

- [54] **ELECTRIC CIRCUIT BREAKER WITH ELECTRONIC TRIP CONTROL UNIT**
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[22] Filed: **Dec. 26, 1972**
[21] Appl. No.: **318,398**

- [52] U.S. Cl. 317/33 R, 317/58
[51] Int. Cl. H02h 1/00
[58] Field of Search..... 317/112, 22, 58,
317/33 R; 337/7

[56] **References Cited**
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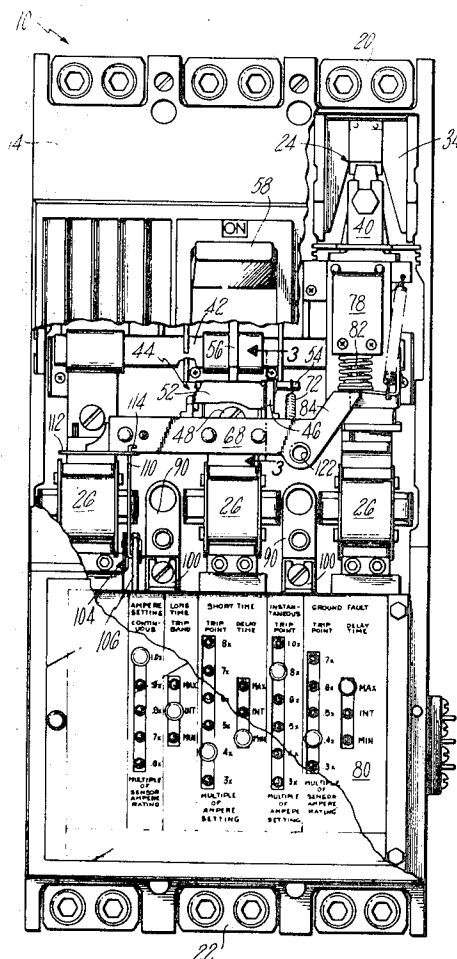
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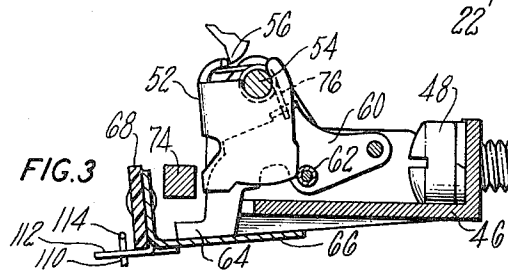
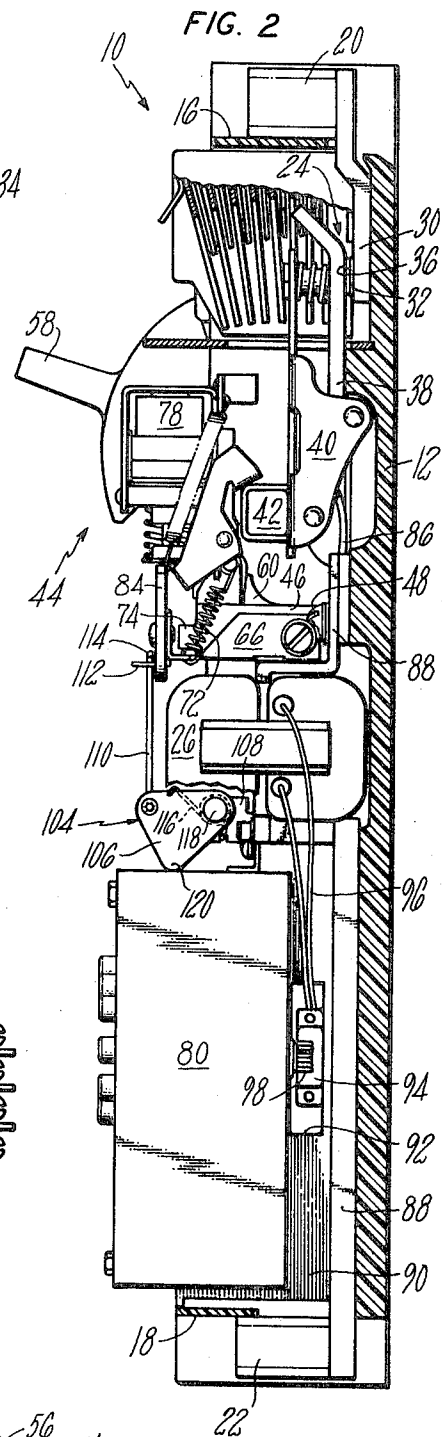
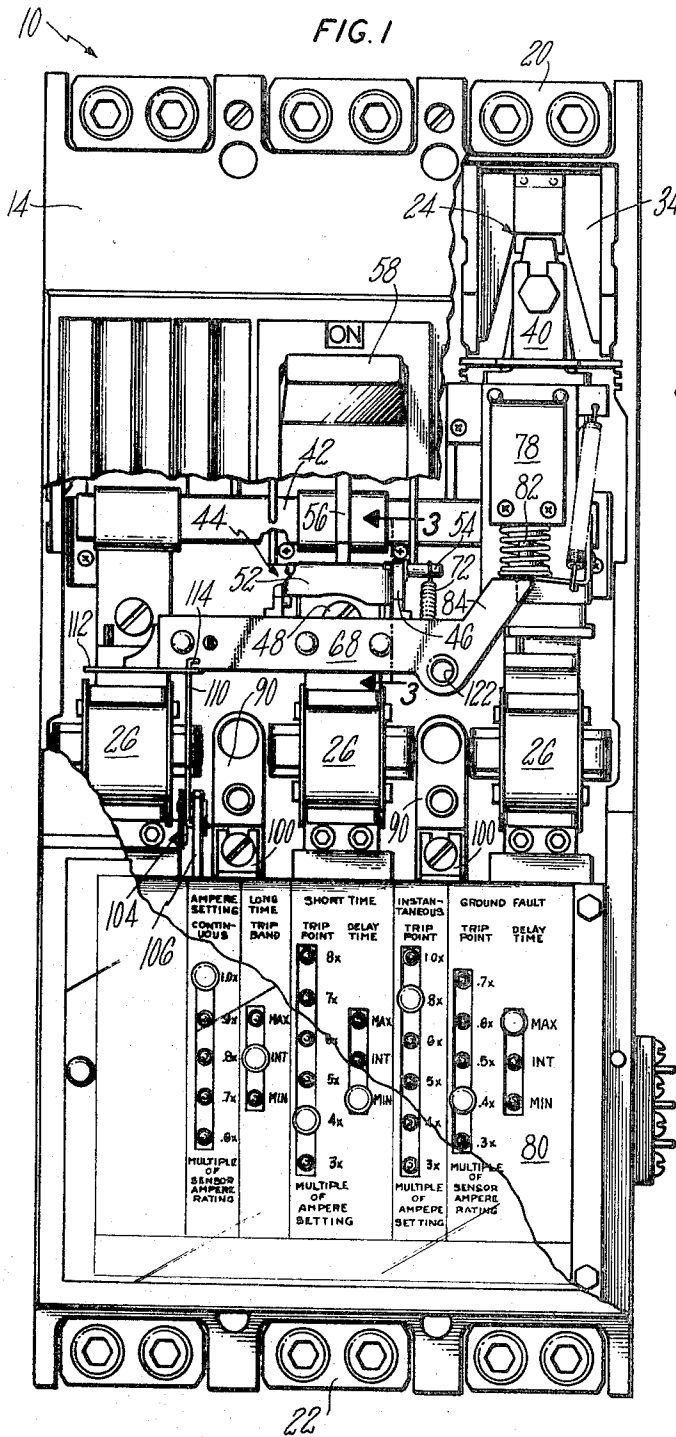
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[57] **ABSTRACT**

An electric circuit breaker is provided with a static or electronic trip control unit adapted for easy removal and replacement during periodic on-site and remote maintenance and testing at controlled current levels. The modular static trip control unit is a standardized interchangeable component operative to effect movement of the trip bar to its tripping position upon the occurrence of preselected electrical conditions and removably mounted in the casing for easy removal and replacement during periodic maintenance and testing of the accuracy of these units for detecting such electrical conditions. A fail-safe interlock is operatively connected to the trip bar of the circuit breaker and is responsive to removal of the interchangeable unit to cause movement of the trip bar to its tripping position and retention thereof in the tripping position while the interchangeable unit is absent from the circuit breaker.

8 Claims, 3 Drawing Figures





ELECTRIC CIRCUIT BREAKER WITH ELECTRONIC TRIP CONTROL UNIT

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to electric circuit breakers and is more particularly concerned with a new and improved electric circuit breaker of the molded insulating case type.

One of the primary concerns in the electric circuit breaker art is reliable operation upon the occurrence of predetermined electrical conditions within the circuits controlled by the circuit breaker. This concern arises primarily from the fact that a circuit breaker frequently remains inactive for prolonged periods of time during normal operation and such periods of inactivity by the tripping mechanism can result in a malfunction when the breaker is called upon to perform its desired function. Accordingly, a continuing program of periodic maintenance of the circuit breakers together with testing of the trip mechanism to determine its operability is required in order to assure full reliability coupled with precise and accurate operation.

Heretofore, the testing of circuit breakers has necessarily been conducted in on-site locations by subjecting the circuit controlled by the circuit breaker to those electrical power conditions necessary for operating the circuit breaker or by completely removing the entire circuit breaker from the line in order to provide the necessary testing operations at controlled current levels. This unfortunately caused interruption in the operation of those systems controlled by the circuit breaker and was both an undesirable and troublesome, though necessary, solution to the problem of maintenance and reliability. This problem becomes even more acute when the electric circuit breakers are being utilized to protect circuits connected to exceptionally high power capacity circuits, particularly since such breakers are used in electric power systems of exceptionally high and virtually unlimited capacity and testing under power current conditions could seriously affect units associated with the system if the circuit breaker did not adequately and rapidly perform its required function.

A related problem long recognized in the circuit breaker art is the provision for appropriate adjustment or calibration of a circuit breaker's ability to automatically and precisely open all circuits controlled by the circuit breaker upon the occurrence of any one of a number of different predetermined electrical power conditions. Although such an adjustment or calibration of the circuit breaker might be performed prior to installation of the circuit breaker within the system it was to control, subsequent readjustment or recalibration of the circuit breaker has been required to assure precise and reliable performance. This generally necessitated removal of the entire circuit breaker from the system coupled with at least temporary replacement despite the disadvantageous costs associated with such an operation. These problems were particularly prevalent with circuit breakers incorporating both thermal and magnetic tripping means which frequently required separate adjustment and calibration. Additionally, the unavoidable variations in construction and assembly of the units and the undesirable intereffects of the thermal and magnetic tripping units often disrupted the original calibration or adjustment of the circuit breaker.

Accordingly, it is a primary object of the present invention to provide a new and improved circuit breaker of the static trip control type suited to periodic maintenance and testing without removal of the entire circuit breaker from the system controlled thereby and without causing substantial interruption in the services provided by the systems controlled by the circuit breaker. Included in this object is the provision for periodic maintenance and testing of the circuit breaker under controlled current level conditions at a location remote from the circuit breaker coupled with the ability to provide the adjustment and calibration necessary to assure a very high level of reliability in the effective operation of the circuit breaker.

Another object of the present invention is to provide a new and improved electric circuit breaker of the type described which makes it possible to provide periodic checks on the operation of a standardized modular trip control unit at the substantially varied varied and controlled circuit conditions required for triggering the operation of the circuit breaker. The standardized and interchangeable control unit can be tested either on-site, if proper testing equipment is available, or by rapid plug-in replacement of a pretested and preadjusted replacement unit accompanied by factory testing and maintenance of the unit removed from the system.

Still another object of the present invention is to provide a new and improved circuit breaker of the static trip control unit type wherein all of the electronics of the static trip control unit are housed within a single standardized modular compartment removably mountable within the insulating case of the circuit breaker. The modular unit is easily removable for testing and maintenance and the circuit breaker further provides a fail-safe interlock arrangement which assures automatic open circuit conditions across all contacts of the circuit breaker when the electronic unit is removed therefrom adding the dimension of safety to the advantageous maintenance and testing characteristics associated therewith.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

These and related objects are achieved in accordance with the present invention by providing an electric circuit breaker with a static or electronic trip control unit adapted for easy removal and replacement during periodic maintenance and testing. Such a circuit breaker is comprised of an insulating case, relatively separable contacts mounted on the case for movement between open and closed circuit positions, a trip bar movable toward a tripping position to effect relative separation of the contacts, a modular static trip control unit and a fail-safe interlock system. The modular static trip control unit is a standardized interchangeable component operative to effect movement of the trip bar to its tripping position upon the occurrence of preselected electrical conditions and removably mounted in the casing for easy removal and replacement during periodic maintenance and testing of the accuracy of these units for detecting such electrical conditions. The fail-safe interlock is operatively connected to the trip bar and is responsive to removal of the interchangeable unit to cause movement of the trip bar to its tripping position and retention thereof in the tripping position while the interchangeable unit is absent from the circuit breaker.

A better understanding of the invention will be obtained from the following detailed description and the accompanying drawing which set forth an illustrative embodiment indicative of the way in which the principles of the invention are employed.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a top plan view of a circuit breaker embodying the features of the present invention, the cover thereof being partially broken away to reveal the fail-safe interlock and a portion of the tripping mechanism of the circuit breaker;

FIG. 2 is the side elevational view, partially in section, of the circuit breaker of FIG. 1 with the side of the molded case removed to expose the internal components of the circuit breaker; and

FIG. 3 is an enlarged sectional view taken along the line 3—3 of FIG. 1 and showing a portion of the trip mechanism of the circuit breaker.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing in greater detail wherein like reference numerals indicate like parts throughout the several figures. A multi-phase electric circuit breaker 10 is illustrated as comprised of a generally rectangular insulating case of durable molded insulating material such as a polyester fiberglass composition. The insulating case includes a box-like base 12 and a cover 14 mounted on the base to fully enclose the components of the circuit breaker. The base is provided with apertured end walls 16, 18 having a plurality of terminal locating recesses for receiving line terminals 20 on one end and load terminals 22 on the opposite end of the circuit breaker. It will be understood, of course, that the relative location of the terminals may vary without departing from the spirit of the invention. However, for economic and practical reasons the electrical path between the line and load terminals, hereinafter referred to as a "phase," extends in linear fashion along the length of the circuit breaker between those aligned terminals. The several components of the circuit breaker associated with each phase, such as the separable contact assemblies 24 and current transformers 26 are also mounted in alignment with the line and load terminals.

Each line terminal 20 is mountably supported by, and electrically connected to, a short length of conductive strap 30 which extends into the interior of the case through the apertured end wall 16. The straps are fixedly supported in the case and, in turn, fixedly carry stationary contacts 32 within individual arc suppressing chambers 34 located adjacent the end wall 16. A movable contact 36 is carried by a conductive arm 38 and in conventional fashion, is pivotally supported by a contact arm mount 40 fixedly secured to a common cross-arm 42 extending fully across the circuit breaker for simultaneous and common pivotal movement between a closed circuit position shown in FIG. 2 and an open circuit position (not shown).

A common operating mechanism suitably connected to the separable contacts and indicated generally by the numeral 44 is provided for simultaneously actuating all three movable contacts in unison either manually between their open and closed circuit positions or automatically from the closed circuit position to the open circuit position. The mechanism includes a mounting

bracket 46 fixedly secured at 48 to the back of the insulating casing base 12 and a latching member 52 pivotally supported on a pin 54 journaled in the mounting bracket 46. A trip-latch 56 operatively associated with the contacts and with a manually operated handle 58 is adapted to be driven by the handle during movement of the handle toward its "off" position into releasable engagement with the latching member 52. The bracket 46 also pivotally supports an intermediate latch 60 which carries a latch roller 62 at an intermediate point and a trip bar contact leg 64 at one end thereof. The trip bar contact leg 64 is releasably engaged and held by a supporting yoke 66 for the insulating trip bar 68, the yoke 66 being pivotally mounted on the bracket 46. A return spring 72 mounted on one end of the pin 54 and secured to the yoke 66 retainably biases the trip bar 68 in a clockwise direction as viewed in FIG. 2 toward the bracket 46. The latching member 52 and intermediate latch 60 are also biased in a clockwise direction as viewed in FIG. 2 toward the stop lug 74 of the bracket 46 by a torsion spring 76 mounted on the pin 54.

Movement of the manual handle 58 to the "off" position will be effective for conditioning the trip mechanism for a subsequent tripping operation. This operation is similar to that described in Stokes U.S. Pat. No. 3,171,922 assigned to the assignee of this invention. The trip-latch 56 is driven by the handle into latching engagement with the latching member 52 causing counterclockwise rotation thereof against the bias of its torsion spring 76. The latching member 52, in turn, engages the roller 62 carried by the intermediate latch 60 to drive the intermediate latch counterclockwise against the bias of the torsion spring 76, urging the contact leg 64 into engagement with the trip bar yoke 66. As the trip-latch 56 passes the latching member 52 the latter returns slightly to effectively restrain the trip latch in the cocked position shown in FIG. 3. Subsequent movement of the handle 58 to the "on" position does not alter this condition, but merely rotates the movable contacts in a clockwise direction as viewed in FIG. 2 to their illustrated closed circuit position.

The manually operated handle 58 is located centrally across the transverse dimension of the circuit breaker and on one side thereof is positioned a sensitive magnetic trip actuating device 78 suited for operation by a relatively low powered signal pulse received from a static trip control module 80. The trip actuating device 78 includes a push rod 82 that acts against an obliquely extending portion 84 located at one end of the trip bar 68 for moving the trip bar in a counterclockwise direction as viewed in FIG. 2 against the bias of its return spring 72. This movement permits counterclockwise movement of the intermediate latch 60 and latching member 52 by the trip latch 56 to effect release thereof and tripping of the circuit breaker. The sensitive magnetic trip actuating device 78 is preferably of the construction and operation described and explained in U.S. Pat. No. 3,693,122 assigned to the assignee of this invention. The details of construction and operation of this mechanism are fully set forth in the aforementioned patent.

The moveable contacts 38 are electrically connected through flexible conductors 86 to their respective elongated phase conductor straps 88 extending toward the load terminal end of the circuit breaker. In the embodiment illustrated, a portion of each phase conductor

strap 88 located between the load terminal 22 and the separable contact assembly 24 is displaced substantially from the back of the casing for passage through a low profile twin winding current transformer 26 associated with each phase of the multi-phase circuit breaker.

The base of the casing in the area located between the current transformers and the load terminals is divided into three longitudinally extending channels through which the phase conductor straps 88 run. These channels are formed by the side walls of the casing and by a pair of spaced interior dividing walls 90 integrally upstanding from the back of the insulating casing from the load terminal end wall 18 continuously to a point between the current transformers 26. The dividing walls 90 are each provided with a central notch 92 mid-way along their length for receiving a single electrical socket 94 to which the transformer leads 96 and the leads (not shown) from the magnetic trip actuating device 78 are connected.

The programmer on a static trip control unit 80 of the circuit breaker is a self-contained, easily removable, modular device housing solid state circuitry suited to providing control over various conditions that might occur within any of the three phases controlled by the circuit breaker. This solid state device is electrically and operatively connected to the magnetic trip actuating device and to the current transformers by means of a plug 98 readily connected to the socket 94. The static trip control unit is a standardized component housed within a single compartment and extends across the circuit breaker, resting on the dividing walls 90 in spaced overlying and nestable relationship with the phase conductor straps 88. The modular unit is removably held in the insulating casing by means of a pair of bolted brackets 100 secured to the interior walls 90 adjacent the transformer ends thereof.

As can be appreciated, the static trip control unit 80 being a single compartmentalized module can be easily removed from the circuit breaker by simply disconnecting the bolted brackets 100 from the two interior walls 90 and disconnecting the plug 98 from the socket 94 associated with the current transformers 26 and magnetic trip actuating device 78. The entire modular compartment may then be removed to a remote location where it can be fully and accurately tested under controlled bench conditions to determine whether its multiple settings accurately and precisely control the operation and functioning of the circuit breaker in the desired fashion. As will be appreciated, the standardized size and operation of each control unit enables interchangeability in different circuit breakers and facilitates full testing and subsequent use as a replacement for another control unit so that it, in turn, can be tested under controlled conditions.

An additional feature of the present invention is a fail-safe interlock 104 operable upon removal of the control unit 80 to effect movement of the trip bar to its tripping position and cause a fully open circuit condition across all phases of the circuit breaker. The fail-safe interlock 104 includes an insulating sensing plate 106 of generally triangular configuration pivotally mounted at one corner thereof on a frame member 108 fixedly secured within the circuit breaker. A trip bar drive rod 110 is pivotally connected at a second corner of the triangular sensing plate 106 and extends toward the trip bar 68, which is provided with an upstanding

plate 112 fixedly secured to the end thereof opposite the oblique portion 84. The free end of the drive rod extends through an aperture in the plate 112 and is provided with a drive hook 114 that engages the upstanding plate 112 to draw the trip bar 68 toward its tripping position against the bias of its return spring 72. A torsion spring 116 mounted on the pivot pin 118 for the sensing plate 106 acts against the sensing plate to urge the sensing nose portion 120 thereof into engagement with the module housing for the static trip control unit, spring 116 being of sufficient size and strength to overcome the bias of the trip bar retaining spring 72 so that upon removal of the control unit 80 from the circuit breaker the sensing plate 106 will be driven in a counterclockwise direction as viewed in FIG. 2. As will be appreciated, this causes the drive arm hook 114 to engage plate 112 and drive the trip bar 68 to its tripping position against the bias of its retaining spring 72. The counterclockwise movement of the trip bar 68 will effect tripping of the operating mechanism 44 so as to release the trip latch 56 and cause the separable contacts to move to their open circuit position. It also will be appreciated that so long as the trip control unit 80 is removed from the circuit breaker, movement of the handle 58 to the "off" position will be ineffective to cock the trip mechanism.

In the embodiment illustrated, the trip bar 68 is further provided with chamfered aperture 122 adjacent its oblique portion 84. An aligned aperture (not shown) in the cover 14 of the circuit breaker is provided directly above the chamfered aperture 122 for insertion of a tool and manual movement of the trip bar to its tripping position.

As will be apparent to persons skilled in the art, various modifications, adaptations and variations of the foregoing specific disclosure can be made without departing from the teachings of the present invention.

We claim:

1. An electric circuit breaker with a static control unit adapted for easy replacement during periodic maintenance and testing at control current levels comprising an insulating case, relatively separable contact means mounted on said case for movement between open and closed circuit positions, a trip bar movable toward a tripping position to effect relative separation of said contact means, modular static trip control means operative to effect movement of said trip bar to its tripping position upon the occurrence of preselected electrical conditions, said modular static trip control means being a standardized interchangeable unit removably mounted in said casing for easy removal and replacement during periodic on-site and remote maintenance and testing of the accuracy of said unit for detecting said electrical conditions, and failsafe interlock means operatively connected to said trip bar and responsive to removal of said interchangeable unit to cause movement of said trip bar to its tripping position.

2. The electric circuit breaker of claim 1 wherein said modular static trip control means includes electronic trip control circuitry responsive to selected electrical conditions within the systems controlled by the circuit breaker, said circuitry being housed within a single standardized removable compartment.

3. The electric circuit breaker of claim 1 wherein said trip control unit includes a solid state trip circuit having multiple settings for different preselected tripping conditions, said unit being suited to adjustment to different

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settings without removal of said unit from said insulating casing.

4. The electric circuit breaker of claim 1 wherein the trip bar is biased away from the tripping position and the failsafe interlock means includes drive means operable to overcome the bias on the trip bar upon the removal of said interchangeable unit.

5. The electric circuit breaker of claim 1 wherein the failsafe interlock means includes a sensing plate for contacting said interchangeable unit and trip bar drive means associated with the sensing plate for driving the trip bar toward the tripping position upon removal of the unit from engagement with the sensing plate.

6. The electric circuit breaker of claim 5 wherein the trip bar drive means includes a drive rod and a one way driving connection between said rod and said trip bar.

7. The electric circuit breaker of claim 1 including a

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retaining spring resisting movement of the trip bar to the tripping position and wherein the interlock includes a sensing plate and trip drive spring for urging said plate toward the interchangeable unit and for driving said trip bar into the tripping position against the bias of said retaining spring.

8. The circuit breaker of claim 1 including releasable means movable between a cocked position and a released position to effect relative separation of the contact means, said trip bar being effective to hold said releasable means in the cocked position and effect release thereof upon movement toward the tripping position, said interlock being effective to retain the trip bar in the tripping position while the interchangeable unit is removed to prevent retention of the releasable means in its cocked position.

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