United States Patent [19]

Gryctko et al.

[11] **3,812,400**

[45] **May 21, 1974**

[54] **MODULAR GROUND FAULT INTERRUPTER**

[75] Inventors: **Carl E. Gryctko,** Haddon Heights, N.J.; **Paul Muchnick,** Norwald; **Frank C. Jaconette,** Trumbell, both of Conn.

[73] Assignees: **I-T-E Imperial Corporation,** Spring House, Pa.; **Harvey Hubbell Incorporated,** Bridgeport, Conn. ; part interest to each

[22] Filed: **Mar. 5, 1973**

[21] Appl. No.: **338,405**

[52] **U.S. Cl.** ..... **317/18 D,** 317/18 R, 335/18, 200/5 B

[51] **Int. Cl.** **H02h 1/02**

[58] **Field of Search** ..... 317/18 D, 18 R, 17, 38, 317/58, 112, 118, 119, 120; 335/18, 20, 6; 200/5 B

[56] **References Cited**

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Primary Examiner—J. D. Miller
Assistant Examiner—Patrick R. Salce
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

A circuit breaker module and a sensor module are secured together side by side to form a ground fault interrupter, with all moving parts of the interrupter being contained within the housing of the circuit breaker module. The modules are electrically connected at an interface region disposed outside of the module housings. This interface region is enclosed by a cover that cooperates with portions of the sensor module housing to form a plurality of compartments each of which contains a different electrical splicing element.

10 Claims, 13 Drawing Figures

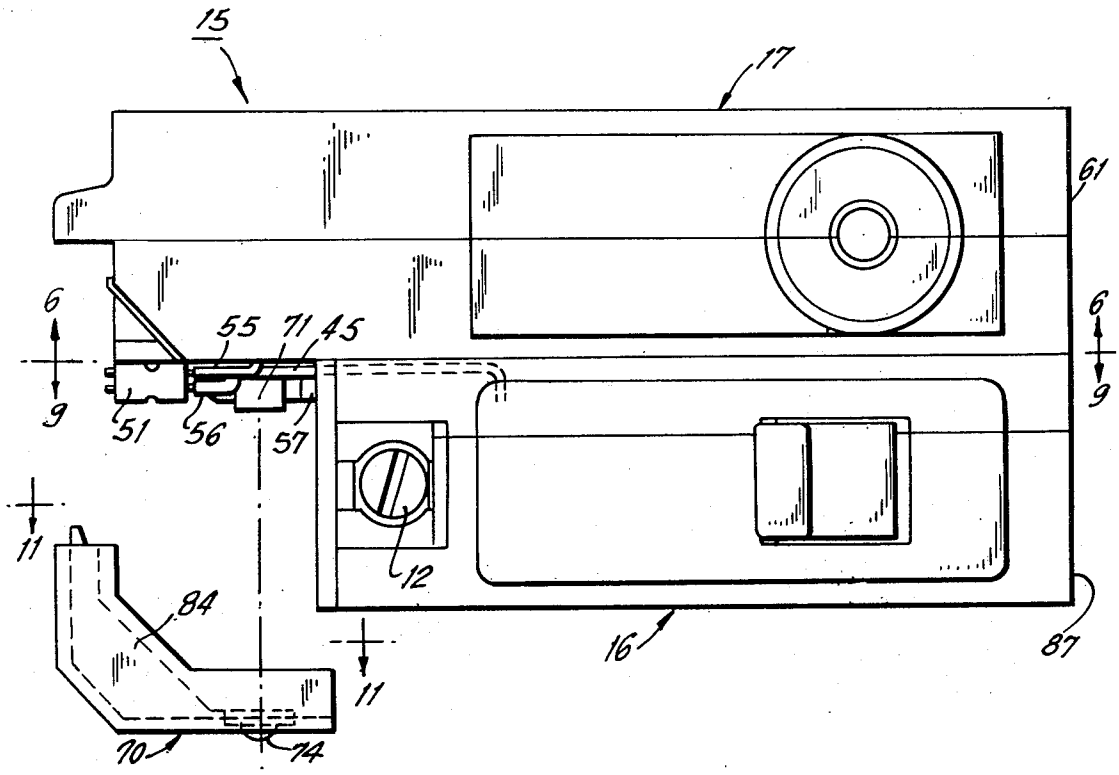


FIG. 1.

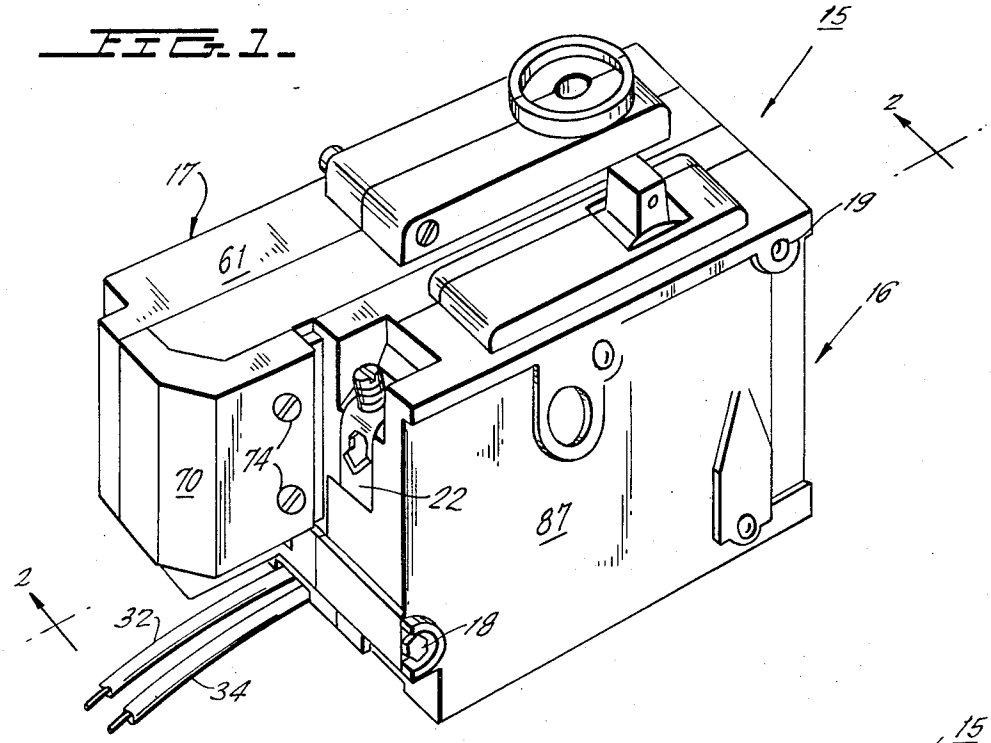


FIG. 4.

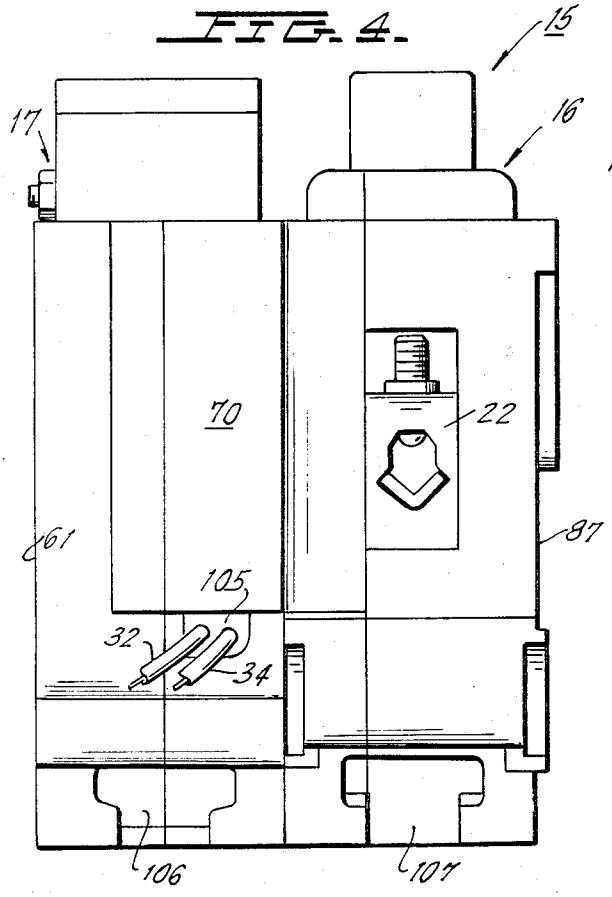


FIG. 5.

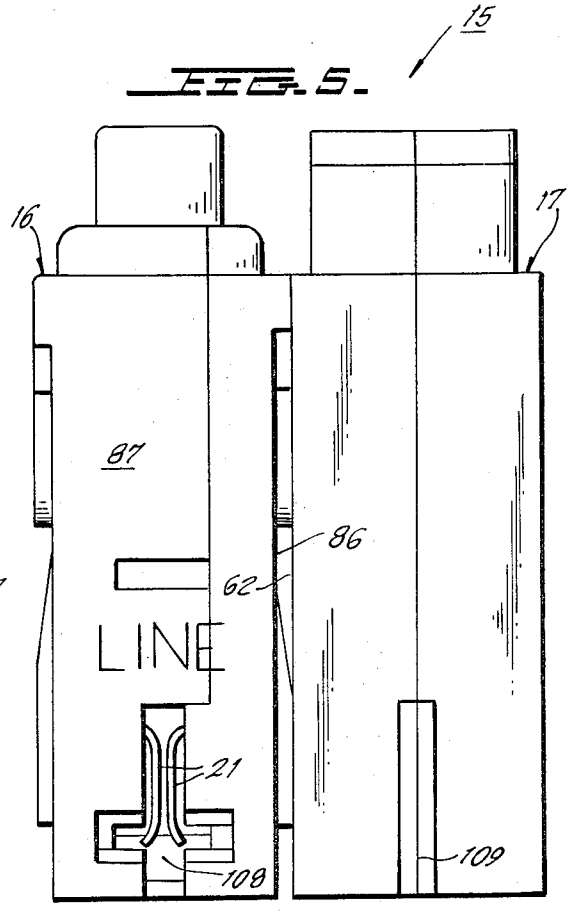


FIG. 2.

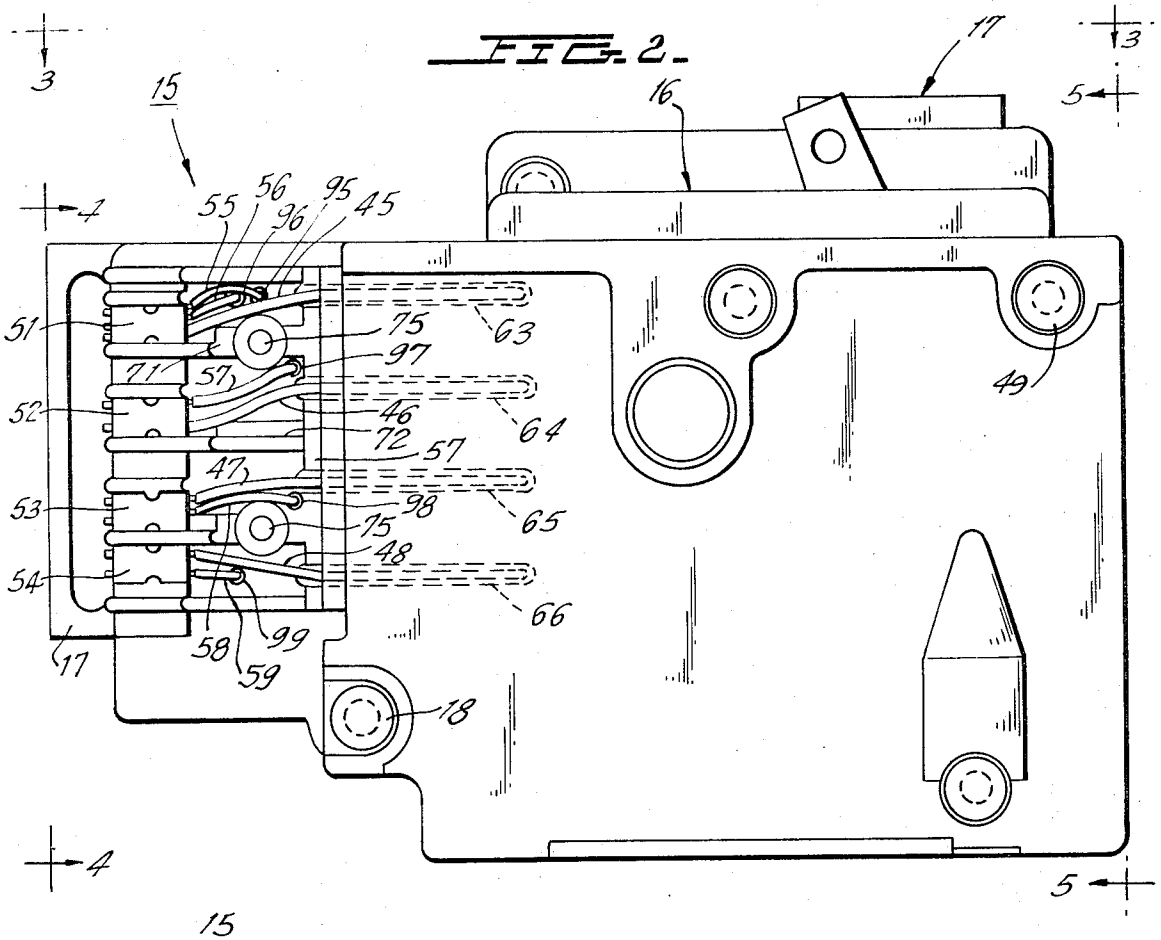

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FIG. 3.

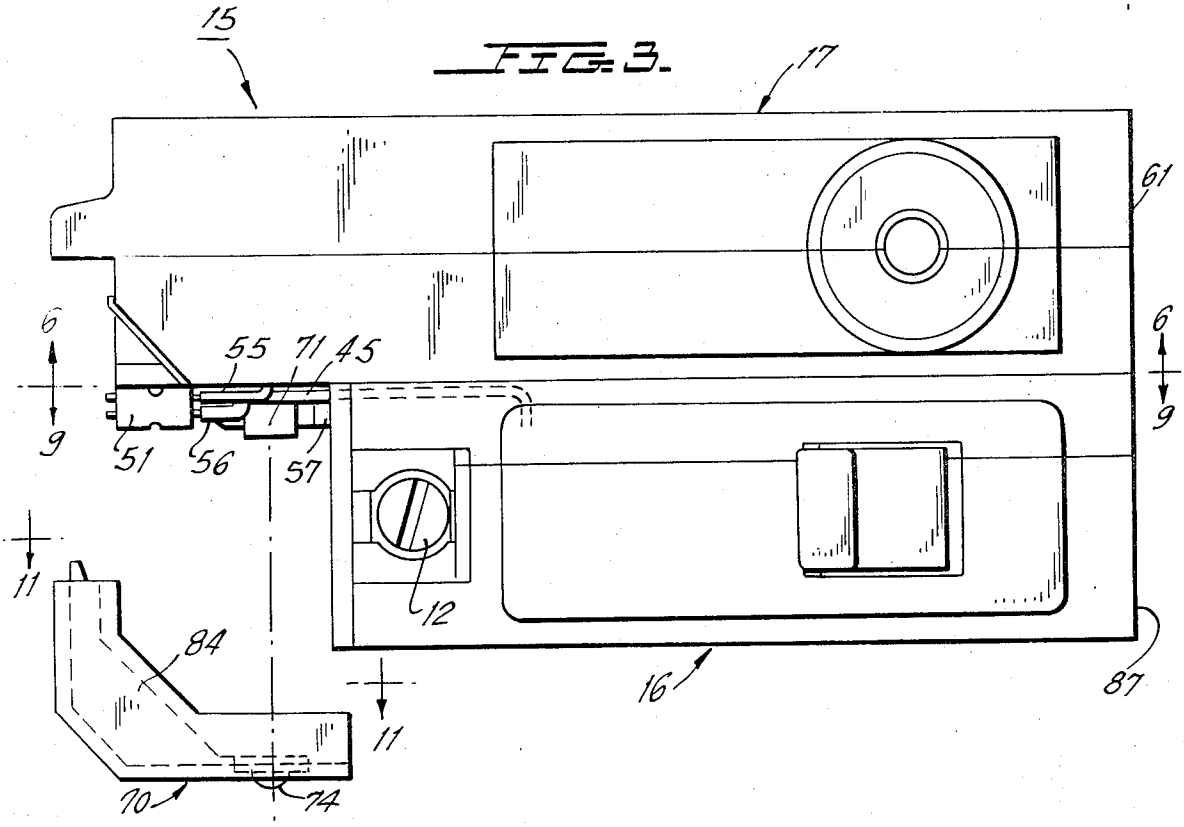

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FIG. 6

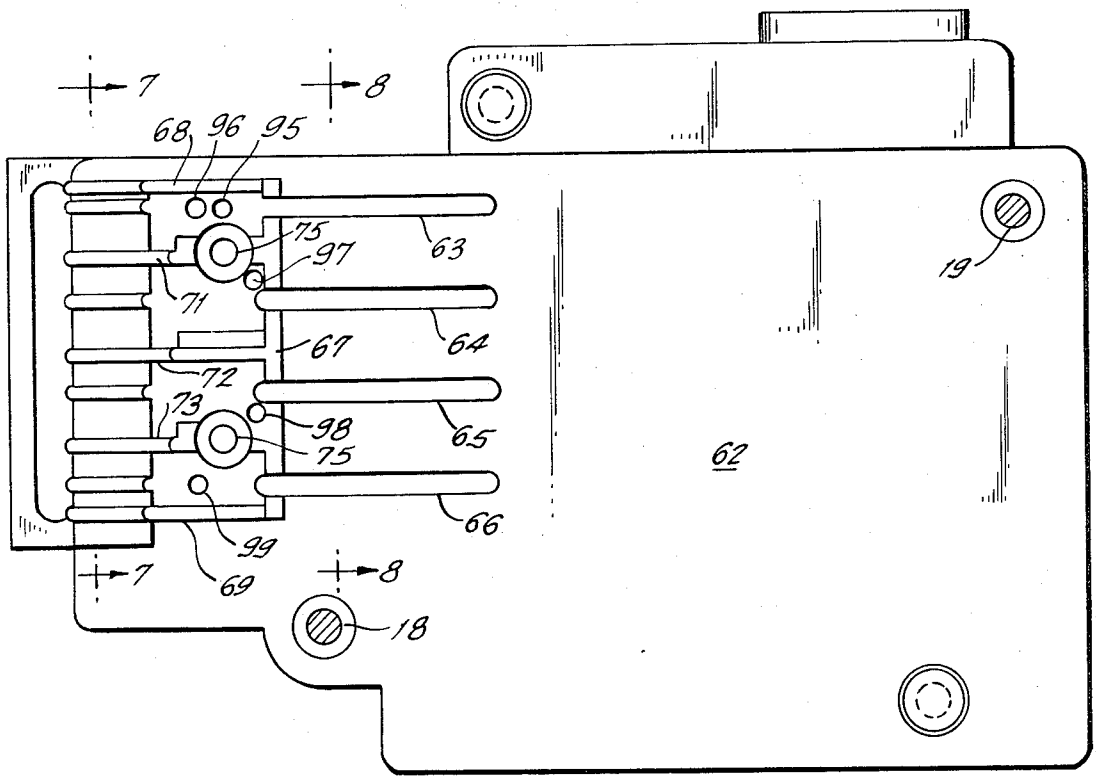


FIG. 11

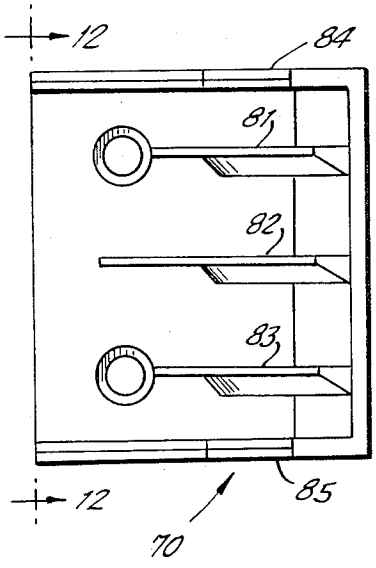


FIG. 12

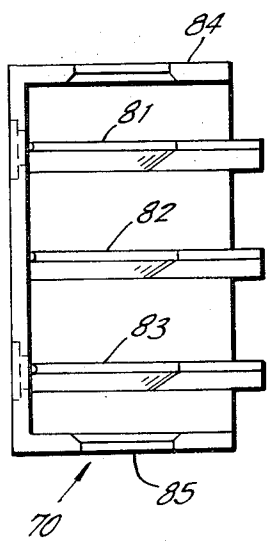


FIG. 7

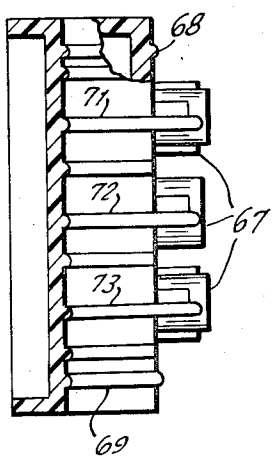


FIG. 8

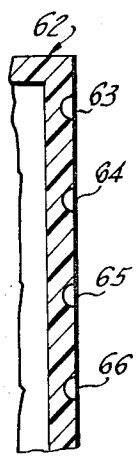


FIG. 9.

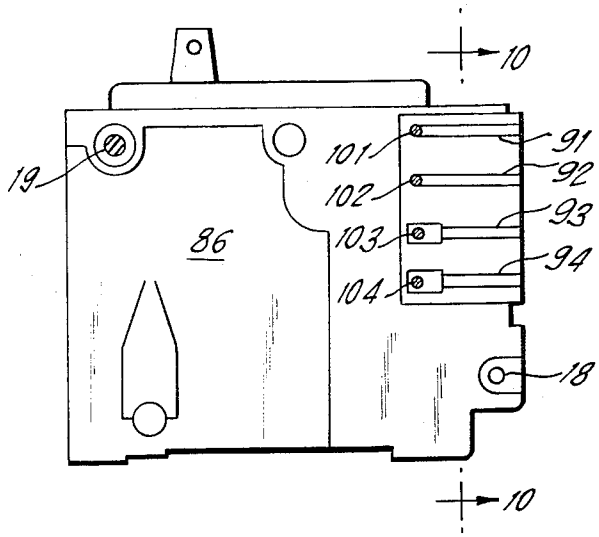


FIG. 10.

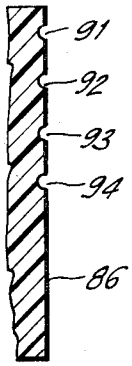
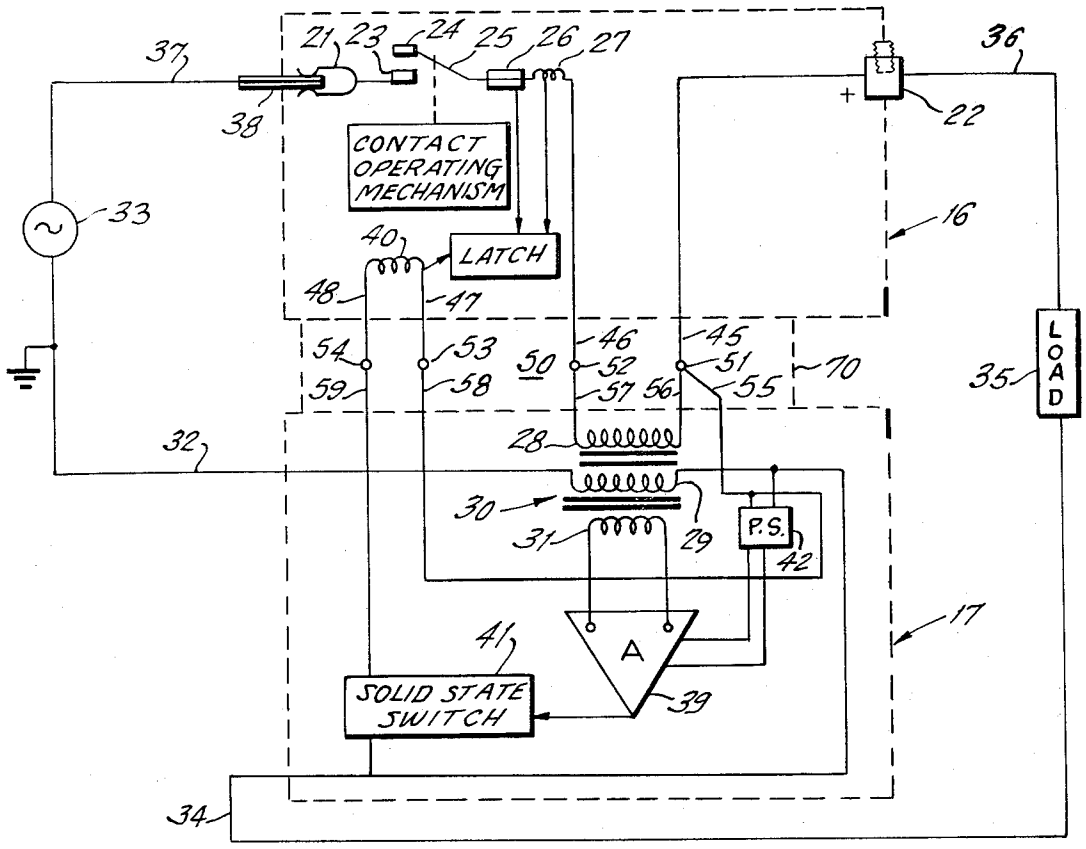


FIG. 13.



MODULAR GROUND FAULT INTERRUPTER

Conventional circuit breakers for home and light industrial applications usually have thermal and magnetic fault responsive trip means to automatically open the main contacts of the circuit breaker when excessively high current flows through the main contacts. The protection afforded prevents damage to load wiring and to the load. However, this does not insure that low magnitude fault currents caused by high resistance faults to ground will not start fires or result in injury to personnel.

In order to obtain protection against the aforesaid low magnitude faults, so-called ground fault interrupters have been provided to extend the protection afforded by conventional circuit breakers. Typical circuitry for a ground fault interrupter is described in U.S. Pat. No. 3,555,359, issued Jan. 12, 1971, to A. R. Morris for a "Circuit Protective Device."

In accordance with the instant invention, circuit breaker and ground fault sensor modules of substantially the same relatively narrow width, say one inch, are secured together in side-by-side relationship to form a ground fault interrupter that is mountable in many existing panelboards. The circuit breaker module housing contains all of the mechanical moving elements of the interrupter including a shunt trip device that is actuated in accordance with signals generated by these sensor unit responsive to the sensing of predetermined ground fault currents. The sensor module includes a differential transformer having a primary winding electrically connected to the main contacts of the circuit breaker module in a series circuit extending between the line and load terminals of the circuit breaker module. A solid-state switch of the sensor module is electrically connected to the shunt trip device to control energization thereof. Electrical connections between the modules are made at an inter-face region at the load end of the circuit breaker module. This interface region is enclosed by a cover and is divided into compartments whereby the individual electrical splicers are isolated from each other.

As will hereinafter be seen, the construction in accordance with the instant invention is such that the modules may be manufactured and stored at different locations, and assembly of a circuit breaker module with a sensor module is readily accomplished, even at another location. Assembly is facilitated by providing channels and notches to position the electrical leads extending from the circuit breaker module and to direct these leads into predetermined compartments of the interface region.

Accordingly, a primary object of the instant invention is to provide a novel construction for a ground fault interrupter constructed of a circuit breaker module and a sensor module.

Another object is to provide an interrupter of this type in which all of the mechanical moving parts are contained within the housing of the circuit breaker module.

Still another object is to provide an interrupter of this type having a novel interface region where the electrical connections between the modules are made.

These objects as well as other objects of this invention will become readily apparent after reading the following description of the accompanying drawings in which:

FIG. 1 is a perspective looking toward the load end of a ground fault interrupter constructed in accordance with teachings of the instant invention.

FIG. 2 is a side elevation of the interrupter looking in the direction of arrows 2—2 of FIG. 1, with the cover of the interface region removed.

FIG. 3 is a plan view looking in the direction of arrows 3—3 of FIG. 2 with the cover of the interface region exploded from the remainder of the interrupter.

FIGS. 4 and 5 are respective load and line end views of the interrupter, looking in the direction of the respective arrows 4—4 and 5—5 of FIG. 2.

FIG. 6 is a side elevation of the sensor module housing looking in the direction of arrows 6-6 of FIG. 3.

FIGS. 7 and 8 are fragmentary cross-sections taken through the respective lines 7—7 and 8—8 of FIG. 6, looking in the direction of the respective arrows 7—7 and 8—8.

FIG. 9 is a side elevation of the circuit breaker module housing looking in the direction of arrows 9—9 of FIG. 3.

FIG. 10 is a cross-section taken through line 10—10 of FIG. 9, looking in the direction of arrows 10—10.

FIG. 11 is an elevation looking in the direction of arrows 11—11 of FIG. 3, showing the inside of the interface region cover.

FIG. 12 is an end view of the cover looking in the direction of arrows 12—12 of FIG. 11.

FIG. 13 is primarily an electrical schematic showing the ground fault interrupter of FIG. 1 connecting an electrical load to an A.C. power source.

Now referring to the figures. Ground fault interrupter 15 is constructed of circuit breaker module 16 and ground fault sensor module 17 secured together in abutting side-by-side relationship by rivets 18, 19. Circuit breaker module 16 is a one-inch wide molded-case circuit breaker of the type described in U.S. Pat. No. 3,703,691 issued November 21, 1972, to C. E. Gryctko et al. for a SHUNT TRIP WITH LOAD TERMINAL, modified to conform with the electrical arrangement illustrated in the schematic of FIG. 13 hereof.

As seen in FIG. 13, the current path through circuit breaker module 16, between line 21 and load 22 terminals thereof, consists of female-type plug-in terminal 21 to stationary contact 23 engaged by movable contact 24 on contact arm 25, through contact arm 25, to and through thermal trip bimetal 26 and magnetic trip coil 27 to a gap between coil 27 and load terminal 22, which gap is bridged by primary winding 28 of balanced transformer 30 that is part of sensor module 17.

The other primary winding 29 of transformer 30 is connected by lead 32 to the grounded terminal of a.c. power source 33 and is connected by lead 34 to one terminal of electrical load 35. The other terminal of load 35 is connected by line 36 to load terminal 22 of circuit breaker module 16. The ungrounded or energized terminal of source 33 is connected by lead 37 to male stab 38 of a panelboard (not shown), with stab 38 being removably engaged by line terminal 21 of circuit breaker module 16.

As is well known in the art and as explained in the aforesaid U.S. Pat. No. 3,555,359 when unequal currents flow in primary windings 28, 29 a ground fault signal is generated in secondary winding 31 of transformer 30. This signal is fed through amplifier 39 to the control electrode of solid-state switch 41. The power circuit for

switch 41 is connected in series between one end of shunt trip coil 40 of circuit breaker module 16 and the load side of primary winding 28. The other side of shunt trip winding 40 is connected to the load side of primary winding 29. Amplifier 39 is energized by power supply 42, whose input is connected to the load sides of primary windings 28 and 29.

Crimped connector 51 (FIG. 2), at interface region 50 partially bounded by cover 70, splices lead 45 from load terminal 22 together with leads 55, 56 from power supply 42 and primary winding 28 respectively. Similarly, other crimped connectors 52–54 at interface regions 50, provide the other electrical connections between modules 16 and 17. Thus, connector 52 splices lead 46 from coil 27 to lead 57 from primary winding 28, connector 52 splices lead 47 from shunt trip coil 40 to lead 58 from the common terminal of power supply 42, and connector 54 splices lead 48 from the other terminal of shunt trip coil 40 to lead 59 from solid-state switch 41.

Housing 61 of sensor module 17 is provided with wall 62 (FIGS. 6–8) which, in the surface thereof confronting circuit breaker module 16, is provided with parallel channels 63–66 of semi-circular cross-section extending from barrier 67 toward the line end of module 17. Barrier 67 is formed integrally with wall 62 and notches in barrier 67, aligned with the respective grooves 63–66, are provided as will hereinafter be seen to guide leads 45–48 to the compartments on the line side of barrier 67. Parallel barriers 71–73 formed integrally with wall 62 are perpendicular to barrier 67 and extend therefrom toward the load end of module 61. Sensor module leads 55–59 extend externally of housing 61 through the respective apertures 95–99 in wall 62 disposed on the load side of barrier 67.

Outboard ribs 68, 69 (FIG. 7), formed integrally with wall 62 and extending parallel to barriers 71–73, serve to position cover 70 before securement thereof to wall 62 by one way self-tapping screws 74 received by recesses 75 in barriers 71 and 73. The interior of modified L-shaped cover 70 is provided with parallel ribs 81–83 that cooperate with the respective barriers 71–73 to form compartments for splicing connectors 52, 53. Compartments for splicing connectors 51, 54 are bounded by the lip portions 84, 85 of cover 70 and the respective ribs 81, 83; splicing connectors 52, 53 are in compartments bounded by the respective pairs of cover ribs 81, 82 and 82, 83.

As best seen in FIGS. 9 and 10, wall 86 of circuit breaker module housing 87 is adjacent to sensor module wall 62. Wall 86 is provided with parallel grooves 91–94 of semi-circular cross-section extending from the load end of wall 86 partway toward the line end thereof. Apertures 101–104 at the line ends of the respective grooves 91–94 are provided for the passage of the respective leads 45–48 from the inside to the outside of circuit breaker module housing 87. Grooves 91–94 confront the respective grooves 63–66 and cooperate therewith to form channels of circular cross-sections through which leads 45–48 extend and are guided to the load side of barrier 67 through notches therein.

As best seen in FIGS. 3–5, the two piece housings 87, 61 for modules 16, 17 are identical in width, with this width preferably being one inch. Both housings 61 and 87 are provided with similar mounting recesses 106, 107 respectively (FIG. 4) at the load ends thereof to receive adjacent mounting hooks (not shown) spaced on one inch centers in a common type of commerical panelboard. Leads 32, 34 for primary winding 29 extend through load end aperture 105 of sensor housing 61. The line ends of housing 61, 87 are provided with similarly shaped slots 108, 109, respectively, which receive adjacent male-type line stabs, such as line stabs 38 (FIG. 13) that are disposed in a row and spaced on one inch centers in a typical type of commercial panelboard. Line terminal 21 of circuit breaker module 16 is aligned with slot 108 to engage the panelboard line stab received by slots 108, and the panelboard line stab received by slot 109 is not electrically engaged with any of the operating elements of ground fault interrupter 15.

Thus, it is seen that the instant invention provides a novel construction for a ground fault interrupter including a sensor module 17 and a circuit breaker module 16, with the latter having all of the movable mechanical elements of interrupter 15. The making of electrical connections between modules 16 and 17 is facilitated by providing an interface region having individual compartments for each of the splicing elements 51–54 as well as guide channels formed by the cooperation of grooves 63–66 with grooves 101–104. Interrupter 15 is assembled by mechanically securing modules 16 and 17 together, with circuit breaker module leads 45–48 extending past the load end of module 16 and through the notches in barrier 67. Splicing devices 51–54 are then applied to make all electrical interconnections between modules 16 and 17. Finally interface cover 70 is secured to sensor housing 61 to close off interface region 50.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now become apparent to those skilled in the art. Therefore, this invention is to be limited not by the specific disclosure herein but only by the appending claims.

The embodiments of the invention in which an exclusive priviledge or property is claimed are defined as follows:

1. An interrupter assembly including a switch module and a sensor module secured together side by side; said switch module including a relatively narrow first housing having a first side adjacent said sensor module, line and load terminals at the front and rear, respectively, of said first housing, cooperating contacts, a contact operating means for opening said contacts, and a shunt trip device which upon actuation thereof operates said mechanism to open said contacts; said sensor module including a fault detector, first means for generating a shunt grip actuating signal when a fault of predetermined magnitude is sensed by said detector, and a relatively narrow second housing wherein said fault detector and first means are disposed, said second housing having a second side adjacent said first side; a first plurality of electrical leads extending external of said first housing from at least said shunt trip device through first aperture means in said first side; a second plurality of electrical leads extending external of said second housing from at least said first means and said detector through second aperture means in said second side; a plurality of splice means electrically connecting said first plurality of leads to said second plurality of leads to electrically connect said first means to said shunt trip and electrically connect a portion of said detector in a

series circuit extending between said terminals and including said contacts; said splice means being disposed at a region to the rear of said first housing; and cover means at said region cooperating with portions of said second housing to form an enclosure wherein said plurality of splice means are disposed.

2. An interrupter assembly as set forth in claim 1 in which the second aperture means is positioned to the rear of said first housing and is covered by said cover.

3. An interrupter assembly as set forth in claim 2 in which the plurality of splice means is positioned to the rear of said second aperture means.

4. An interrupter assembly as set forth in claim 2 in which there is a plurality of channels formed through the cooperation of said first and second sides; the leads of said first plurality of leads being disposed within said channels; said channels extending from said first aperture means toward said second aperture means.

5. An interrupter assembly as set forth in claim 4 in which there is a barrer on said channel wall having guide notches aligned with said channels for positioning said first plurality of leads as they enter said region.

6. An interrupter assembly as set forth in claim 4 in which there are a plurality of generally parallel barriers within said cover positioned between adjacent apertures of said second aperture means.

7. An interrupter assembly as set forth in claim 6 in which said barriers are disposed between adjacent ones of said splice means.

8. An interrupter assembly as set forth in claim 7 in which there is another barrier transverse to said parallel barriers; said another barrier having guide notches aligned with said channels for positioning said first plurality of leads as they extend into said region in the spaces between the barriers of said parallel barriers.

9. An interrupter assembly as set forth in claim 8 in which each of the channels is formed by aligned cooperating grooves in said first and second sides.

10. An interrupter assembly as set forth in claim 1 in which the housings are substantially of equal width and the forward surfaces thereof are generally aligned; similarly positioned slot in each of said housings at the front ends thereof; said slots being spaced apart by the width of one of said housings and each being constructed to receive a plug-in connector of a panelboard; said line terminal being aligned with the slot of said first housing to engage a panelboard plug-in connector inserted into the slot of said first housing; first and second flexible leads, extending from a portion of said detector through aperture means at the rear end of said second housing, for connection to a neutral terminal of a panelboard and an electrical load respectively.

* * * * *