller arm of the "L" in a tractional hook 169 which engages in a cavity 172 formed on the rear surface of the circuit breaker 106. The L-shaped element 166 is housed in a matching seat 173 formed in the actuating device 103 along a front vertical edge and is fixed by means of a screw 181 which is screwed into a metal plate (not shown in the figure).

With reference now to Fig. 2a (the elements already shown in Fig. 1 are identified by the same reference numbers), a bar 202 parallel to the wall 158 of the actuating device 103 extends perpendicularly from the driving bar 154 of the actuating device 103 (connected in a manner known per se to an electric motor, not shown in the figure). A flange 204 projects upwards from the bar 202; a curved circular-shaped projection 205 with its centre on the axis of rotation 112 extends, in relief, from the rear wall of the bar 202 and the flange 204.

A substantially triangular-shaped plate 206, parallel to the wall 158, is pivotably mounted on the pin 160 which projects from the slot 159. The plate 206 has, at each of its corners, a tongue 207,208,210 which is bent towards the inside of the actuating device 103. An L-shaped element 212 is also pivotably mounted on the pin 160 at a common end of its arms. The bigger arm and the smaller arm of the L-shaped element 212 rest in abutment, respectively, against a rib 213 (formed on the wall 158) and against the tongue 208 of the plate 206; an additional rib 215 is formed on the wall 158 above the rib 213. The free end of the smaller arm of the L-shaped element 212 is provided with a turret piece 214 (parallel to the pin 160) which rests in abutment against a bar 216 pivotably mounted at one of its free ends on the pin 160; the other end of the bar 216 is movable rotatably about a pivot 218 parallel to the pin 160. A flat spring 220 (or other equivalent resilient means) is wound around the pivot 218 and a parallel pin 222; the spring 220 acts with one of its ends against the tongue 210 of the plate 206 and with its other end on the turret piece 214 of the L-shaped element 212 so as to keep the lever mechanism consisting of the elements 206, 212 and 216 in the position shown in the figure.

A microswitch 224, which is electrically connected to the terminal strip (118 in Fig. 1) by means of one or more suitable wires 226, is arranged in the vicinity of the lever mechanism 206,212,216. A flat spring 228 (or other equivalent resilient means) is associated with the microswitch 224 and in the rest condition rests in abutment with one of its free ends against the rib 213, so that the microswitch 224 is open.

In order to explain operation of the lever mechanism 206,212,216, let us assume that the actuating device 103 is in the condition shown in the figure, with the driving bar 154 and the pin 160 in a position, indicated respectively by 154" and 160", corresponding to the closing position of the circuit breaker. If the actuating device 103 receives an opening command signal, the driving element 154 starts to rotate in the clockwise direction about the axis 112. As described above, until the driving element 154 reaches a position corresponding to the release position of the operating lever (110"' in Fig. 1), the pin 160 does not move, so that the lever mechanism 206,212,216 remains in the position shown in the figure. In this way, the projection 205 comes into contact with the tongue 207 of the plate 206, causing the plate 206 to rotate in an anti-clockwise direction about the pin 160. The tongue 208 of the plate 206

transmits this movement also to the L-shaped element 212, so that the smaller arm provided with the turret piece 214 moves away from the bar 216 against the action of the spring 220. When the driving element 154 reaches a position corresponding to the release position of the operating lever, the pin 160 starts to move towards the right, causing rotation of the lever mechanism 206,212,216 in a clockwise direction about the pivot 218. In this situation, the free end of the bigger arm of the L-shaped element 212 is located above the rib 215 which acts as a guide, preventing this end from coming into contact with the spring 228. The projection 205 then disengages from the tongue 207 of the plate 206 and the driving element 154 and the pin 160 complete their movement.

As shown in Fig. 2b (the elements already shown in Fig. 2a are identified by the same reference numbers), the driving element 154 and the pin 160 reach a position, indicated respectively by 154' and 160', corresponding to the opening position of the circuit breaker; it should be noted that the pin 160 does not reach the top end of the slot 159, owing to the elongated shape of the groove 116. If, in the condition shown in the figure, the actuating device 103 receives a closing command signal, the driving element 154 starts to rotate in an anticlockwise direction about the axis 112; the pin 160 moves correspondingly towards the left, causing rotation of the lever mechanism 206,212,216 in an anticlockwise direction about the pivot 218. When the projection 205 comes into contact with the tongue 207, the plate 206 is made to rotate in a clockwise direction about the pin 160 in opposition to the spring 220. The tongue 207 then disengages from the projection 205, the free end of the bigger arm of the L-shaped element is freed from the rib 215 and the spring 220 brings the lever mechanism 206,212,216 back into the position illustrated in Fig. 2a.

With reference to Fig. 2a again, let us now consider the case where, in the condition shown in the figure, a malfunction situation of the circuit containing the circuit breaker arises. In this case, as described above, the safety mechanism of the circuit breaker displaces the pin 160 towards the right, so as to rotate the lever mechanism 206,212,216 in a clockwise direction about the pivot 218. Therefore, when the driving element 154 is triggered so as to move into the opening position, rotating in the clockwise direction about the axis 112, the projection 205 does not come into contact with the tongue 207 of the plate 206. The free end of the bigger arm of the L-shaped element 121 is thus pushed against the spring 228 so that it closes the contact of the microswitch 224, as shown in Fig. 2c. Closing of the microswitch 224 produces a malfunction signal which is transmitted (by means of the wires 226) to a remote location. This signal activates a warning device, for example of the luminous type, so as to inform an operator of the malfunction situation in the circuit in which the electrical assembly is arranged; typically, the operator locks the driving element 154 of the actuating device 103 in the opening position 154', for example by means of a padlock (not shown in the figure), so as to prevent the circuit breaker from being accidentally closed. The present invention may, however, also be realized using different systems for transmission of the malfunction signal (for example using radio waves), with a luminous signalling device incorporated directly in the actuating device or using other equivalent signalling means. Once any fault in the circuit connected to the circuit breaker has been located and repaired, the driving element 154 is released and a closing command signal is sent to the actuating device 103 (or the driving element 154 is displaced manually towards the closing position 154"). In this case, the actuating device 103 returns, in a manner similar to that described above, into the condition shown in Fig. 2a.

The lever mechanism described above is particularly compact, reliable and effective. Moreover, it is extremely simple and may be mass-produced at a low cost, so that it does not increase the final cost of the entire actuating device. The present invention may, however, be constructed also with a driven member different from the lever mechanism described above, with other cam systems, or with equivalent means for activation of the microswitch.

Obviously a person skilled in the art may make numerous modifications and variations to the electrical assembly described above, in order to satisfy contingent and specific requirements, all of which, however, fall within the scope of protection of the invention, as defined by the claims below.

Claims

1. Electrical assembly (100) comprising a circuit breaker (106) having an operating element (110) movable between an opening position (110') and a closing position (110") and a safety mechanism (113-114) for moving the operating element (110) from the closing position (110") into the opening position (110') when a malfunction occurs;

   an actuating device (103) for moving the operating element (110) between the opening position (110') and the closing position (110");
   means (115,116;159,160) for connecting the safety mechanism (113-114) to the actuating device (103);
   characterized in that
   the actuating device (103) includes signalling means (224,228) and means (206,212,216,220) for activating the signalling means (224,228) when there is a non-voluntary movement of the operating element (110) from the closing position (110") into the opening position (110') caused by the safety mechanism (113-114).

2. Electrical assembly (100) according to Claim 1, in which the connecting means include a pin (160) housed in a slot (159) formed in a wall (158) of the actuating device (103) facing the circuit breaker (106), following a voluntary movement of the operating element (110) from the closing position (110") into the opening position (110') not caused by the safety mechanism (113-114) the pin (160) moving from a closing position (160") into an opening position (160') and following said non-voluntary movement the pin (160) not moving when there is a movement from the closing position (110") into an intermediate release position (110"') of the operating element (110) and moving from the closing position (160") into the opening position (160') when there is a movement from the release position (110"') into the opening position (110') of the operating element (110).

3. Electrical assembly (100) according to Claim 1 or 2, in which the signalling means (224, 228) include a microswitch (224) and corresponding resilient means (228), the resilient means (228) in a rest condition keeping the microswitch (224) in a non-active state and in a working condition keeping the microswitch (224) in an active state for generating a malfunction signal.

4. Electrical assembly (100) according to Claim 3, further comprising at least one wire (226) connected to the microswitch (224) for transmitting the malfunction signal externally.

5. Electrical assembly (100) according to Claim 3 or 4, in which the actuating device (103) includes driving means (154,202,204,205) coupled to the operating element (110) and in which the activation means (206,212,216,220) include a lever mechanism (206,212,216) connected to the pin (160), following said non-voluntary movement the driving means (154,202,204,205) not cooperating with the lever mechanism (206,212,216) so that the pin (160) moves the lever mechanism (206,212,216) into contact with the resilient means (228) so as to bring the resilient means (228) into the working position and following said voluntary movement the driving means (154,202,204,205) co-operating with the lever mechanism (206,212,216) so that the pin (160) moves the lever mechanism (206,212,216) not in contact with the resilient means (228) so as to keep the resilient means (228) in the rest condition.

6. Electrical assembly (100) according to Claim 5, in which the lever mechanism (206,212,216) comprises a plate (206) and an L-shaped element (212) pivotably mounted on the pin (160) and a bar (216) movable rotatably about a pivot (218) and pivotably mounted at one of its free ends on the pin (160), following said non-voluntary movement the pin (160) rotating the lever mechanism (206,212,216) about the pivot (218) so that an arm of the L-shaped element (212) makes contact with the resilient means (228) and following said voluntary movement the driving means (154,202,204,205) rotating the plate (206) about the pin (160), the plate (206) rotating correspondingly the L-shaped element (212) about the pin (160) so that the arm of the L-shaped element (212) does not make contact with the resilient means (228).

7. Electrical assembly (100) according to Claim 6, further comprising a rib (215) formed on said wall (158) of the actuating device (103) so as to keep the arm of the L-shaped element (212) not in contact with the resilient means (228) following said voluntary movement.

8. Electrical assembly (100) according to Claims 6 or 7, in which the plate (206) includes a first tongue (208) for co-operating with the L-shaped element (212) and the L-shaped element (212) includes a turret piece (214) for co-operating with the bar (216), the activating means (206,212,216,220) comprising additional resilient means (220) co-operating with a second tongue (210) formed on the plate (206) and with the turret piece (214) so as to keep the first tongue (208) and the turret piece (214) in contact, respectively, with the L-shaped element (212) and the bar (216).

9. Electrical assembly (100) according to Claim 8, in which the driving means (154,202,204,205) include a curved projection (205) for co-operating with a third tongue (207) formed on the plate (206).

10. Electrical assembly (100) according to Claim 9, in which the driving means (154,202,204,205) include a driving bar (154) parallel to an axis of rotation (112) of the driving means, an additional bar (202) perpendicular to the driving bar (154) and a flange (204) parallel to the additional bar (202), the curved projection (205) extending from the additional bar (202) and the flange (204).

11. Electrical assembly (100) according to Claim 10, in which the curved projection (205) has a circular shape with its centre on the axis of rotation (112).

12. Electrical assembly (100) according to any one of Claims 5 to 11, in which the pin (160) moves from the opening position (160') into the closing position (160") when there is a closing movement of the operating element (110) from the opening position (110') into the closing position (110"), following said closing movement the pin (160) moving the lever mechanism (206,212,216) so as to keep the resil-

ient means (228) in or bring them into the rest position.

13. Actuating device (103) for use in the electrical assembly (100) according to any one of Claims 1 to 12.

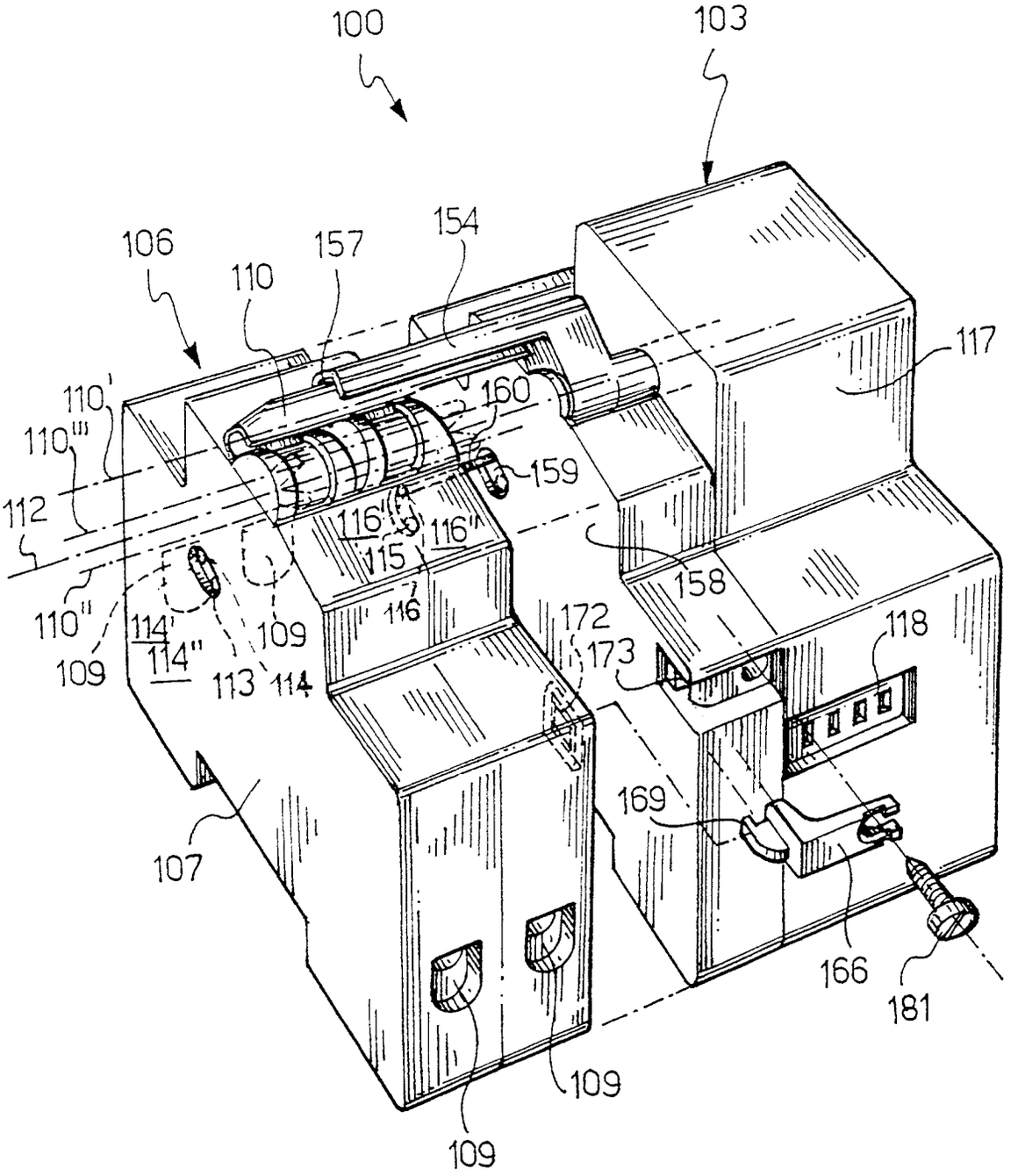
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FIG.1

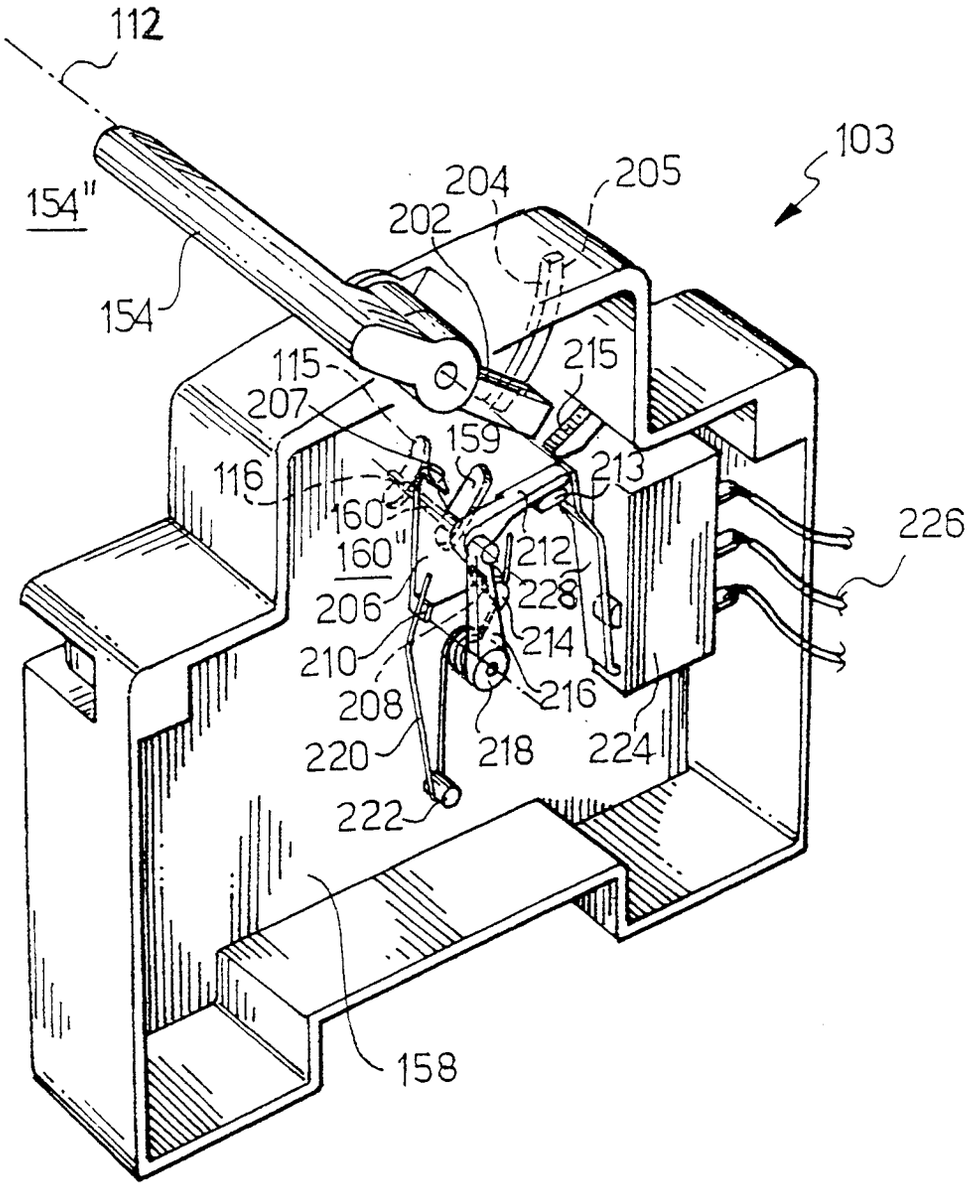
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FIG.2a

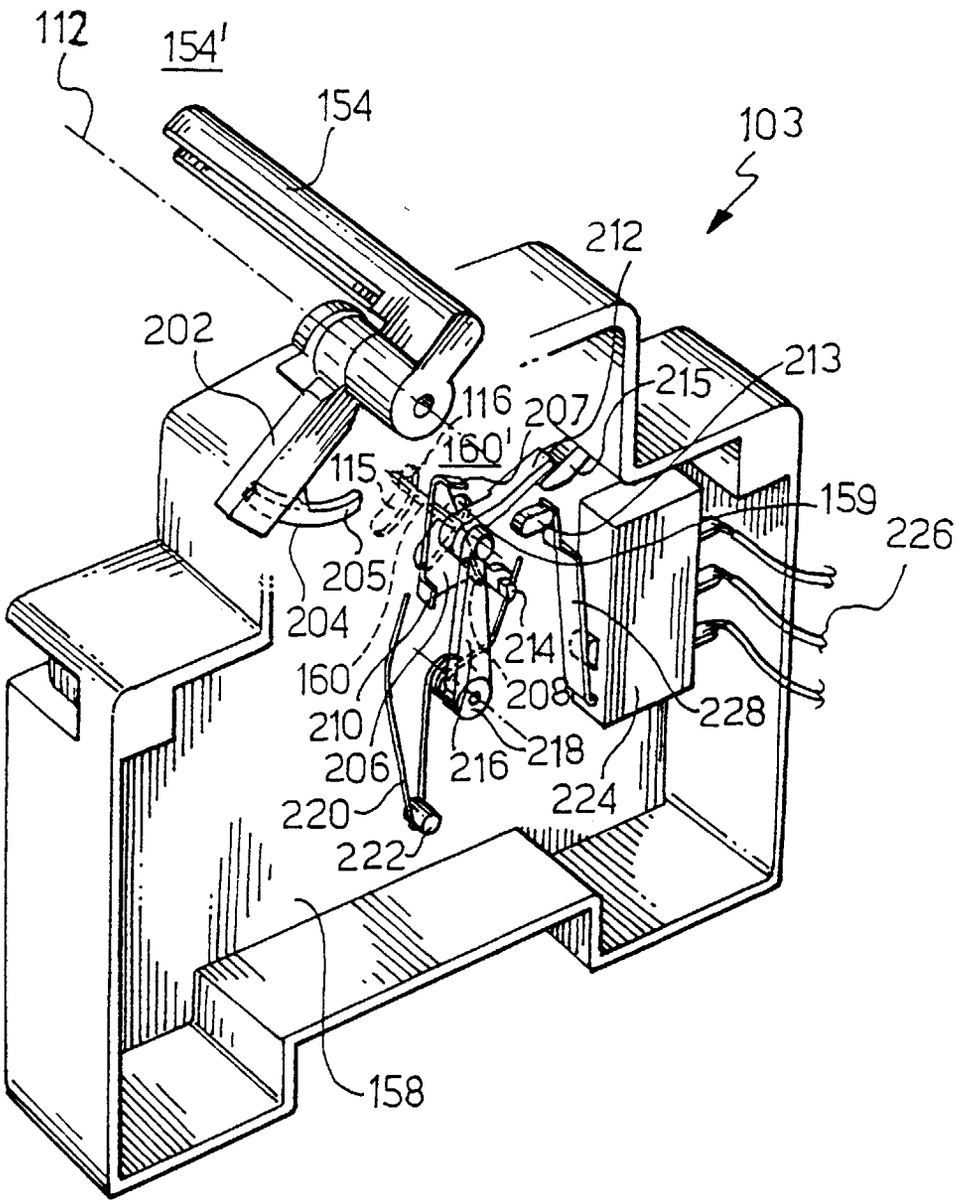
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FIG.2b

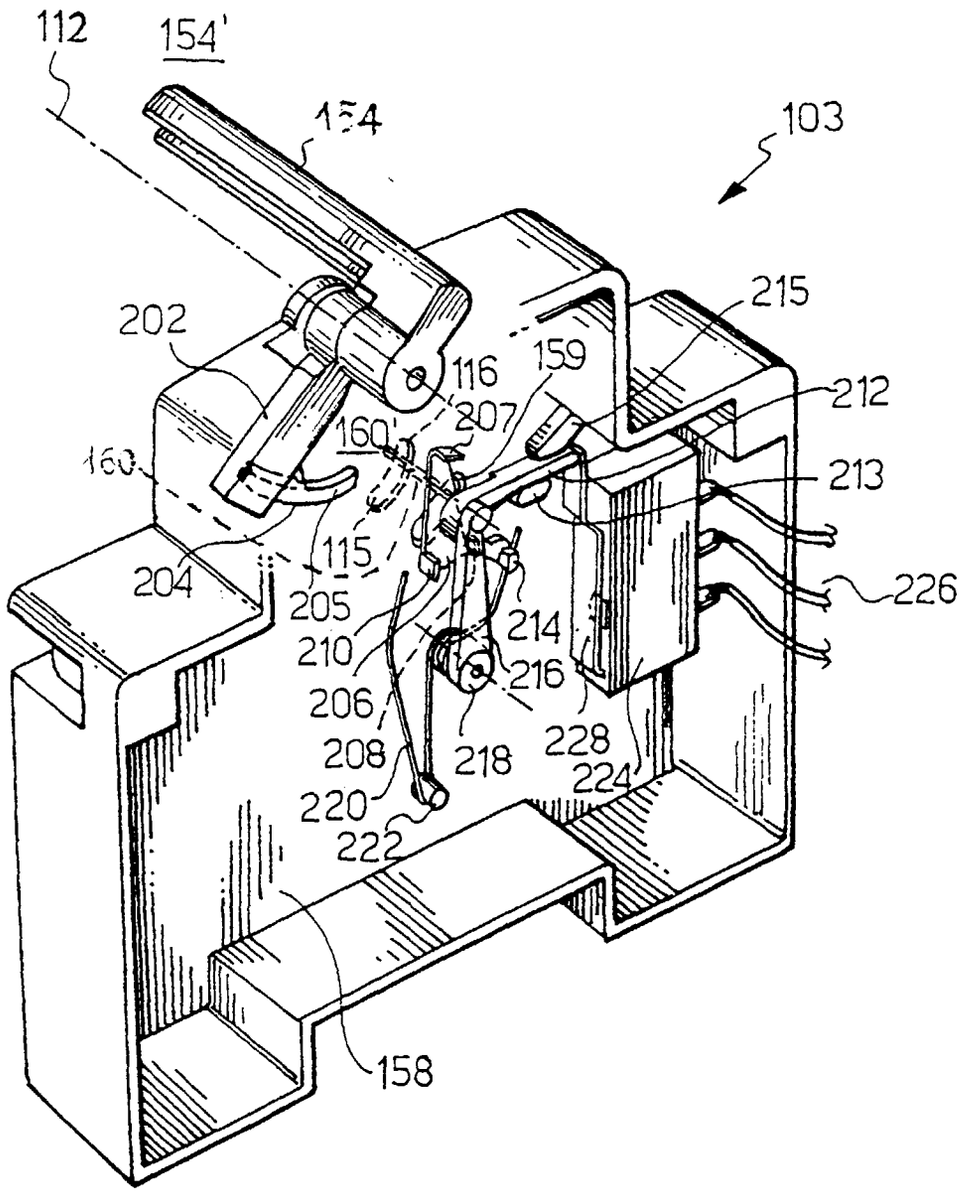
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FIG.2c