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(54) **Circuit breaker and method of tripping a circuit breaker**

(57) A circuit breaker includes a trigger assembly having first and second trigger members, and a tripping mechanism configured and disposed to act upon the first and second trigger members to selectively open an electrical circuit upon receipt of a mechanical trip signal input, and provide a mechanical trip signal output. The tripping mechanism includes a hammer having a first end defining an axis of rotation, a second end configured and disposed to act upon one of the first and trigger members and an intermediate portion spaced from each of the first and second ends. A spring member includes an end section arranged to act upon the intermediate portion. The spring member is configured and disposed to apply a force to the intermediate portion to urge the hammer about the axis of rotation to cause the second end to disengage from the one of the first and second trigger members.

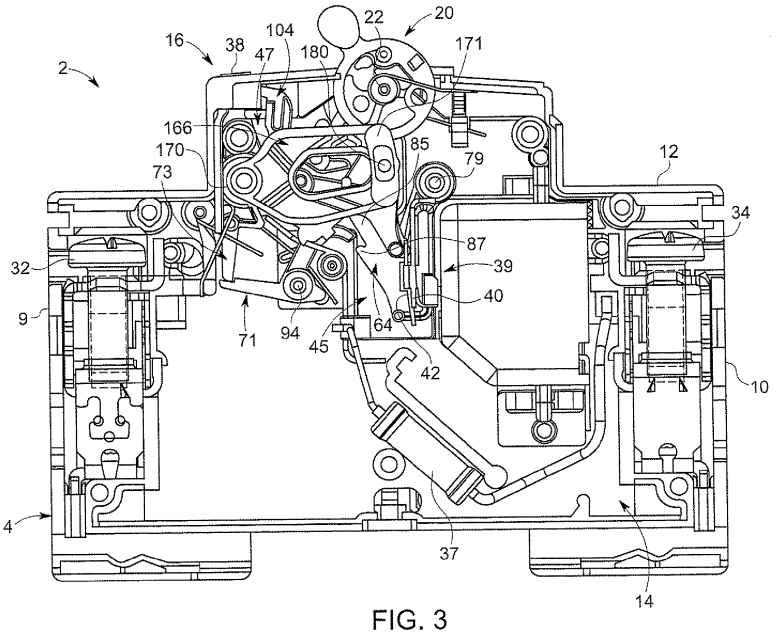

FIG. 3

EP 2 669 923 A1

Description

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates to the art of circuit breakers and, more particularly, to a circuit breaker tripping mechanism.

[0002] Circuit breakers are configured to interrupt a current flow in the event of an electrical anomaly, typically an overcurrent condition. The interruption of current flow provides protection to electrical consumers as well as associated conductors and electrical loads. Generally, many circuit breakers take the form of residual current circuit breakers (RCCB). Residual current circuit breakers disconnect a circuit when an imbalance is detected between current flowing between line and neutral conductors. In many cases, residual current circuit breakers may include both overcurrent and leakage protection. More specifically, in addition to sensing overcurrent conditions, residual current circuit breakers may also be configured with earth leakage detecting circuitry that will interrupt power in the event that current is sensed leaking to ground.

[0003] Circuit breakers may also include internal mechanisms that receive and/or transmit mechanical tripping forces from/to another associated circuit breaker. More specifically, in a ganged circuit breaker arrangement, or an arrangement of multiple connected circuit breakers used to protect multiple phases of a multi-phase system, a trip signal resulting from an electrical fault detected on one circuit breaker is mechanically transmitted to adjacent circuit breakers. In this manner, all breakers connected to a multiple phase system are tripped even if the electrical anomaly is found in only one phase.

BRIEF DESCRIPTION OF THE INVENTION

[0004] According to one aspect of the exemplary embodiment, a circuit breaker includes a trigger assembly having first and second trigger members, and a tripping mechanism configured and disposed to act upon one of the first and second trigger members to selectively open an electrical circuit upon receipt of a mechanical trip signal input, and provide a mechanical trip signal output. The tripping mechanism includes a hammer having a first end defining an axis of rotation, a second end configured and disposed to act upon one of the first and second trigger members, and an intermediate portion spaced from each of the first and second ends. A spring member includes an end section arranged to act upon the intermediate portion of the hammer. The spring member is configured and disposed to apply a force to the intermediate portion to urge the hammer about the axis of rotation to cause the second end to disengage from the one of the first and second trigger members and open the electrical circuit.

[0005] In accordance with another aspect of the exemplary embodiment, a circuit breaker includes a trigger assembly having first and second trigger members, and a first tripping mechanism operatively connected to the first and second trigger members. The first tripping mechanism is configured and disposed to act upon one of the first and second trigger members to open an electrical circuit. A second tripping mechanism is configured and disposed to act upon the one of the first and second trigger members to open the electrical circuit upon receipt of a mechanical trip signal input, and provide a mechanical trip signal output. The second tripping mechanism includes a hammer having a first end defining an axis of rotation, a second end configured and disposed to act upon the one of the first and second trigger members, and an intermediate portion spaced from each of the first and second ends. A spring member includes an end section arranged to act upon the intermediate portion of the hammer. The spring member is configured and disposed to apply a force to the intermediate portion to urge the hammer about the axis of rotation to cause the second end disengage from the one of the first and second trigger members and open the electrical circuit.

[0006] According to yet another aspect of the exemplary embodiment, a method of tripping a circuit breaker includes releasing a hammer having a first end, a second end and an intermediate portion from a connected position, pivoting the hammer about an axis of rotation defined at the first end, applying a spring force to the intermediate portion of the hammer spaced from the axis of rotation, and shifting the second end of the hammer from one of first and second trigger members to open an electrical circuit.

[0007] These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0008] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0009] FIG. 1 is a left perspective view of a circuit breaker including a tripping mechanism shown in a connected condition in accordance with an exemplary embodiment;

[0010] FIG. 2 is a right perspective view of the circuit breaker of FIG. 1 shown in a disconnected condition;

[0011] FIG. 3 is a cross-sectional side view of the circuit breaker of FIG. 1;

[0012] FIG. 4 is a detail view of the cross-sectional view of FIG. 1 illustrating a first tripping mechanism in accordance with the exemplary embodiment shown in a tripped position;

[0013] FIG. 5 is a detail view of the cross-sectional view of FIG. 1 illustrating a first tripping mechanism in accord-

ance with the exemplary embodiment shown in a tripped position;

[0014] FIG. 6 is a detail view of the cross-sectional view of FIG. 1 illustrating a second tripping mechanism in accordance with the exemplary embodiment shown in a non-tripped position;

[0015] FIG. 7 is a graph illustrating a mechanical force generated by the second tripping mechanism in accordance with the exemplary embodiment; and

[0016] FIG. 8 is a flow chart illustrating a method of operating a circuit breaker in accordance with an exemplary embodiment.

[0017] The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0018] A circuit breaker in accordance with an exemplary embodiment is illustrated generally at 2 in FIGs. 1-3. Circuit breaker 2 includes a housing 4 having first and second side walls 6 and 7 joined by first and second end walls 9 and 10 and a face portion 12 to form an interior portion 14. Face portion 12 includes an extended region 16 that supports a manual operating toggle 20 as well as houses various tripping mechanism components as will be discussed more fully below. As will also be discussed more fully below, manual operating toggle 20 is pivotal between three positions; a connect position, a disconnect position, and a tripped position, about an axis of rotation 22.

[0019] Circuit breaker 2 includes a first opening 25, provided on first side wall 6, and a second opening 28, provided on second side wall 7. An axle member 26 passes through first and second openings 25 and 28. Axle member 26 is configured to receive and/or transmit a mechanical trip signal to and/or from an adjacent circuit breaker (not shown). Circuit breaker 2 is further shown to include a first connector member 32 that is configured to connect to a load conductor (not shown), and a second connector member 34 configured to connect to a line conductor (also not shown). At this point it should be understood that first connector member 32 may alternatively be connected to a line conductor and second connector member 34 may alternatively be connected to the load conductor. In addition to the above, circuit breaker 2 includes a ground leakage test element shown in the form of a resistor 37. Ground leakage test element 37 simulates a ground leakage to provide a test signal to trip circuit breaker 2 upon activation of a test button 38.

[0020] Regardless of configuration, first and second connector members 32 and 34 are electrically coupled to a trigger assembly 39 having first and second trigger members 40 and 42. Trigger members 40 and 42 are configured to act upon electrical contacts (not shown) arranged within housing 4. The electrical contacts (not shown) are selectively connected/disconnected to pass electrical current between a source of electrical energy (not shown) and an electrical load (also not shown). As will become more readily apparent below, first and second trigger members 40 and 42 are operatively connected to first and second tripping mechanisms 45 and 47. First tripping mechanism 45 selectively acts upon first and second trigger members 40 and 42 based on a sensed electrical anomaly such as an over current condition, a ground leakage, and/or an arc fault condition. Second tripping mechanism 47 selectively acts upon first and second trigger members 40 and 42 based on a received mechanical trip signal from an adjacent circuit breaker. Second tripping mechanism 47 also generates a mechanical trip signal that is passed to adjacent circuit breakers. At this point it should be understood that the phrase "act upon" includes releasing a biasing force from one, the other, or both of trigger members 40 and 42.

[0021] Reference will now be made to FIG. 4 in describing first tripping mechanism 45. As shown, first tripping mechanism 45 includes a relay 60 having an actuator 61. Actuator 61 is selectively extended by relay 60 upon receiving an electrical trip signal from a sensor (not separately labeled) indicating an electrical anomaly. As discussed above, the electrical anomaly may include an over current condition, a ground leakage condition and/or an arc fault condition. Actuator 61 acts upon a relay tripping lever 64 which, in turn, acts upon a tripping member 68. As will be detailed more fully below, tripping member 68 is configured to act upon first and second trigger members 40 and 42 to move manual operating toggle to a tripped position as shown. Relay tripping lever 64 also acts upon a trip flag release 71 to release a trip flag 73 to provide a visual indication of a trip condition.

[0022] Relay tripping lever 64 includes a first end section 77 that defines an axis of rotation 79. First end section 77 extends to a second end section 82 having a contact pad 83 that receives input from actuator 61. Relay tripping lever 64 also includes a first actuator member 85 and a second actuator member 87. First actuator member 85 contacts and operates tripping member 68, and second actuator member 87 acts upon trip flag release 71. More specifically, upon sensing the electrical anomaly, actuator 61 extends from relay 60 and causes relay tripping lever 64 to pivot about axis of rotation 79. As relay tripping 64 lever pivots, first actuator member 85 acts upon tripping member 68 to shift first and second trigger members 40 and 42 as will be detailed below. Second actuator member 87 acts upon trip flag release 71 to free trip flag 73. Trip flag release 71 includes a first end portion 91 that extends to a second end portion 92 through an intermediate portion 93 that defines an axis of rotation 94. Second end portion 92 includes a release member 96 that releases trip flag 73 to expose a visual indicator 104.

[0023] In further accordance with the exemplary embodiment, tripping member 68 includes a central portion 108 that includes a center portion 110. Tripping member 68 further includes a first actuating element 112 and a second actuating element 113. First actuating element 112 is configured to receive an input from first actuator

member 85 to pivot tripping member 68 about center portion 110. Second actuator element 113 includes a pin element 114 that is configured to activate second tripping mechanism 47. Tripping member 68 is also operatively coupled to manual operating toggle 20 through a lever member 116. Lever member 116 includes a first end (not shown) coupled to tripping member 68 and a second end 117 coupled to manual operating toggle 20 at a position off-set from axis of rotation 22.

[0024] With this arrangement, tripping member 68 ties together inputs received from manual operating toggle 20, first tripping mechanism 45, and second tripping mechanism 47 to selectively act upon first and second trigger members 40 and 42. More specifically, tripping member 68 selectively shifts first and second trigger members 40 and 42 through operation of manual operating toggle 20, and based on inputs received from first and second tripping mechanisms 45 and 47.

[0025] Reference will now be made to FIG.s 5 and 6 in describing second tripping mechanism 47 in accordance with an exemplary embodiment. Second tripping mechanism 47 includes a hammer 130 operatively connected to tripping member 68. Hammer 130 includes a first end 134 that extends to a second end 135 through an intermediate section 136. First end 134 defines an axis of rotation 139 for hammer 130. Second end portion 135 includes a pin member 141 that is configured to act upon second trigger member 42. More specifically, pin member 141 moves second trigger member 42 relative to first trigger member 40. Intermediate portion 136 includes an actuator portion 145 having an opening 147 that receives pin element 114. Actuator portion 145 also includes a contact feature 149.

[0026] Contact feature 149 is engaged by a spring member or main spring 153. Main spring 153 includes a first end section 155 that extends to a second end section 156 through an intermediate section 158. First end section 155 is fixed relative to housing 4. Second end section 156 is cantilevered from a post 160 to produce a biasing force. The biasing force causes second end section 156 to act against contact feature 149 to urge pin member 141 against second trigger member 42. Second tripping mechanism 47 is also shown to include an external tripping element 166 (FIG. 3) operatively coupled to hammer 130. A second external tripping element (not shown) is also mounted to an opposing side of hammer 130. External tripping element 166 includes a first end 170 that extends to a second end 171. First end 170 includes an axis of rotation (not separately labeled) that coincides with axis of rotation 139 of hammer 130 and second end 171 includes an axle receiving element 180 that is configured to receive axle member 26. With this arrangement, rotation of hammer 130 is mechanically coupled to external tripping element 166 and the second external tripping element (not shown). As will be detailed more fully below, a mechanical tripping signal input received at axle member 26 acts upon external tripping element 166. External tripping element 166 in turn acts upon hammer 130 which moves first and second trigger members 40 and 42. Likewise, movement of hammer 130 resulting from a sensed over current condition will generate a force or mechanical energy that provides a mechanical trip signal output 182, illustrated in FIG. 7, at external tripping element 166 and the second external tripping element (not shown). Mechanical trip signal output 182 is transmitted to adjacent circuit breakers (also not shown) through axle member 26.

[0027] In accordance with the exemplary embodiment, upon sensing an electrical anomaly as discussed above and shown in block 300 in FIG. 8, first actuator member 85 acts upon first actuating element 112 of tripping member 68 as shown in block 302. Tripping member 68 pivots causing pin element 114 to act upon actuating portion 145 of hammer 130. In addition, central portion 110 crosses an imaginary line that extends between pin elements 114 and second end 117 of lever member 116 allowing main spring 156 to shift hammer 130 about axis of rotation 139 as shown in block 304. Rotation of precursor 130 disengages/releases pin member 141 from second trigger member 42 in block 306 to open first and second contacts (not shown) that open an associated electrical circuit (also not shown). Main spring 156 generates mechanical trip signal output 182 in block 308 that shifts manual operating toggle to the tripped position- More specifically, mechanical trip signal output 182 develops a generally square wave form as a result of main spring 156 providing a biasing force to hammer 130 spaced from axis of rotation 139. Mechanical trip signal output 182 is also passed to external tripping element 166 to mechanically trip adjacent circuit breakers (not shown) such as shown in block 310. Similarly, a mechanical trip signal received at external tripping element 166 is passed to hammer 130 which acts upon pin element 114. Pin element 114 rotates tripping member 68 causing central portion 110 to cross the imaginary line that extends between pin element 114 and second end 117 of lever member 116 allowing main spring 156 to force hammer 130 upward releasing second contact 42.

[0028] In either case, mechanical trip signal 182 generated by main spring 156 has a prolonged dwell that balances on/off trip forces with on/off actuation through manual operating toggle 20. Circuit breakers require a specific force to be tripped such as shown at 400 in FIG. 7. In contrast prior art arrangements create a sharply degrading mechanical trip signal 410 due to the spring force being provided at the axis of rotation of the precursor. Sharply degrading signal 410 quickly loses energy. As such, prior art arrangements are often incapable of dislodging contacts that may become struck together. The exemplary embodiments provide a trip signal having a prolonged dwell that is configured to more completely capture the force required to trip the circuit breaker. In addition to balancing on/off trip forces with on/off actuation forces, the prolonged dwell provides increased time and energy to the delivery or mechanical tripping force that may assist in disconnecting mechanisms that may

have become stuck together.

[0029] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

Claims

1. A circuit breaker comprising:

a trigger assembly having first and second trigger members; and
a tripping mechanism configured and disposed to act upon the first and second trigger members to selectively open an electrical circuit upon receipt of a mechanical trip signal input, and to provide a mechanical trip signal output, the tripping mechanism including a hammer having a first end defining an axis of rotation, a second end configured and disposed to act upon one of the first and second trigger members and an intermediate portion spaced from each of the first and second ends, and a spring member including an end section arranged to act upon the intermediate portion of the hammer, the spring member being configured and disposed to apply a force to the intermediate portion to urge the hammer about the axis of rotation to cause the second end to disengage from the one of the first and second trigger members .

2. The circuit breaker according to claim 1 further comprising: a tripping member operatively connected to the tripping mechanism, the tripping member being configured and disposed to act upon the hammer.

3. The circuit breaker according to claim 2, further comprising: a manual operating toggle operatively connected to the tripping member, the manual operating toggle being configured and disposed to provide a manual operation of the tripping mechanism.

4. The circuit breaker according to claim 1, further comprising: an external tripping element operatively connected to the hammer, the external tripping element being configured and disposed to provide the mechanical trip signal output.

5. The circuit breaker according to claim 4, further comprising: an axle element operatively connected to the external tripping element, the axle element being configured and disposed to transmit the mechanical trip signal output to another circuit breaker.

6. The circuit breaker according to claim 4, wherein the mechanical trip signal output provided by the tripping mechanism includes a generally square waveform produced by the spring member.

7. A circuit breaker comprising:

a trigger assembly having first and second trigger members;
a first tripping mechanism operatively connected to the first trigger member and the second trigger member, the first tripping mechanism being configured and disposed to operate the trigger assembly to selectively disconnect first and second contacts; and
a second tripping mechanism configured and disposed to operate the trigger assembly upon receipt of a mechanical trip signal input, and provide a mechanical trip signal output, the second tripping mechanism including a hammer having a first end defining an axis of rotation, a second end configured and disposed to act upon one of the first and second trigger members and an intermediate portion spaced from each of the first and second ends, and a spring member including an end section arranged to act upon the intermediate portion of the hammer, the spring member being configured and disposed apply a force to the intermediate portion to urge the hammer about the axis of rotation to cause the second end to disengage from the one of the first and second trigger members.

8. The circuit breaker according to claim 7, further comprising: a tripping member operatively connected to each of the first tripping mechanism and the second tripping mechanism, the tripping member being configured and disposed to act upon the hammer.

9. The circuit breaker according to claim 8, wherein the first tripping mechanism includes a relay having an actuator, and a tripping lever pivotally mounted between the actuator and the tripping member.

10. The circuit breaker according to claim 8, further comprising: a manual operating toggle operatively connected to the tripping member, the manual operating toggle being configured and disposed to provide a manual operation of one of the first and second tripping mechanisms.

11. The circuit breaker according to claim 7, further com-

prising: a flag release operatively connected to a trip flag, the trip flag providing a visual indication of a trip condition of the first and second tripping mechanisms.

12. The circuit breaker according to claim 7, further comprising: an external tripping element operatively connected to the hammer, the external tripping element being configured and disposed to provide the mechanical trip signal output.

13. The circuit breaker according to claim 12, further comprising: an axle element operatively connected to the external tripping element, the axle element being configured and disposed to transmit the mechanical trip signal output to another circuit breaker.

14. The circuit breaker according to claim 7, wherein the mechanical trip signal output includes a generally square waveform produced by the spring member.

15. A method of tripping a circuit breaker, the method comprising:

releasing a hammer having a first end, a second end and an intermediate portion from a connected position;
pivoting the hammer about an axis of rotation defined at the first end;
applying a spring force to the intermediate portion of the hammer spaced from the axis of rotation; and
shifting the second end of the hammer from one of first and second trigger members to open an electrical circuit.

16. The method of claim 15, further comprising: providing a mechanical trip signal output from the hammer.

17. The method of claim 16, further comprising: transmitting the mechanical trip signal output to another circuit breaker.

18. The method of claim 15, wherein releasing the hammer includes receiving a mechanical trip signal input from another circuit breaker at the hammer.

19. The method of claim 15, wherein releasing the hammer includes receiving a trip signal from a relay in the circuit breaker.

20. The method of claim 15, wherein releasing the hammer includes receiving an open command from a manual operating toggle of the circuit breaker.

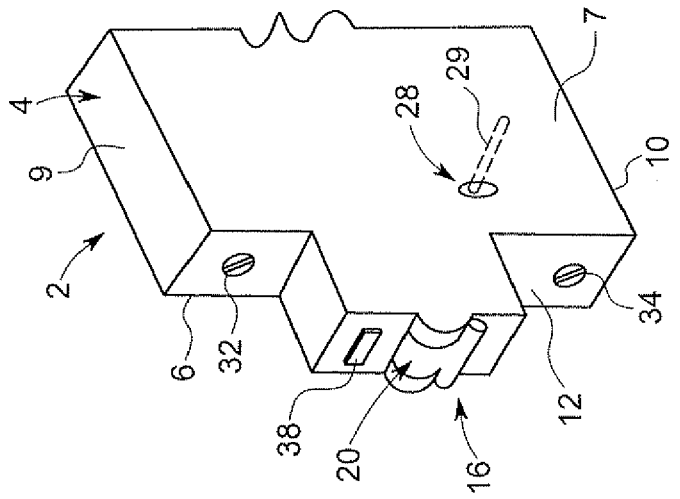

FIG. 2

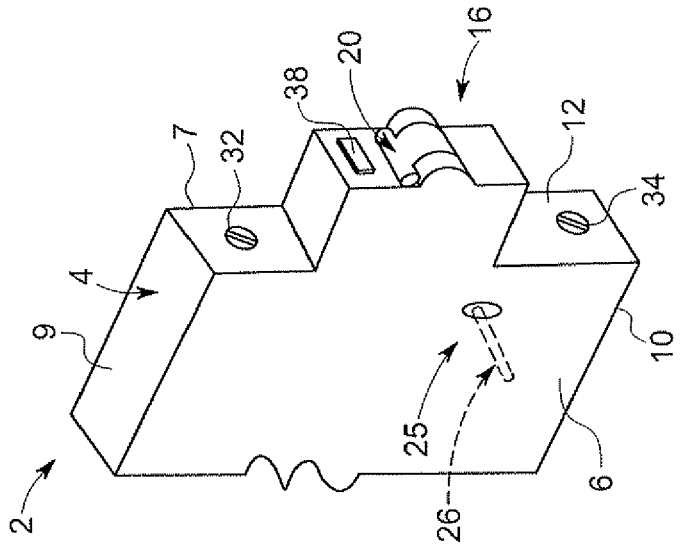

FIG. 1

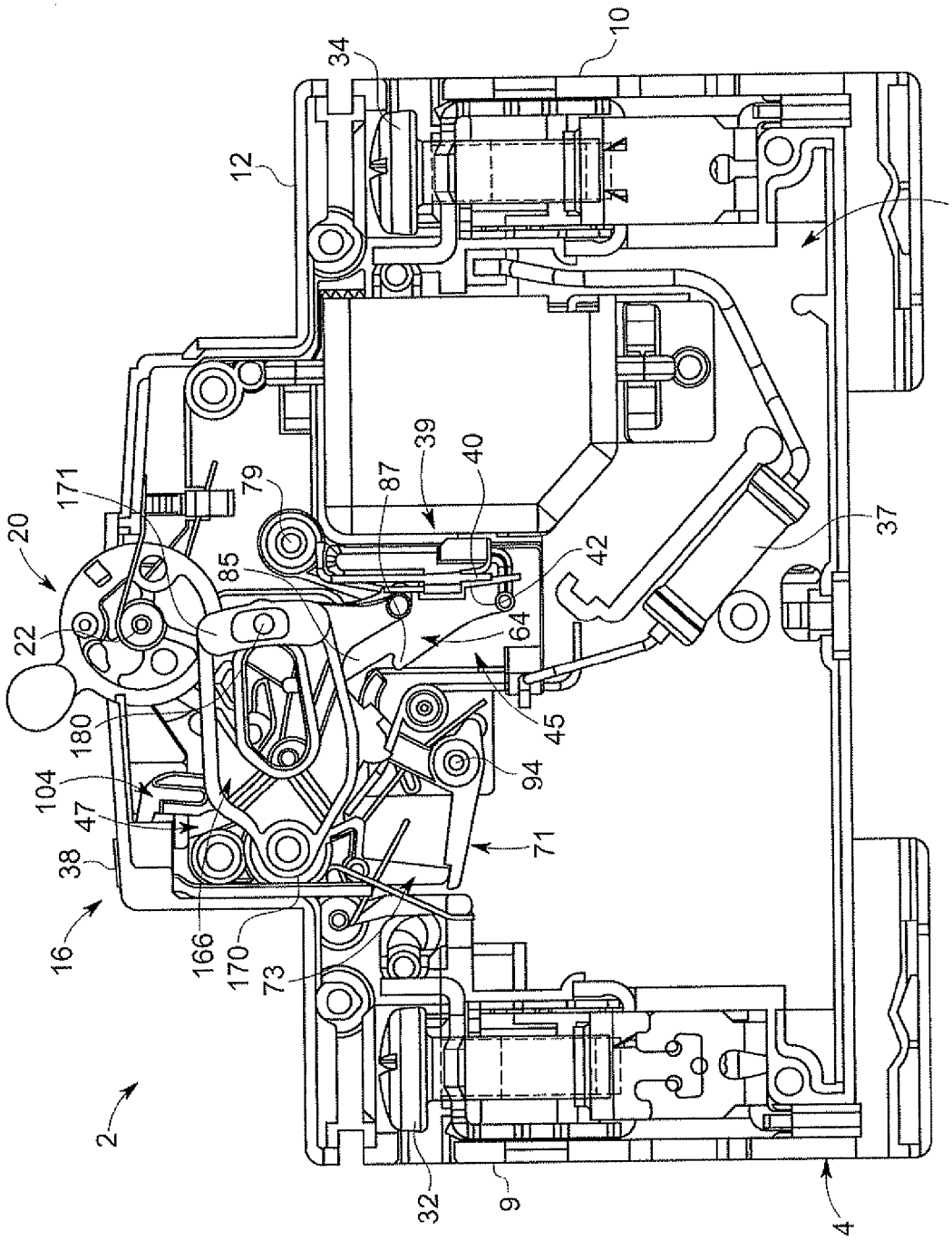
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FIG. 3

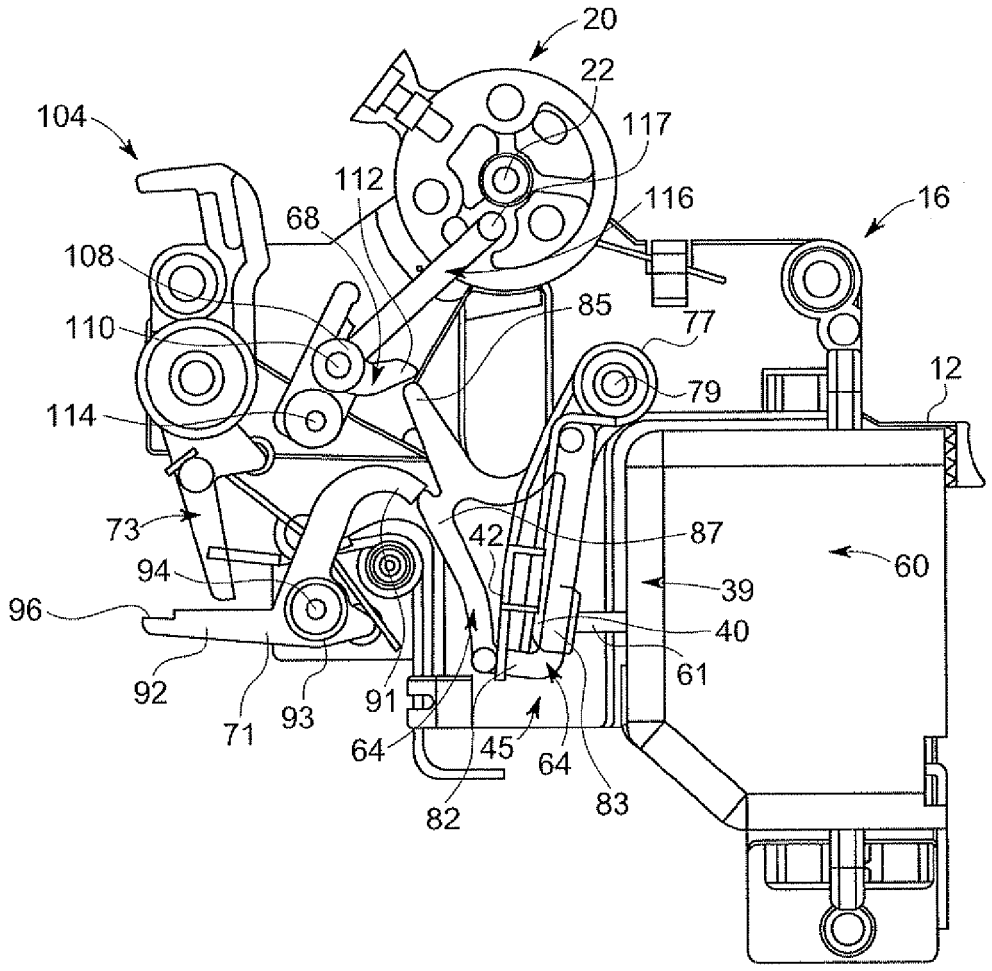
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FIG. 4

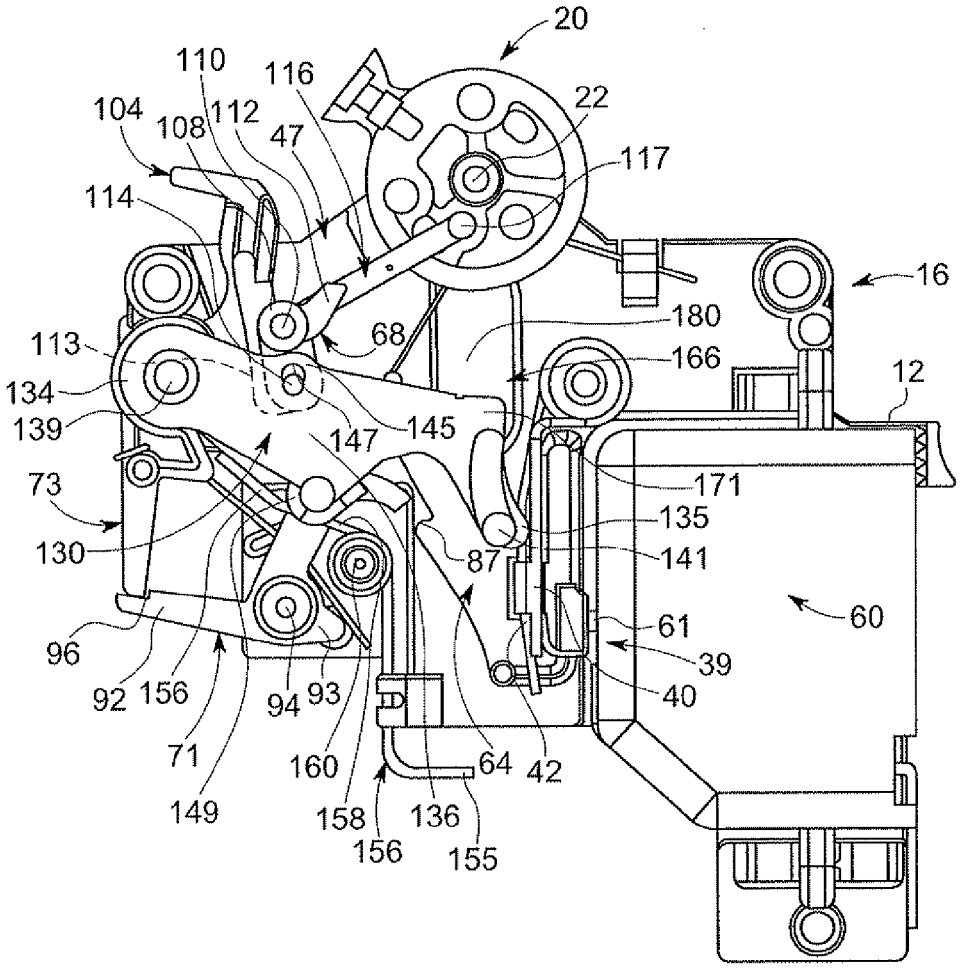
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FIG. 5

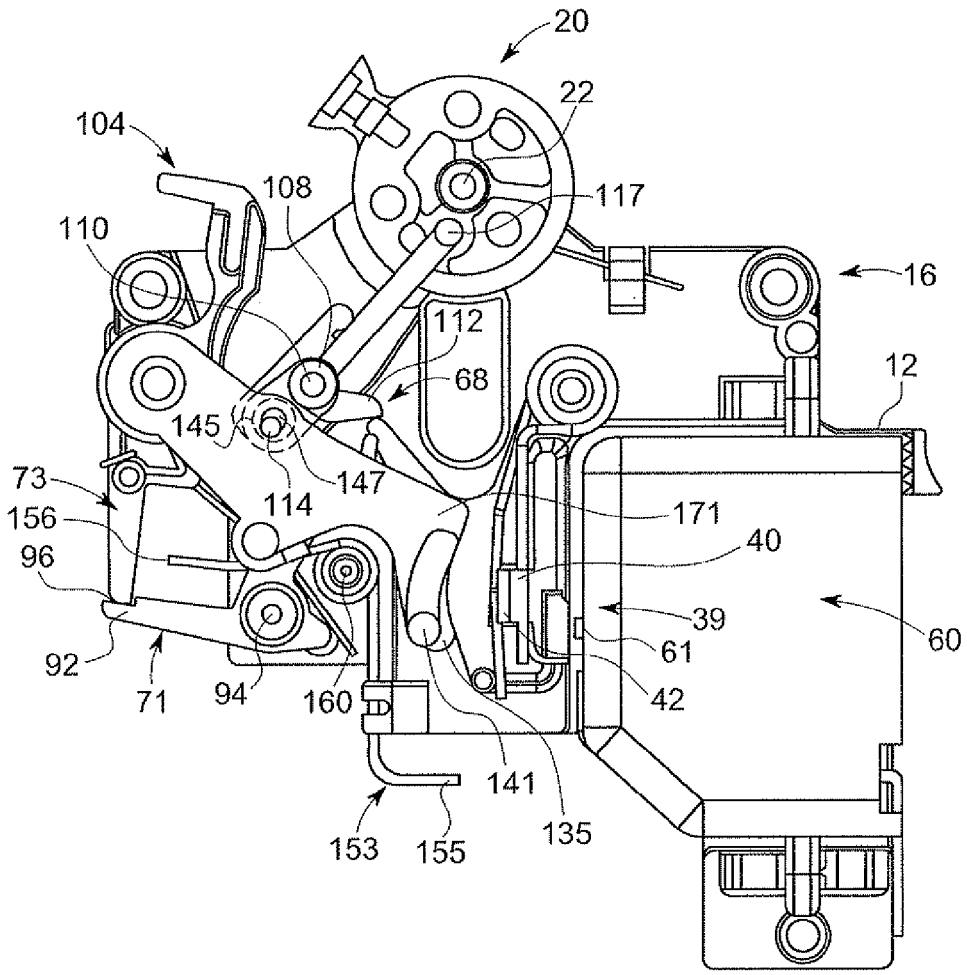
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FIG. 6

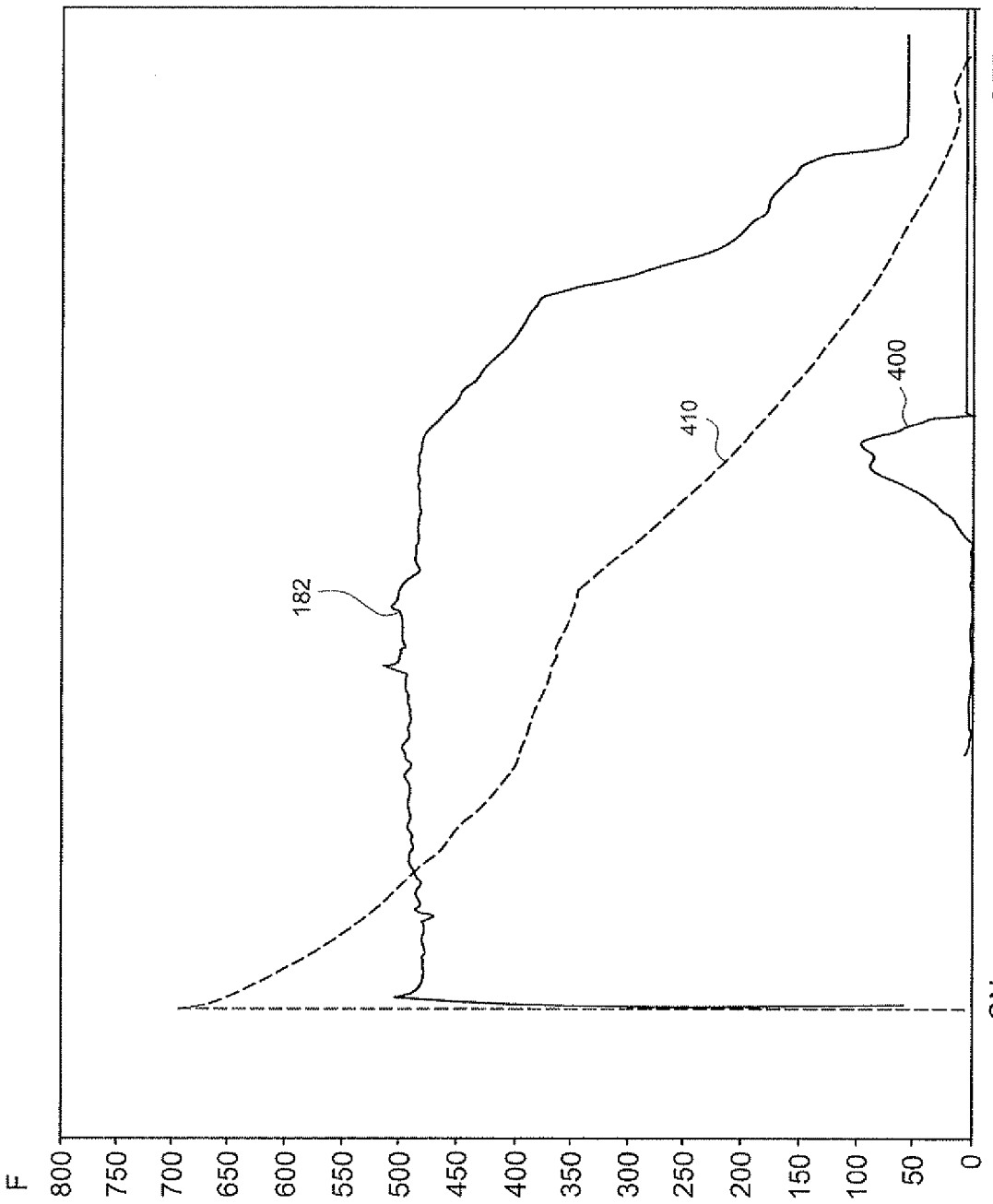
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FIG. 7

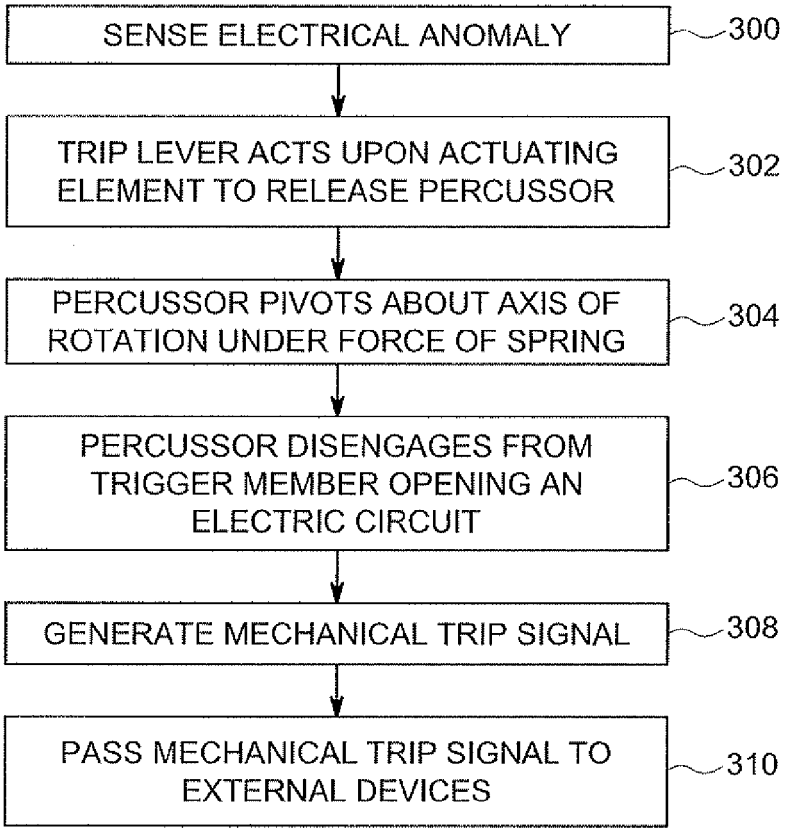
SENSE ELECTRICAL ANOMALY
300
TRIP LEVER ACTS UPON ACTUATING ELEMENT TO RELEASE PERCUSSOR
302
PERCUSSOR PIVOTS ABOUT AXIS OF ROTATION UNDER FORCE OF SPRING
304
PERCUSSOR DISENGAGES FROM TRIGGER MEMBER OPENING AN ELECTRIC CIRCUIT
306
GENERATE MECHANICAL TRIP SIGNAL
308
PASS MECHANICAL TRIP SIGNAL TO EXTERNAL DEVICES
310

FIG. 8

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 12 38 2222

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	EP 2 360 706 A1 (BTICINO SPA [IT]) 24 August 2011 (2011-08-24) * paragraphs [0033] - [0034]; figures 3,4 * -----	5,6	H01H3/46 H01H71/52 H01H83/04 H01H73/12
A	DE 10 2010 019741 A1 (SIEMENS AG [DE]) 10 November 2011 (2011-11-10) * abstract; figure 3b * -----	1	
Y	DE 199 33 166 A1 (HAGER ELECTRO GMBH [DE]) 18 January 2001 (2001-01-18) * abstract; figure 1 * -----	4-6	

TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 October 2012	Simonini, Stefano

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 38 2222

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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31-10-2012

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82