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Acampora et al.

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[54] **ACCESSORY APPARATUS FOR TRIPPING AN ELECTRIC CIRCUIT BREAKER**

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[52] **U.S. Cl.** **335/20;** 335/169; 335/171

[51] **Int. Cl.²** **H01H 83/00**

[58] **Field of Search** 335/169, 20, 170, 171, 335/174

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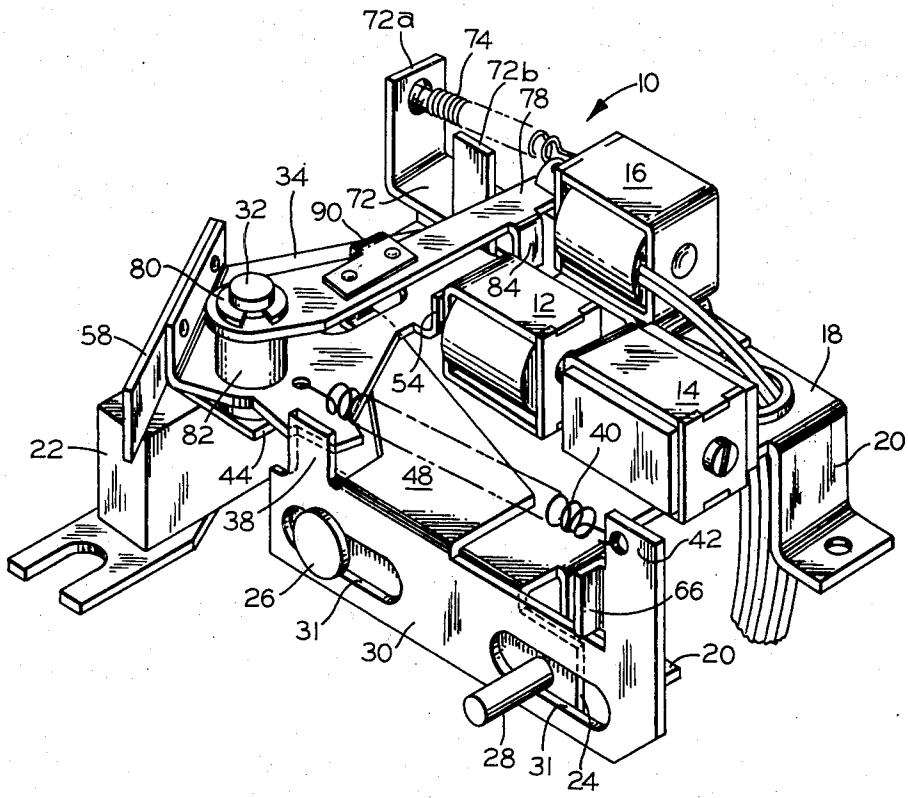
Primary Examiner—Harold Broome

Attorney, Agent, or Firm—R. A. Cahill; W. C. Bernkopf; F. L. Neuhauser

[57] **ABSTRACT**

An accessory apparatus package for electric circuit breakers includes a first pivotal lever latching a slide in a reset position. Either one of two trip solenoids acts on this lever to unlatch the slide. A single tension spring is connected between the slide and the lever. The unlatched slide is propelled to an actuated position by the spring, and, in the process, pivots the lever into tripping impact with the circuit breaker latch. An optional second pivotal lever and trip solenoid act through the first lever to also unlatch the slide. All parts are operatively mounted by a common support.

20 Claims, 6 Drawing Figures



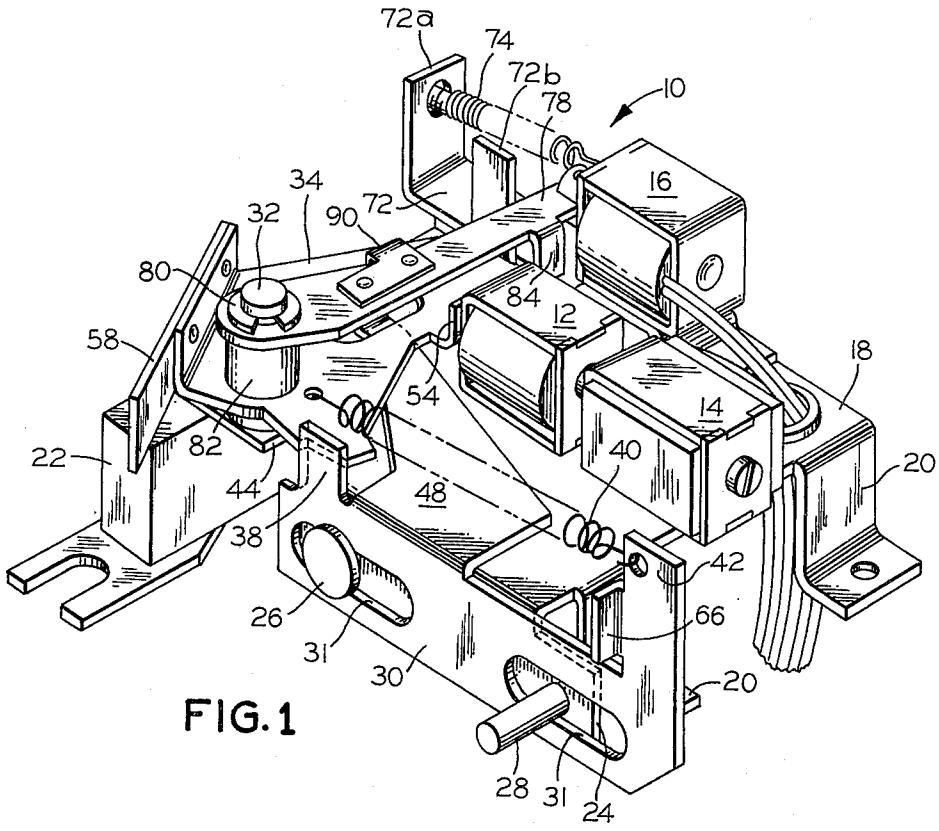

72a
74
72b
78
10
34
32
90
72
16
80
84
12
58
18
54
14
22
82
40
20
44
48
38
42
26
66
31
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31
24

FIG. 1

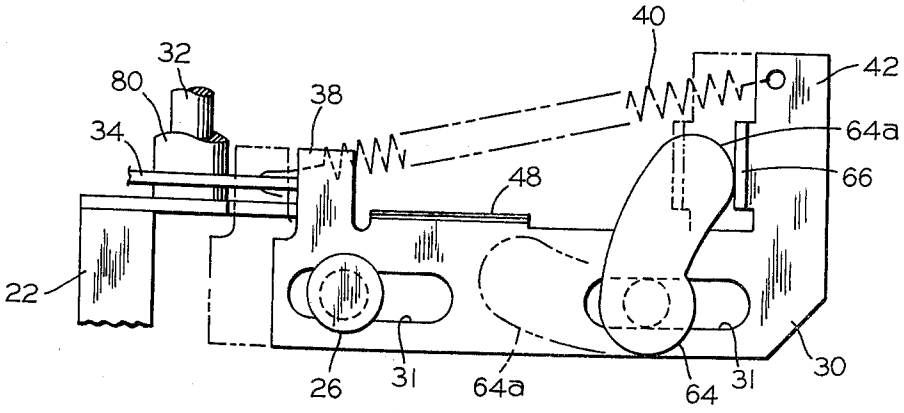

40
32
42
80
38
34
64a
66
48
22
26
31
64a
64
31
30

FIG. 2

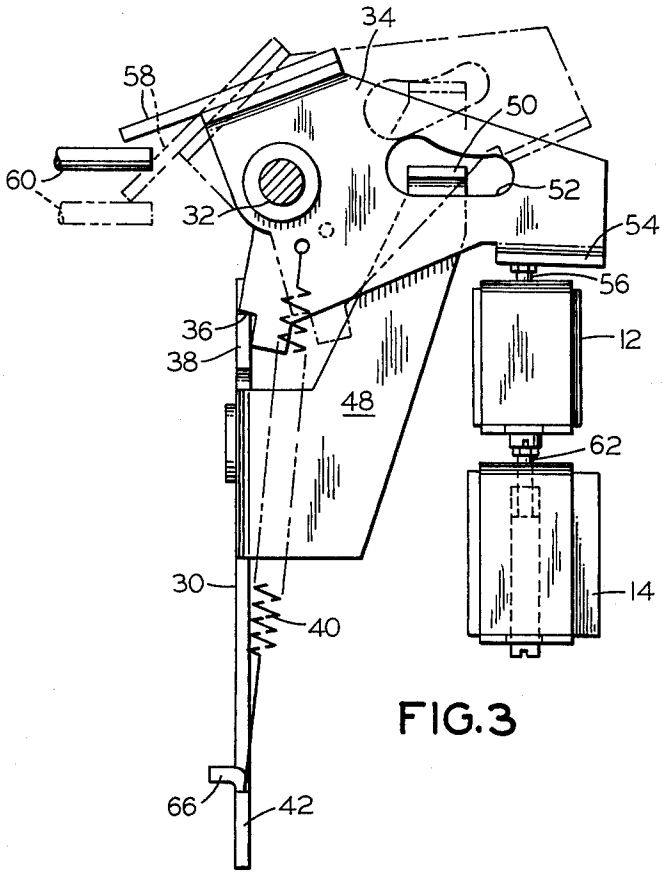


FIG.3

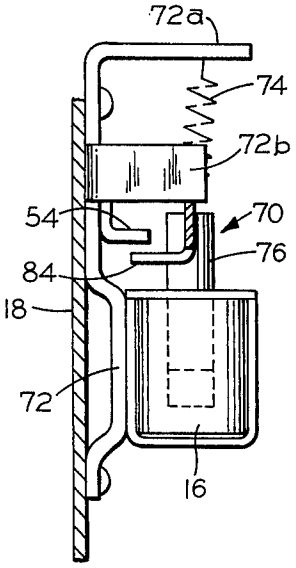


FIG.6

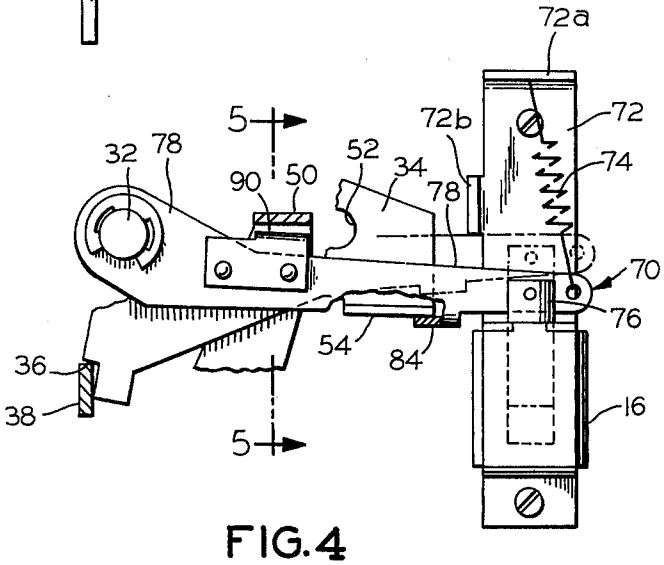


FIG.4

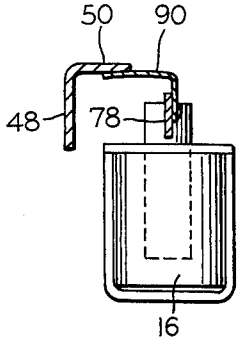


FIG.5

ACCESSORY APPARATUS FOR TRIPPING AN ELECTRIC CIRCUIT BREAKER

BACKGROUND OF THE INVENTION

Users of automatic electric circuit breakers, particularly in industrial applications, often require additional capabilities, over and above conventional overload and short circuit protection. For example, the user often desires the capability of interrupting a circuit from a location, such as a central control panel, which is remote from the circuit breaker. To serve this function, a so-called "shunt trip" is incorporated in the circuit breaker. A shunt trip typically takes the form of a solenoid whose plunger is mechanically linked to a latch engaging the circuit breaker operating mechanism to sustain a closed circuit condition. The shunt trip solenoid energization circuit is wired to a remote location where a switch is closed to produce solenoid actuation, thereby effecting release of the operating mechanism and circuit interruption in the same manner as though an overload or short circuit condition was sensed by the internal circuit breaker trip mechanism.

Another capability often required is automatic circuit interruption in the event the line voltage falls significantly below its nominal level for a sustained, as contrasted to a momentary, period. To serve this function, a so-called "undervoltage release" (UVR) is incorporated in the circuit breaker. A UVR is typically embodied in a solenoid which is energized by line voltage to magnetically hold its plunger in against the force of a return spring as long as the line voltage remains within a predetermined range below the nominal level. When the line voltage drops below the level necessary to enable the UVR solenoid to overcome the return spring force, the plunger is retracted by the spring. This retracting movement is communicated to the circuit breaker latch, thereby releasing the operating mechanism to effect circuit interruption.

Yet another capability, though rather infrequently specified, is coordination of the operations of a fused circuit breaker. For some applications, the customer may desire a circuit breaker-fuse combination, wherein fuses are connected in series with the circuit breaker to increase the effective current interrupting capacity. In a three phase circuit, a fuse is connected in series with each of the three circuit breaker poles. In the event one fuse blows to interrupt one phase of the circuit, it is important that the other two phases also be interrupted forthwith in order to prevent the damaging consequences of so-called "single phasing." To insure against single phasing, a three coil shunt trip solenoid can be incorporated in the circuit breaker. Each coil is connected across a different fuse, such that, when one blows, current is diverted through the coil connected thereacross. The solenoid is thus actuated to trip the circuit breaker, interrupting the other two phases.

Heretofore, any one of these functions could readily be incorporated in a circuit breaker. However, it became extremely difficult, if not impossible, in existing circuit breaker designs, to accommodate a customer specifying any two or possibly all three of these functions.

It is accordingly an object of the present invention to provide circuit breaker accessory apparatus universally adaptable to accommodating any one or all of a plurality of trip functions.

An additional object of the invention is to provide accessory apparatus of the above character wherein plural trip functions are accommodated through a common assembly of cooperative parts.

A further object is to provide accessory apparatus of the above character, wherein plural trip functions are independently resolved into the movement of a single component into tripping impact with a circuit breaker latch.

Another object is to provide accessory apparatus of the above character which, having precipitated a trip function, is automatically reset preparatory to subsequent reclosure of the circuit breaker contacts.

Still another object is to provide accessory apparatus of the above character wherein trip function capabilities may be readily added or subtracted without modifying the basic operative components of the assembly.

Yet another object of the invention is to provide accessory apparatus of the above character, which is compact in size, efficient in design, reliable in operation, and inexpensive to manufacture.

Other objects of the invention will become apparent from the detailed description to follow.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided accessory apparatus capable of being readily incorporated in an electric circuit breaker for accommodating any one, several or all of a plurality of diverse trip functions. The accessory apparatus utilizes a single support for mounting the operative components in compact assembly, thus facilitating physical incorporation within the molded case of the circuit breaker. More specifically, the support mounts a post which, in turn, pivotally mounts a lever adapted, while in its reset position, to latch a slide in its reset position. A tension spring is connected between the lever and the slide. A first trip solenoid, mounted by the support, acts via its plunger lever to unlatch the slide, which is then propelled by the spring toward an actuated position. In the process, the slide picks up the lever, pivoting it into tripping impact with the circuit breaker latch to trip the circuit breaker. An optional second trip solenoid may be mounted on the support with its plunger in end-to-end alignment with the first trip solenoid plunger which acts directly on the lever. The second trip solenoid plunger then acts on the lever via the first solenoid plunger to unlatch the slide.

An optional sub-assembly may be added to the support to serve still another trip function in conjunction with or to the exclusion of one or both of the trip functions served by the first and second trip solenoid. This sub-assembly includes a second lever pivotally mounted on the post. A third trip solenoid acts on this second lever, which, in turn, acts on the first lever to unlatch the slide.

The accessory apparatus, having executed a trip function, is reset by a reset element which may be manually operated, but preferably is driven by the circuit breaker operating mechanism to automatically return the slide to its reset position.

Resetting movement of the slide is communicated to the first lever by the spring and to the second lever (if present) by an arm attached to and moveable with the slide to reset both levers.

The invention accordingly comprises the features of construction, combinations of elements, and arrange-

ments of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a better understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a circuit breaker accessory apparatus package constructed according to an embodiment of the present invention;

FIG. 2 is a partial side elevational view of the accessory apparatus of FIG. 1;

FIG. 3 is a partial plan view of the accessory apparatus of FIG. 1;

FIG. 4 is a partial plan view of the accessory apparatus of FIG. 1;

FIG. 5 is a fragmentary sectional view taken along line 5—5 of FIG. 4; and

FIG. 6 is a side elevational view of the portion of the accessory apparatus depicted in FIG. 4.

Like reference numerals refer to corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

The circuit breaker accessory apparatus package of the present invention, generally indicated at **10** in FIG. **1**, is illustrated in the embodiment accommodating three diverse trip functions, namely, shunt trip, three coil shunt trip, and under voltage release (UVR). As will become apparent from the description to follow, the accessory package of the present invention may be readily embodied to accommodate any one, two or all three of these trip functions. In the illustrated embodiment of FIG. **1**, three trip solenoids, namely, a shunt trip solenoid **12**, a three coil shunt trip solenoid **14**, and a UVR trip solenoid **16**, are mounted on a common platform **18** having turned down feet **20** at one end and a mounting block **22** at the other end facilitating mounting of the package within a circuit breaker case (not shown). A turned down side **24** of platform **18** carries a headed pin **26** and a stub shaft **28**, which, in turn, slidingly mount a slide **30**. Pin **26** and shaft **28** are received in elongated slots **31** in slide **30** to mount and guide the slide for movement between a reset position and an actuated position.

Still referring to FIG. **1**, platform **18** mounts an upright post **32** which, in turn, pivotally mounts a lever **34**. This lever is notched, as best seen in FIG. **3** at **36**, to provide a latch edge which engages an upright tab **38** carried by slide **30** to maintain the slide in its reset position. A tension spring **40** has hooked ends engaged in apertures punched in lever **34** and an upright extension **42** of slide **30**, such that the slide is biased toward an actuated position where the leading edge of slide tab **38** abuts an edge surface **44** formed in platform **18**. Spring **40** also serves to bias lever **34** to a reset position. The point of connection of the spring to lever **34** is located near pivot post **32** so that minimal force is required to unlatch slide **30**. Slide **30** also carries an arm **48** which extends across the upper surface of platform **18** and under lever **34** which it terminates in an upright tab **50** protruding upwardly through an oblong opening **52** formed in lever **34**. This lever is also provided with an upturned tab **54** which is positioned in confronting relation with a plunger **56** of shunt trip solenoid **12**, while the lever is in its reset position latching the slide in its reset position. Lever **34** additionally carries a paddle **58** which is poised to impact against a circuit breaker latch element **60** pursuant to tripping the circuit breaker.

From the description thus far, it is seen that when a shunt trip function is initiated, shunt trip solenoid **12** is energized and its plunger **56** impacts against tab **54**, causing lever **34** to rotate about pivot post **32** in the counterclockwise direction, as seen in FIG. **3**. This movement of the lever disengages latch **36** from tab **38**, and the slide is propelled toward its actuated position by spring **40**. In the course of the slide's movement, tab **50** at the end of slide arm **48** engages the back edge of opening **52** in lever **34**. Thus, continued counterclockwise pivotal movement of lever **34** is propelled by spring **40**, via slide **30** and arm **48**, and paddle **58** is swung into trip precipitating impact with latch **60**. The back edge of opening **52** in lever **34** is bowed so as to provide an arcuate edge surface against which the flat back surface of tab **50** operates, thus to insure smooth non-binding co-action therebetween.

As an important feature of the present invention, a second shunt trip solenoid, such as three coil shunt trip solenoid **14**, is mounted by platform **18** with their plungers in axial alignment. Thus, if a three coil shunt trip function is signaled, solenoid **14** is energized, and its plunger **62** impacts against the end of shunt trip solenoid plunger **56** which, in turn, impacts against tab **54** of lever **34** to unlatch the slide **30**. It will be appreciated that the positions of trip solenoids **12** and **14** may just as well be reversed. Also to be appreciated is the fact that if only one shunt trip function is specified, only one of the solenoids **12** and **14** is provided with the accessory package **10**, and this one solenoid would occupy the position of trip solenoid **12** in the drawings.

To return the operating elements of the accessory package from their respective actuated positions to their respective reset positions following a trip function, a reset cam **64**, seen in FIG. **2**, is mounted on stub shaft **28** and operated off the circuit breaker operating mechanism (not shown). When the circuit breaker is in its closed circuit condition, and slide **30** is latched in its reset position by the latch **36** of lever **34**, the cam is in orientation indicated in phantom with its lob **64*a*** ducked down out of the way. After the slide has been unlatched and has moved to its actuated position with the consequent tripping of the circuit breaker, cam **64** is rotated in the clockwise direction, as seen in FIG. **2**, and its lobe **64*a*** engages a tab **66** extending laterally from upright slide extension **42** to drive the slide back to its reset position. As the slide is being returned, spring **40** draws lever **34** around in the clockwise direction to its reset position to relatch slide **30** in its reset position. Incident to assuming its reset position, tab **54** of lever **34** retracts solenoid plunger **56**, as well as solenoid plunger **62** if solenoid **14** is present and was energized to initiate the trip function. The use of spring **40** to draw lever **34** back to its reset position has the advantage of relaxing manufacturing tolerances. That is, spring **40** provides a yieldable linkage between the slide **30** and lever **34** which will accommodate some degree of overtravel of the slide in the resetting direction calculated to insure that the trip solenoid plunger(s) is completely retracted. Thus, continued movement of the slide in the resetting direction after the solenoid plunger(s) is retracted merely stretches spring **40** without damaging any parts. In this connection, it is important to note that tab **50** of slide arm **48** does not engage the edge of opening in lever **34** during resetting of the

accessory package **10**. To conclude the resetting of accessory package **10**, cam **64** is rotated back in counterclockwise direction by the circuit breaker operating mechanism, either incident to resetting or reclosure of the circuit breaker, to duck lobe **64***a* down below the level of slide reset tab **66**. As slide **30** is released by cam **64**, spring **40** takes up the overtravel to bring its latch tab **38** into engagement with latch edge **36** of lever **34**.

When accessory package **10** is equipped exclusively with an undervoltage release or an undervoltage release in conjunction with one or both of the shunt trip solenoids **12** and **14**, a UVR sub-assembly is mounted to platform **18**. This sub-assembly, generally indicated at **70** in FIG. **6**, includes a mounting bracket **72** which is secured to platform **18** and to which is mounted the UVR trip solenoid **16**. A spring **74** connected at one end to an upright extension **72***a* of bracket **72** urges the plunger **76** of the UVR trip solenoid to a retracted or actuated position. The exposed end of UVR trip solenoid plunger **76** is pinned to one end of an elongated lever **78** which is pivotally mounted at its other end to pivot post **32**. As best seen in FIG. **1**, a snap ring **80** retains lever **78** on post **32**, and a sleeve **82** encompassing the post maintains vertical separation between levers **78** and **34**. Lever **78** is provided with a depending tab **84** which, as best seen in FIG. **4**, is positioned to encounter tab **54** of lever **34** when the lever is swung counterclockwise by spring **74** from its reset position to its actuated position determined by a stop **72***b* bent up from bracket **72**.

As long as the line voltage is above a predetermined minimum level, the energization of UVR trip solenoid **16** develops sufficient magnetic force to overpower spring **74** and maintain its plunger **76** seated and lever **78** in its reset position. Should the line voltage drop below this predetermined minimum level, spring **74** becomes effective to overpower the magnetic force developed by the UVR trip solenoid **16**, and plunger **76** is retracted. Lever **78** is thus pivoted about post **32** in the counterclockwise direction from its reset position to its actuated position against stop **72***b*. During the course of this movement of lever **78**, depending tab **84** engages tab **54** of lever **34**, causing the latter to also pivot counterclockwise about post **32**. Slide **30** is unlatched, and spring **40** takes over to power the impacting engagement of paddle **58** with circuit breaker latch **60** in the manner previously described. To reset the UVR trip solenoid **16** together with the other parts of the accessory package **10**, a resilient, depending tab **90** of metal spring stock is attached to lever **78** in position to be encountered by tab **50** at the end of slide arm **48** as the slide **30** is reset by cam **64**. Thus, lever **78** is rotated back in the clockwise direction to its reset position, reseating the UVR trip solenoid plunger **76** against the urgency of spring **74**. The resiliency of tab **90** accommodates a degree of overtravel of the slide **30** in the reset direction to insure that the plunger **76** is firmly reseated, thus enabling the attractive magnetic force of the trip solenoid **16** developed by line voltages above the predetermined minimum level to overpower spring **74**. It is seen that if a low voltage condition persists during resetting of the accessory apparatus, the plunger **76** cannot be held in by the UVR solenoid **16** and spring **74** will operate to prevent slide **30** from being latched. Thus, when the slide is released by reset cam **64**, paddle **58** is swung around to engage the circuit breaker latch, thereby aborting attempts to reclose the circuit breaker contacts.

From the forgoing description, it is seen that the accessory apparatus of the present invention is capable of accommodating a plurality of diverse, auxiliary circuit breaker trip functions with a rather simple, compact construction of relatively few parts. As such, the various parts of the accessory apparatus can be mounted on a common support structure which can readily be accommodated within the circuit breaker case. One particular feature which contributes to the relatively few number of parts in applicants' construction is the multi-purpose spring **40**. As is seen from the foregoing detailed description and drawings, spring **40** generates the forces necessary for producing tripping impact with the circuit breaker latch. In addition, this spring serves as a resilient interconnecting link between slide **30** and lever **34**, such that the resetting of the slide also resets the lever. Spring **40** also resiliently holds lever **34** in its reset position so as to releasably sustain the latching inter-engagement between the lever and slide necessary to hold the slide in its reset position in anticipation of a stip function. It will also be observed that the present invention conveniently permits the adding on of additional trip functions in the field. That is, the basic elements of the accessory apparatus, namely, platform **18**, slide **30** together with its integrally formed arm **48**, lever **34**, and spring **40**, can readily be augmented with one or both of the shunt trip solenoids **12** or **14**, and/or the UVR sub-assembly **70** to implement the various trip functions as desired.

In the disclosed embodiment of the invention, lever **34**, or more precisely paddle **58** carried by this lever, impacts the circuit breaker latch to precipitate tripping of the circuit breaker. However, it will be appreciated that slide **30** or an extension thereof could just as well be responsible for providing the requisite tripping impact with the circuit breaker latch as the slide moves from its reset to its actuated position. In this modification, arm **48** need not engage lever **34**, but could be utilized to reset lever **78**.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described our invention, what we claim as new and desire to secure by letters patent is:

1. Accessory apparatus for tripping an electric circuit breaker, said apparatus comprising, in combination:

A. a support for mounting attachment to the circuit breaker;

B. first and second members mounted by said support for movements between respective reset and actuated positions;

C. latch means carried by said second member for releasably latching said first member in its reset position while said second member is assuming its reset position;

D. a tension spring connected between said first and second members;

E. tripping means carried by one of said first and second members for movement therewith into tripping engagement with a circuit breaker latch as said one

member is propelled to its actuated position by said spring;

F. a trip solenoid mounted on said support and having a plunger acting to move said second member away from its reset position against the bias of said spring and thereby unlatch said first member for movement to its actuated position under the influence of said spring; and

G. reset means acting to return said first member from its actuated position to its reset position,

1. said spring pulling said second member back to its reset position as said first member is returned to its reset position to thereby bring said latch means into latching engagement with said first member.

2. The accessory apparatus defined in claim **1**, wherein said tripping means is carried by said second member, and said apparatus further includes an arm secured to said first member for movement therewith, said arm disposed to engage and propel said second member to its actuated position as said first member is propelled by said spring to its actuated position.

3. The accessory apparatus defined in claim **1**, wherein said second member includes means engaging said solenoid plunger to reseat said plunger as said second member is returned to its reset position.

4. The accessory apparatus defined in claim **1**, which further includes first and second trip solenoids, both mounted on said support and having plungers acting to move said second member away from its reset position.

5. The accessory apparatus defined in claim **4**, wherein said first and second trip solenoids are mounted on said support with their plungers in end-to-end relation, whereby said plunger of said first trip solenoid acts directly on said second member and said plunger of said second trip solenoid acts on said second member through said plunger of said first trip solenoid.

6. The accessory apparatus defined in claim **5**, wherein said second member includes means engaging said first solenoid plunger to reseat it and said second solenoid plunger as said second member is returned to its reset position.

7. The accessory apparatus defined in claim **4**, which further includes a third trip solenoid mounted on said support and having a plunger acting to move said second member away from its reset position.

8. The accessory apparatus defined in claim **7**, which further includes a third member mounted on said support for movement between reset and actuated positions, said plunger of said third solenoid acting on said third member, said third member carrying means for engaging and moving said second member away from its reset position as said third member moves away from its reset position.

9. The accessory apparatus defined in claim **8**, wherein said tripping means is carried by said second member, and said apparatus further includes an arm secured to said first member for movement therewith, said arm disposed to engage and propel said second member to its actuated position as said first member is propelled to its actuated position, said arm engaging and returning said third member from its actuated position to its reset position as said first member is returned from its actuated position to its reset position.

10. The apparatus defined in claim **9**, wherein said first member is slideably mounted by said support, and said second and third members are pivotally mounted by said support.

11. The apparatus defined in claim **10**, which further includes a post mounted by said support, said post pivotally mounting said second and third members in vertically spaced relation.

12. Accessory apparatus for tripping an electric circuit breaker, said apparatus comprising, in combination:

A. a support for mounting attachment to the circuit breaker;

B. first and second members mounted by said support for movements between respective reset and actuated positions;

C. latch means carried by said second member for releasably latching said first member in its reset position while said second member is assuming its reset position;

D. a tension spring connected between said first and second members;

E. tripping means carried by one of said first and second members for movement therewith into tripping engagement with the circuit breaker latch as said one member is propelled to its actuated position by said spring; and

F. trip initiating means mounted on said support and acting to move said second member away from its reset position against the bias of said spring and thereby unlatch said first member for movement to its actuated position under the influence of said spring.

13. The accessory apparatus defined in claim **12**, wherein said tripping means is carried by said second member, and said first member having an extension engaging and propelling said second member to its actuated position as said first member is propelled to its actuated position by said spring.

14. The accessory apparatus defined in claim **12**, wherein said trip initiating means comprises first and second shunt trip solenoids mounted on said support with their plungers in end-to-end relation, whereby said plunger of said solenoid acts directly on said second member to move same away from its reset position and said plunger of said second solenoid acts through said first solenoid plunger to move said second member away from its reset position.

15. The accessory apparatus defined in claim **12**, wherein said trip initiating means is in the form of a UVR sub-assembly including

1. a bracket secured to said support,
2. a UVR solenoid mounted to said bracket, said solenoid having a plunger,
3. a third member moveably mounted by said support, said third member connected to said plunger for attraction to a reset position by the magnetic forces developed by said solenoid in response to energization by line voltage levels above a predetermined minimum,
4. a spring connected to said bracket and acting in opposition to said solenoid to urge said third member to an actuated position, and
5. means carried by said third member for engaging and moving said second member away from its reset position as said third member moves to its actuated position.

16. The accessory apparatus defined in claim **15**, which further includes reset means acting to return said

first member from its actuated position to its reset position, said spring pulling said second member back to its reset position and said first member is returned to its reset position; and a resilient tab carried by said third member to return said third member to its reset position as said first member is returned to its reset position.

17. The accessory apparatus defined in claim **16**, which further includes a post carried by said support and independently pivotally mounting said second and third members in vertically spaced relation, said first member slidably mounted by said support.

18. The accessory apparatus defined in claim **16**, wherein said tripping means is carried by said second member and said extension of said first member engages and propels said second member to its actuated position as said first member is propelled to its actuated postion by said spring.

19. The accessory apparatus defined in claim **15**, which further includes a shunt trip solenoid mounted on said support, said shunt trip solenoid having a plunger acting to move said second member away from its reset position.

20. The accessory apparatus defined in claim **15**, which further includes first and second shunt trip solenoids mounted on said support with their plungers in end-to-end relation, whereby said plunger of said first solenoid acts directly on said second member to move same away from its reset position and said plunger of said second solenoid acts through said first solenoid plunger to move said second member away from its reset position.

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