United States Patent

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[54] **REMOTE CONTROL CIRCUIT BREAKER**
18 Claims, 14 Drawing Figs.

[52] U.S. Cl. **335/13,** 335/38
[51] Int. Cl. **H01h 77/02**
[50] **Field of Search** 335/13, 38, 43, 15, 19, 73, 174, 177

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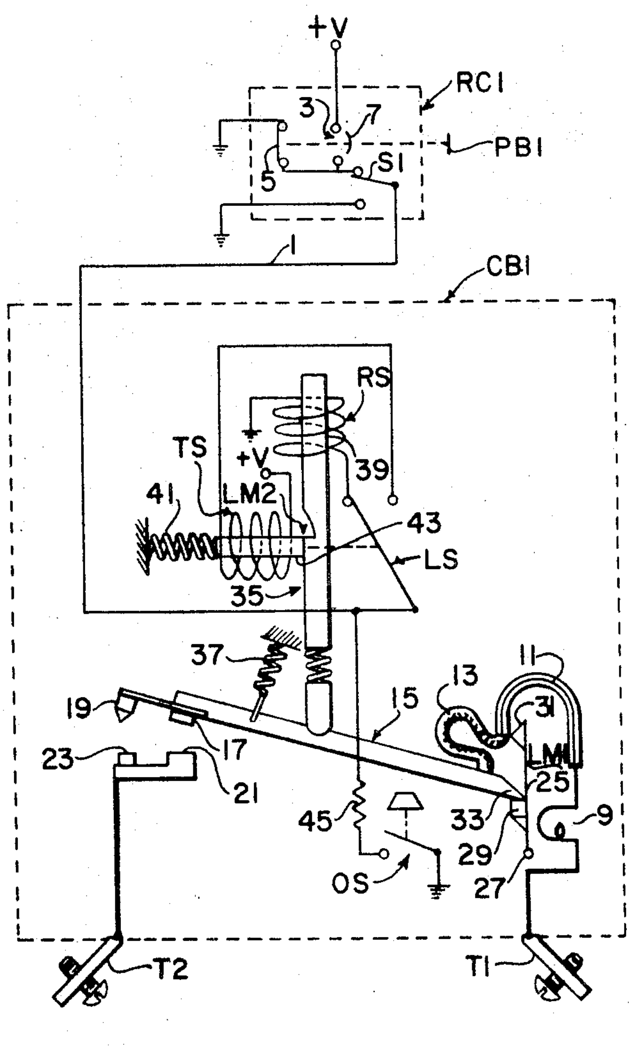
ABSTRACT: A miniature remote control circuit breaker in which a movable contact member including a movable contact is engageable with a fixed contact. Motor means, such as a solenoid and an armature actuated thereby, move the contact member from a contacts-open position to a contacts-closed position when the solenoid is energized by remote switch means. Preferably a linkage including two resiliently connected driving members is employed to couple the motor means to the contact member. Condition-sensing (e.g. current-sensing) latch means retain the contact member in its contacts-closed position until the condition sensed varies beyond a predetermined value whereupon the latch means releases the contact member, thereby opening the contacts independently of the energization of the motor means. Further latch means are provided to retain the contact member in its closed position. The latter latch means are responsive to further actuation of the remote switch means thereby to release the contact member and separate said contacts. A further solenoid and armature are preferably provided to effect the release of the further latch means in response to further actuation of the remote switch means.



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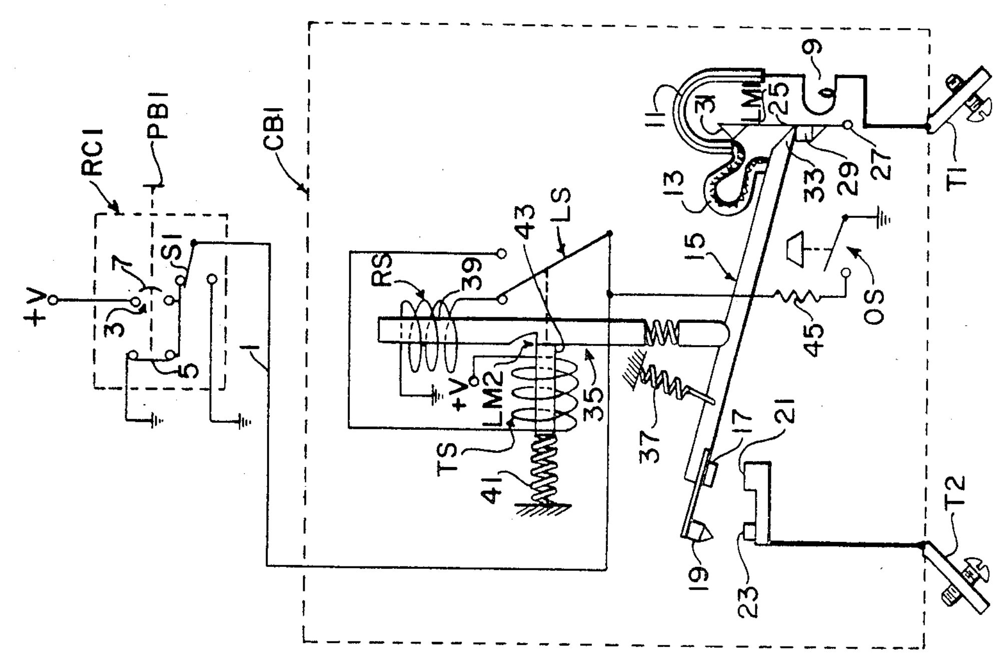

FIG.1.

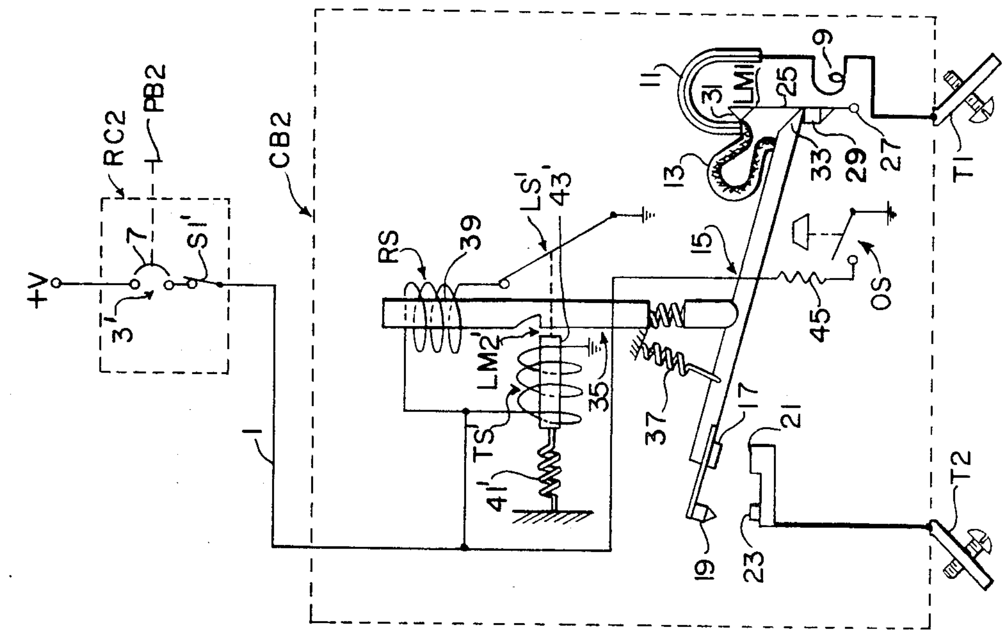

FIG.2.

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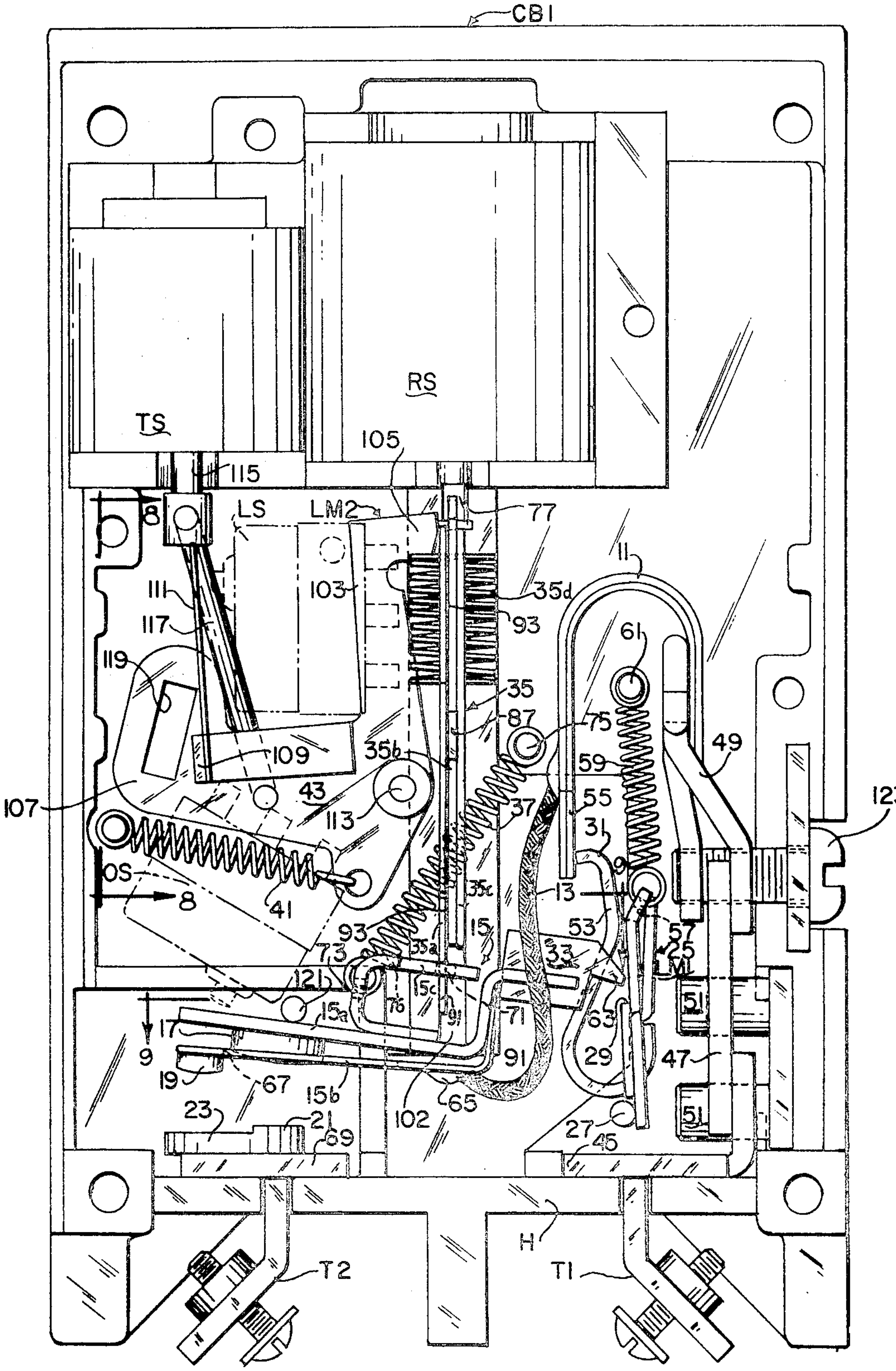

CB1
RS
TS
105
115
77
8
LS
LM2
103
35d
111
117
93
61
11
119
35
87
75
109
35b
49
59
107
43
113
55
123
37
31
41
35c
13
OS
8
93
15
53
57
25
LM
73
35a
33
121
76
15c
91
71
63
51
17
15a
9
19
29
47
91
67
15b
102
65
23
21
27
45
51
69
H
T2
T1

FIG. 3

FIG. 4

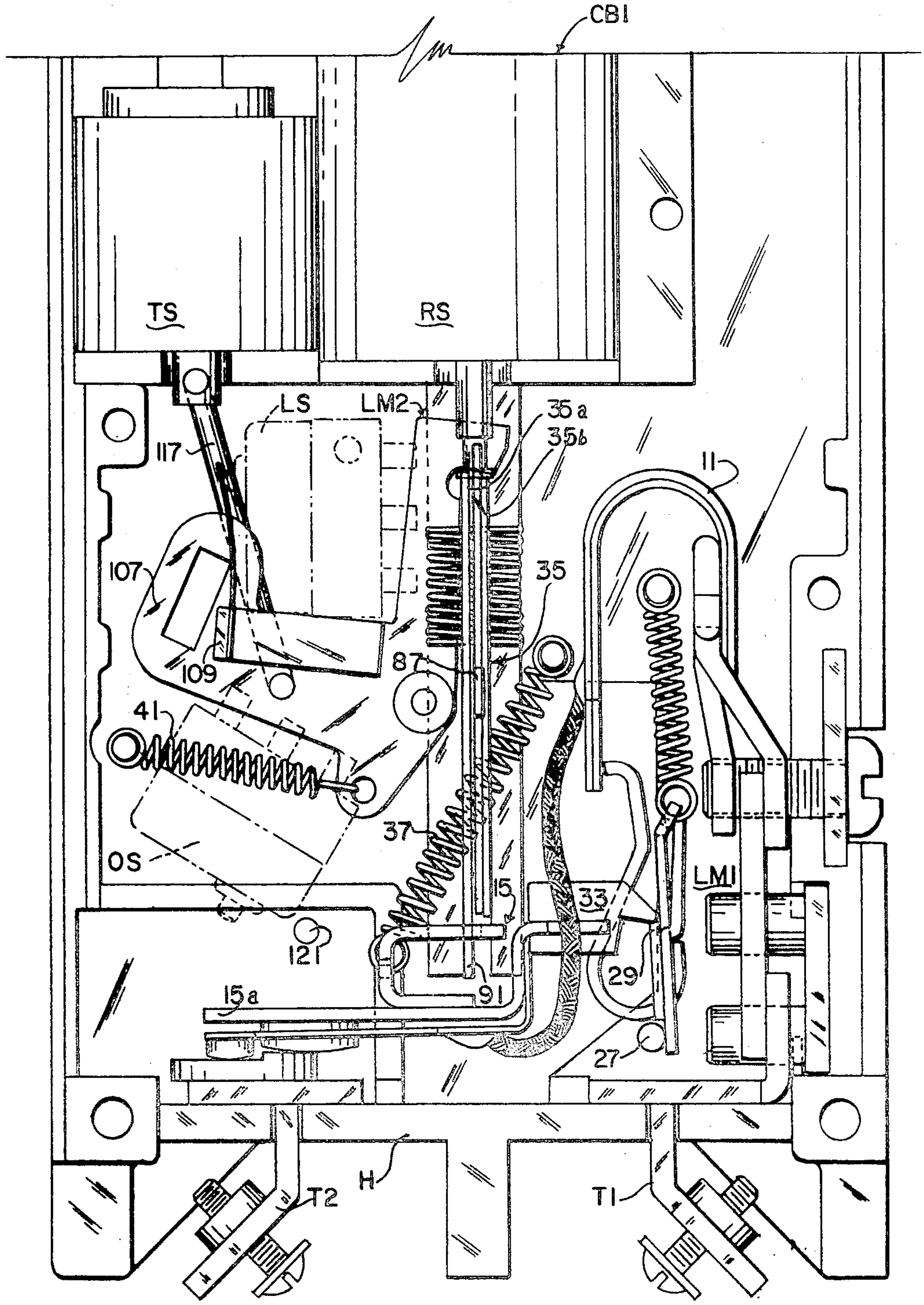
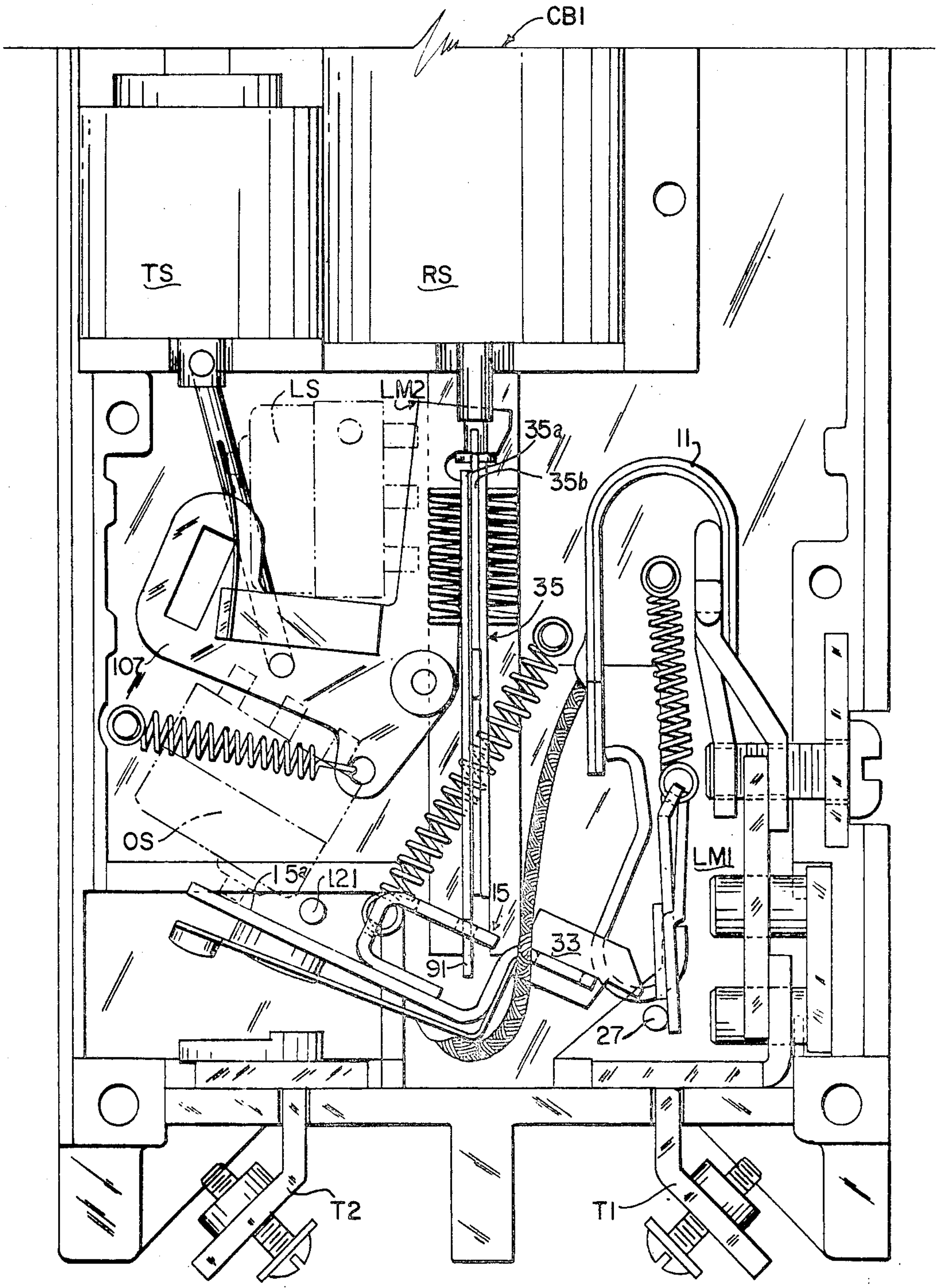

CB1
TS
RS
LS
LM2
35a
35b
117
11
107
35
109
87
41
37
OS
15
33
LM1
121
29
15a
91
27
H
T2
T1

FIG. 5



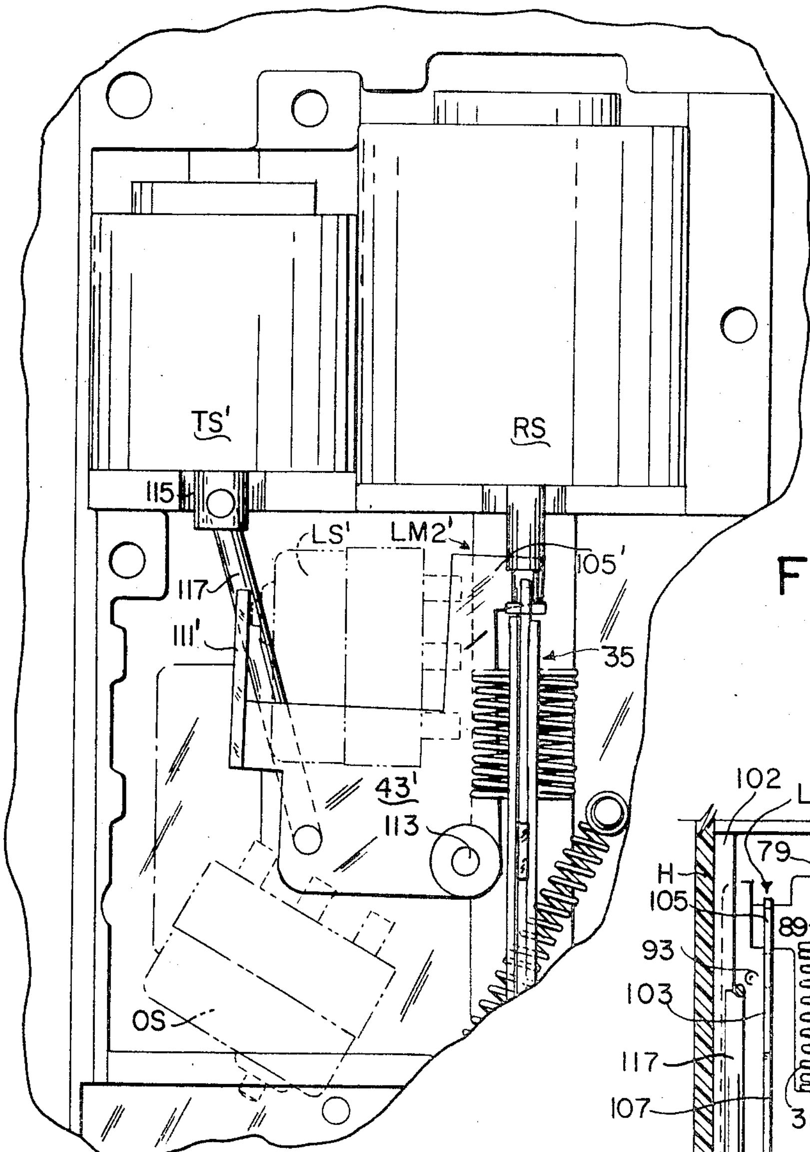


FIG. 6

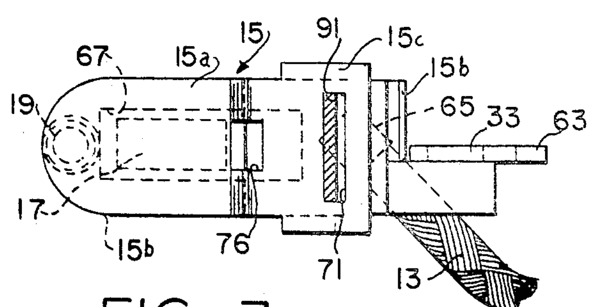


FIG. 7

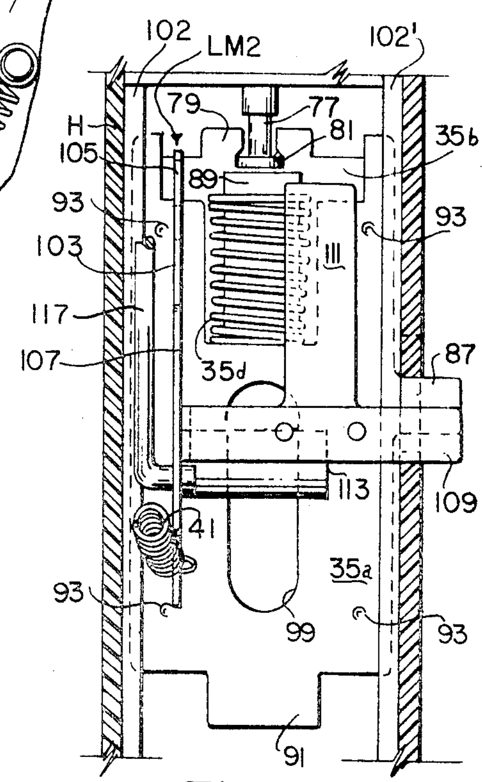
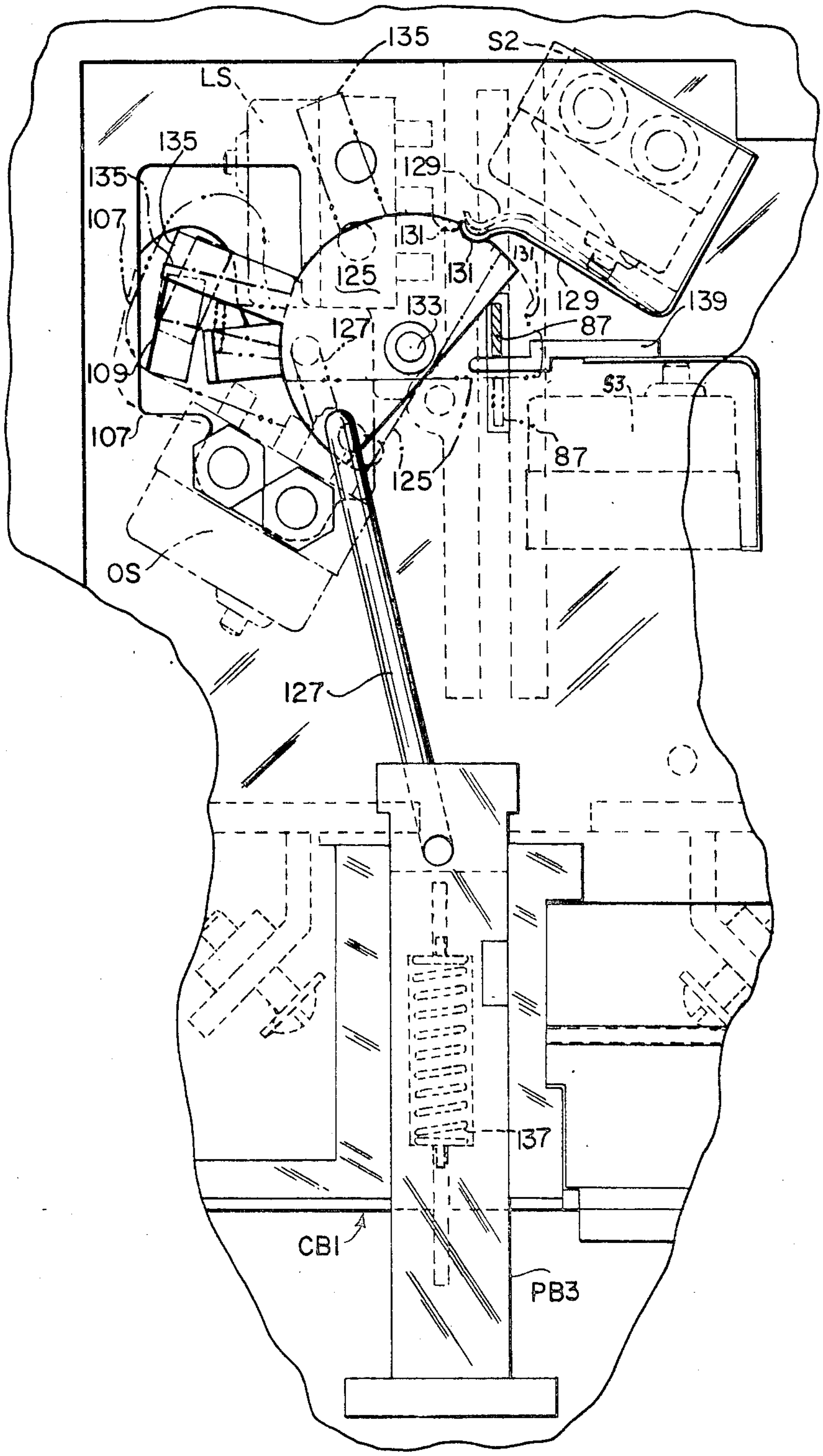


FIG. 8

FIG. 9.


135
S2
LS
135
135
107
129
131
125
131
131
129
139
133
127
87
109
S3
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125
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OS
127
137
CB1
PB3

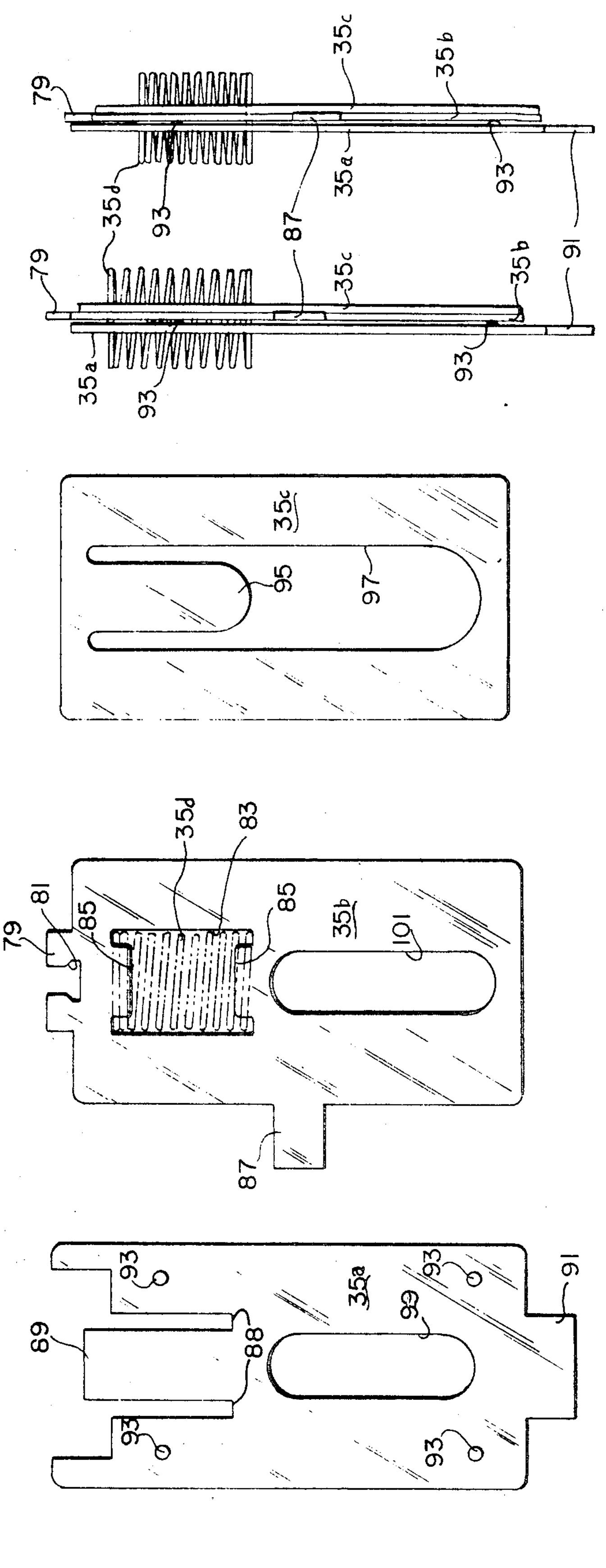

FIG. 10A FIG. 10B FIG. 10C FIG. 11A FIG. 11B

REMOTE CONTROL CIRCUIT BREAKER

This invention relates to circuit breakers and more particularly to remotely controlled circuit breakers.

With the advent of the larger jet aircraft and their increased electrical power requirements, the weight and cost of the larger loop runs of heavy expensive aviation cable between the power generators and electrical loads via the flight engineer's console or cockpit become excessive. A large portion of this cable expense and weight can be eliminated by reducing the lengths of the power lead runs. This can be effectively accomplished by the use of remotely controlled circuit breakers located near the generator with small remote control units positioned in the cockpit and interconnected with the breaker itself by light inexpensive control wires, thus permitting much shorter and direct power lead runs between the generator gear and the loads. A typical jumbo jet may require over 1000 circuit breakers, many of which advantageously could be the remote control type. These remote control breakers should not only function reliably to protect against overloads (both of the short circuit and low level or ultimate trip types), but should also function as contactors which are resettable and trippable from the remote control unit. Existing remote control circuit breakers, however, have various disadvantages. Some lack any means for remotely indicating when the breaker has tripped due to an overload, or fail to provide for both tripping as well as resetting the breaker from the remote control unit, or do not protect a load from both short circuit and ultimate trip or low level overloads. Others do not have or fail to retain close tolerances as to tripping levels, and are subject to other difficulties. The remotely controlled circuit breakers of this invention overcome these disadvantages and provide numerous significant advantageous features.

Among the several objects of this invention may be noted the provision of remotely controlled circuit breakers which permit substantial economies in the reduction of cable weight and expense; the provision of such breakers in which power switching, overload sensing and the protection functions are provided in one unit located in a position close to the power source and the load being supplied and protected, while even smaller remote units are positioned in the strategic and spatially limited area of the cockpit or flight engineer's console, there to provide the control or on-off signalling functions and to indicate overload conditions; the provision of breakers of the type described which combine contactor and breaker functions in one package, protect against all types of overloads, and are inherently trip-free; the provision of remote control circuit breakers which protect the circuits regardless of the condition of the remote control unit and circuitry and are independently fail-safe even in the event of failure of control voltage; the provision of such breakers which may be of the latch-in or nonlatch types and which comprise substantially the same components with only minor modification; the provision of circuit breakers which have and retain close tolerances as to tripping levels and provide specific and substantially constant contact pressure and calibration, which are maintained throughout the life of the breaker; and the provision of such remote control circuit breakers having minimal number of control wires and which are compact, light in weight, reliable in operation, will handle a wide variety of AC and DC voltage and current requirements, and have a long operating life. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, a circuit breaker of this invention includes a fixed contact and a movable contact member having a movable contact engageable with the fixed contact and being movable between a first or contacts-open position and a second or contacts-closed position. Motor means are provided which have a linkage extending therefrom to the contact member for moving said contact member from its first position to its second position when the motor means is actuated. Biasing means urge the contact member toward its first position. A condition-sensing latch means retains the contact member in its second position until the condition sensed varies beyond a predetermined value whereupon the latch means releases said contact member to open the contacts independently of the actuation of the motor means. The linkage includes a first driving member, an attachment between it and the motor means, a second driving member engageable with the movable contact member, and a resilient connection between said first and second driving members to effect resilient engagement between the second driving member and the contact member as the latter is driven to contact-closing position and to effect lost motion between the driving members after contact engagement.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

FIGS. 1 and 2 are schematic and diagrammatic representations of two remote control circuit breaker embodiments of the invention;

FIGS. 3—5 are elevations of the circuit breaker represented in FIG. 1, parts being broken away, illustrating, respectively, the components in a normal contacts-open, a normal contacts-closed and a trip-free configuration or position,

FIG. 6 is an elevation of the circuit breaker represented in FIG. 2, parts being broken away;

FIG. 7 is a detail view of a contact member component taken generally on line 7-7 of FIG. 3 with parts broken away;

FIG. 8 is a detail view of a latch member component taken generally on line 8-8 of FIG. 3 with parts broken away;

FIG. 9 is an elevation of another breaker embodiment of this invention including a manually operable arrangement to move the breaker contact member between its closed and open positions;

FIGS. 10A—C are elevations of three component slider plates of a slider assembly of a circuit breaker of this invention; and

FIGS. 11A and B are edge elevations of the slider assembly in its two positions.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now to the drawings, and more particularly to FIG. 1, a remote control unit, indicated generally at RC1, is shown connected by a single conductor 1 to a circuit breaker CB1. Remote control RC1 includes a circuit breaker device 3 of the bimetal thermostatic type including an auxiliary set of contacts 5 commonly operated by a pushbutton PB1. Upon actuation of PB1 to the left as shown in FIG. 1, the main contacts of device 3 are bridged by the breaker's bimetallic element 7 and auxiliary contacts 5 are opened. A load control switch S1 is optionally provided to connect conductor 1 to the positive side of a control voltage source represented as +V (the negative side of which is grounded) via bimetallic element 7 when pushbutton PB1 is actuated to open contacts 5 and element 7 is bridging the main contacts of breaker 3. Control switch S1, when actuated or moved to its alternate position, grounds conductor 1.

Breaker 3 may be any conventional bimetal type breaker preferably having a low current rating, e.g., on the order of one-half amp. When its rated current-carrying capacity is exceeded, its bimetal element 7 will reverse its curvature and cause pushbutton PB1 to pop outwardly (to the right as shown in FIG. 1) thus serving to indicate, as will be described hereinafter, when main breaker CB1 is tripped because of an overload. It will be understood that other conductor means, such as an electromagnetic type or a light, may be used to provide an indication at the remote control unit RC1 of overload tripping of CB1.

Breaker CB1 includes two terminals T1 and T2 which are connected in series with a power lead or conductor interconnecting a source of electric power to an electrical load. The current path from T1 to T2 includes a current-sensing latch means LM1 having an electromagnet 9 and a U-shaped bimetal element 11, a flexible braid lead 13 and a contact member 15 carrying a movable main contact 17 and a movable arcing contact 19 which respectively conductively engage a fixed main contact 21 and a fixed arcing contact 23. Latch means LM1 also includes a pivotable latch member 25 pivoted about a pin 27 and having an abutment or catch 29 and an upper end 31 adapted to be contacted and moved to the right by the upper end of bimetal element 11 when the latter is heated by current exceeding the breaker's rating. Contact member 15 has an end 33 supported on catch 29 which constitutes a pivot for contact member 15 when the latter is actuated by a linkage 35 to move the fixed and movable contacts thereof into conductive engagement. Contact member 15 is urged or biased toward its contacts-open position by a spring as represented at 37. Linkage 35 is actuatable by an armature 39 of a reset solenoid RS. Coacting with linkage 35 is a further latch means LM2 which, when linkage 35 is actuated to move contact member 15 to its closed position, will engage linkage 35 and retain contact member 15 in its contacts-closed condition. A spring represented at 41 biases a latch arm 43 of LM2 against the linkage for retention thereof. Latch arm 43 is actuatable by a trip solenoid TS which when energized retracts arm 43 to release the linkage 35 and permit the contact member to return to its contacts-open position.

When PB1 is in its closed position with bimetal element 7 bridging the main contacts of breaker 3 and switch S1 is in the position illustrated, a circuit energizing reset solenoid RS is completed through one set of contacts of a double-throw single-pole mode or latch switch LS, thereby driving contact member 15 downwardly into its closed position through linkage 35. This action moves switch LS to its other mode wherein it connects solenoid TS to conductor 1 which is at potential +V. As the other terminal of TS is also connected to +V, it will remain deenergized until further actuation of the breaker 3 or switch S1. If a fault or overload condition occurs, the overcurrent condition will cause latch member 25 of latch means LM1 to pivot clockwise and release the end 33 of contact member 15, thus permitting the contacts to open under the bias of spring 37. As contact member end 33 moves clockwise it actuates a trip or overload switch OS, causing it to close and ground conductor 1 through an optional resistor 45. The current then drawn through bimetal 7 will cause it to heat and pop open, actuating PB1 to indicate at the remote control unit RC1 that an overload condition has tripped breaker CB1. Tripping of remote control RC1 energizes trip solenoid TS which disengages arm 43 of LM2 to release the linkage 35 and permit the contact member to return to its contacts-open position.

Breaker CB1 may be operated as a contactor from RC1 by either moving load control switch S1 to its opposite position or manually moving PB1 to the position illustrated in FIG. 1, thereby to trip breaker CB1 from a remote position. Either action connects conductor 1 to ground and as the other terminal of trip solenoid TS is connected to +V, TS is energized via the contacts of latch switch LS thereby firing or energizing TS to release latch means LM2 and permit contact member 15 to move to its contacts-open position. In this mode of operation the current-sensing thermally responsive latch means LM1 are not actuated and the end 33 of contact member 15 pivots on abutment 29. Thus the overload switch OS is not actuated in this contactor-trip mode of actuation. Resetting of breaker CB1 after tripping is accomplished by actuation of the remote unit RC1 as described above, so as to energize or fire reset solenoid RS. If tripping is due to an overload, CB1 will be trip-free, i.e., as long as bimetal element 11 remains hot, latch member 25 will be moved to the right and contact member end 33 will have no available point on which to pivot.

If loss of control power or an open circuit occurs on the control line, contact member 15 of breaker CB1 will not change its position since neither the trip nor reset solenoids TS and RS can then be energized. Also, if control conductor 1 is grounded when the contact member 15 of breaker CB1 is in its open position, both terminals of solenoid RS are at ground potential and it will not fire, so that CB1 cannot be reset under this condition. If control member 15 is closed and conductor 1 becomes grounded, trip solenoid TS will be fired, opening breaker CB1 and PB1 will be actuated by bimetal element 7.

It is to be noted that load control switch S1 is optionally provided to minimize wear on breaker 3. If the latter is used not only for resetting after overload trips but also for all operations in the contactor mode, this breaker would have to have a useful life of many tens of thousands of operating cycles. By using S1 in this contactor mode of operation and building breaker 3 to last several thousands of cycles, switch S1 can be more economically designed to have a reliable life of many tens of thousands of operational cycles, and provide a remote control unit with increased overall reliability and operating life but at a decreased cost.

The FIG. 1 remote control circuit breaker system is of the latch-in type, i.e., during normal operation the contact member 15 is latched in its contacts-closed position with reset solenoid RS being deenergized. One or the other of latch means LM1 or LM2 must be actuated to open the contacts, the latter by energization of trip solenoid TS to overcome the latching bias of spring 41. In such a latch-in system, failure of the control power or interruption thereof will not trip breaker CB1. In some instances it is desirable to provide a nonlatch type operation, i.e., the contact arm or member is held closed by a latch means which is maintained energized so that upon any interruption of control power the breaker automatically opens and must be reset to reclose. This type operation is conveniently accomplished in accordance with this invention with only minor modification of a few components of breaker CB1 and unit RC1. A nonlatch system is illustrated in FIG. 2, by utilizing a remote control unit RC2 which employs a breaker 3' (which is identical to breaker 3 but includes no auxiliary contacts) and a single-pole single-throw load control switch S1' rather than a double-throw switch S1. A circuit breaker CB2 is utilized instead of breaker CB1, the former having a single-pole single-throw latch switch LS' and modified latch means LM2', trip solenoid TS' and biasing spring 41'. To close or reset contact member 15, load control switch S1' or breaker 3' is operated to apply +V control voltage to reset solenoid RS. However, in this nonlatch system of FIG. 2, the trip solenoid TS' is concurrently energized to urge latch arm 43' into engagement with linkage 35 so as to maintain it in its closed position when it reaches that position. As latch arm 43' is lightly biased out of latching engagement by a spring 41', any loss or interruption of control power will cause latch means LM2' to release linkage 35 and open the contacts. Operation of this nonlatch system of FIG. 2 upon overload is essentially the same as described above in regard to the latch-in system of FIG. 1. That is, overload switch OS is actuated momentarily by contact member 15 moving into its trip-free position as abutment 29 is moved out from under end 33 of contact member 15 thereby applying the control voltage across bimetal element 7 and resistor 45, the controlled short circuit constituted thereby causing a relatively high current flow therethrough, thus causing breaker 3' to operate and indicating at remote control unit RC2 that breaker CB2 has tripped due to an overload. The opening of breaker 3' opens the circuit through bimetal element 7 and the automatic release of linkage 35 by latch means LM2' permits load or mode transfer switch LS' to reclose thus preparing the reset and trip solenoids for subsequent refiring to reset breaker CB2.

It is to be noted that in both the latch-in and nonlatch systems of FIGS. 1 and 2, latch means LM1 operates to cause contact member 15 to move to an open position while linkage 35 remains in its latched or actuated position. Thus, the circuit-productive function of CB1 and CB2 is maintained independently of loss of control power or malfunctions on the control line. Any load fault will cause latch means LM1 to trip breaker CB1 or CB2 and clear the fault.

Referring now more particularly to FIGS. 3—5, the detailed structure of an exemplary circuit breaker CB1 is illustrated in its respective three modes or conditions, viz., open, closed and trip-free. Breaker CB1 is assembled in a housing H molded of suitable plastic or synthetic resin-insulating material with appropriate recesses and the like for retaining and mounting components of the breaker mechanism described hereinafter. Terminal T1 is formed integrally with a base portion 45 having a zigzag extension 47 and an upper portion 49 on which is mounted U-shaped bimetal element 11. Projecting through openings in extension 47 are a pair of insulated poles 51 which, together with the conductive turn or turns constituted by the zigzag configuration of 47, comprise an electromagnet which includes in its magnetic circuit the pivoted latch member 25. Latch member 25 includes an arm portion 53 which is preferably constructed of a bimetal laminate to provide ambient temperature compensation. The distal end 31 of arm 53 is adapted to be engaged by an extension 55 of bimetal element 11. An eye 57 is provided in the top of latch member 25 for attachment of one end of a spring 59, the other end of which is anchored to a pin 61 mounted in the body of housing H. Spring 59 exerts a biasing action on latch member 25, tending to hold it in the position shown and resisting pivoting action around pivot pin 27, also journaled or mounted in housing H. Thus abutment or catch 29 is normally held in a position adapted to be engaged by a finger 63 secured at end 33 of contact member 15. Braid 13 flexibly electrically interconnects the free end of bimetal element 11 to contact member 15 at 65. Contact member 15 includes a main arm portion 15*a* to which is secured the movable main contact 17 and rather flexible resilient auxiliary arm portion 15*b* carrying movable arcing contact 19. Portion 15*b* is slotted to provide an opening 67 through which main contact 17 projects. Secured by welding or the like to a base 69 integrally formed with terminal T2 is a stepped contact assembly, the higher portion constituting the fixed or stationary contact 21, the lower portion being the fixed arcing contact 23. Auxiliary branch or arm 15*b* flexes, as illustrated in FIG. 4, to permit firm conductive engagement between mating pairs of main and arcing contacts, the latter leading the former as member 15 moves into its closed-contact position (FIG. 4) and trailing it as member 15 moves back to its open-contact position (FIG. 3). This action protects the main contacts from the arcing action, concentrating this at the arcing contacts to insure that good electrical conductivity will be maintained between contact member 15 and terminal T2 which is secured to housing H.

Contact member 15 includes a C-shaped bracket 15*c* having a cross slot 71 in its upper reach and an eye 73 in its forward reach. One end of spring 37 is attached to bracket 15*c* at eye 73 and the other end of spring 37 is anchored to a pin 75 mounted in housing H, thus biasing contact member 15 to move clockwise. Bracket 15*c* has an opening 76 at the knee juncture of the upper and front reaches thereof so as to provide for unobstructed passage and movement of spring 37. Linkage 35, which comprises a slider assembly including three slider plates 35*a*, 35*b*, 35*c* and a coil compression spring 35*d*, extends from an armature end 77 of reset solenoid RS to engage contact member 15 by a loose rocking and resilient connection. Slider plate 35*b* of linkage or slider assembly 35 has an extension 79 (FIG. 10B) at its upper end with a T-slot 81 for coupling engagement with the enlarged end 77 of the armature. Coil compression spring 35*d* is nested within a window 83 having opposed tongues 85 projecting from the top and bottom thereof. A laterally extending actuation tab 87 projects from one edge of slider plate 35*b*.

Slider plate 35*a* (FIG. 10A) has an upwardly extending tongue 89 which, when slider plates 35*a* and 35*b* are assembled as shown in FIGS. 11A and 11B, is positioned within the coils of spring 35*d*, the lower end of this spring engaging shoulders 88. A tongue 91 projects downwardly from the lower end of plate 35*a* for engagement within slot 71 of contact member 15. Four bosses 93 are formed in the surface of plate 35*a* and provide a reduced friction engagement with the opposing surface of plate 35*b* when assembled. The third slider plate 35*c* (FIG. 10C) has a tongue 95 formed at the top of a window or slot 97. This tongue extends downwardly so as to be positioned within the coils of spring 35*d* when the plates are assembled and thus serve as a spring retainer. When reset solenoid RS is energized, the downward thrust of armature end 77 is transmitted through the first driving member (slider 35*b*) which is resiliently coupled (by spring 35*d*) to the second driving member (slider plate 35*a*) to drive contact member 15 downwardly. The closing impact of the contacts is cushioned by spring 35*d* which maintains substantially constant contact pressure even though the contacts may wear down from extended usage. As contact member 15 is thus moved from its open position (FIG. 3) to its closed position (FIG. 4) against the bias of spring 37, finger 63 of contact arm end 33 is seated against abutment or latch catch 29. Sliders 35*a* and 35*b* are provided with respective elongate slots 99 and 101 which, when these sliders are assembled with slider plate 35*c*, register with the latter's slot 97 and thus provide an elongate opening for passage of contact arm spring 37. Slide assembly 35 moves within a pair of opposed guideways 102 and 102′ formed on the inner surfaces of the sidewalls of housing H.

When the linkage constituted by slider assembly 35 has moved arm 15 into its closed position of FIG. 4, latch means LM2 engages to hold slider plate 35*b* in its downward position. Latch means LM2 includes a bellcrank lever having an upper arm 103 with a latch hook 105 at its end for engaging the top edge of slider plate 35*b*, and a second arm 107 from which extends a lateral arm 109 carrying a spring finger 111. Latch means LM2 is biased clockwise by spring 41 about a latch pivot pin 113, thereby urging latch hook 105 into engagement with the top edge of slider plate 35*b*. Latch means LM2 is moved from its latched (FIG. 4) to its unlatched (FIG. 3) position by firing or energizing trip solenoid TS, which has an armature 115 coupled to latch arm 107 by a connecting link 117. Energizing solenoid TS moves latch means LM2 counterclockwise about its pivot 113 against the bias of spring 41 and thereby releases linkage 35, permitting arm 15 to move clockwise about its pivot point on catch 29 and under the contact opening bias of spring 37. Latch arm 107 includes an aperture 119 adapted to receive a ganging bar for cross coupling adjacent breaker units CB1 for multiphase operation so that tripping of one breaker CB1 in one phase will trip all of the ganged breakers.

It will be noted that spring finger 111 will depress and thus actuate latch switch LS, shown in phantom when latch means LM2 engages the top edge of slider plate 35*b* upon the contact member 15 reaching its closed position. Thus switch LS remains in its FIG. 4 actuated position as long as contact member 15 is closed and until the trip solenoid TS is fired.

Under an overload condition, breaker CB1 is tripped by latch means LM1 independently of latch means LM2. If the overload is due to a short circuit on an extremely heavy current drawing fault, the electromagnet constituted by poles 51 and the turns formed by extension 47 will immediately pull in latch member 25, moving abutment or catch 29 to the right and causing contact member 15 to move to its tripped position (FIG. 5). A relatively low level longer term fault will cause bimetal element 11 to heat and move its extension 55 to the right, thus actuating latch member 25 similarly to release end 33 of contact member 15. As member 15 moves clockwise under the bias of spring 37, it pivots about tongue 91 so that the upper surface of the free end of main contact arm portion 15*a* moves against the actuator button of overload switch OS and depresses it. As discussed above, actuation of switch OS, shown in phantom, energizes or fires trip solenoid TS, thereby releasing latch means LM2 and allowing slider assembly 35 to move to its FIG. 3 position. As slider assembly 35 moves upwardly, opening to the FIG. 11A expanded position because of compression spring 35*d*, contact member 15 will pivot first around the actuator button of switch OS as spring 37 exerts an upward force on bracket 15*c*. After initial counterclockwise rotation of contact member 15 around this pivot point, the upper intermediate surface of main contact arm portion 15*a* will strike a pin 121 mounted in housing H. The pivot point then shifts to pin 121, which serves as a fulcrum as contact member 15 moves to its FIG. 3 position with its free end separated from switch OS and with its end finger 63 poised over catch 29 when the latter returns to its normal cool position. Thus overload switch OS is only momentarily actuated upon overload tripping by release of latch LM2. This momentary actuation, however, fires trip solenoid TS, which releases latch LM1 and also completes a relatively high current circuit through bimetal 7 of remote unit RC1 so that pushbutton PB1 will pop out to signal tripping of CB1 due to an overload. The fault is thereby cleared and both remote unit RC1 and breaker CB1 are prepared for reclosing or resetting when the current-sensing thermally responsive latch means LM1 has cooled and returned to its normal position.

Breaker CB1 may be calibrated by adjustment of screw 123 which moves the end of bimetal extension 55 relative to end 33 of arm 53 of latch member 25. Once the breaker is calibrated as desired, this calibration will be accurately maintained over the long operational life of the breaker because of the provision of various features of this invention. These features include the unique slider linkage assembly 35, the engagement arrangement between tongue 91 in slot 71 and the method of biasing contact member 15 by spring 37 against latch member 25. Maintenance of close tolerance calibration is a function of a number of variables, all of which are taken into account in this breaker structure. The moment arm from the pivot point of finger 63 on catch 29 to the point of engagement of linkage 35 with the contact member 15 is one such variable. This is maintained constant as spring 37 urges contact member 15 to the right so that the tip of finger 63 will always be snugly moved into abutting contact with the left surface of member 25 and fully engage the top surface of catch 29. Thus catch 29 will always have the same frictional factor to overcome when it moves to a release position and the spacing or moment arm between that point and the point of engagement of tongue 91 and contact member 15 will be maintained constant. Therefore, even with the loose rocking engagement between the latter two components, which can be inexpensive stampings, precise calibration and very close tolerances can be attained as contact member 15 is biased by spring 37 consistently to return to this precise reference position, regardless of wear. Spring 37 also exerts a substantially constant force biasing the slider plates 35*a*, 35*b* and 35*c* together. Further, as discussed above, compression spring 35*d* maintains constant contact force despite possible contact erosion and the resultant changes in the angularity of contact member 15 when closed.

A nonlatch type breaker CB2 as described above in regard to FIG. 2 is further illustrated in FIG. 6. Such a breaker may be made from substantially the same components as those used to fabricate breaker CB1 and with only minor modifications. These involve changing the shape of latch hook 105 to that of latch hook 105′ wherein the engaging face of hook 105′ is angled slightly upwardly, and inverting solenoid TS so that it will pull its armature 115 inwardly upon energization rather than thrusting it outwardly. As the trip solenoid is inverted and the wiring of the latch switch is slightly modified in the CB2 breaker, these components are indicated at TS′ and LS′, the reference character LM2′ being used to indicate the modified nature of this latch means. Another modification involves elimination of spring 41 and the stiffening of spring 111 of the CB2 breaker, as indicated at 111′. This provides a modest bias from the inherent biasing force of the internal spring in the microswitch type latch switch LS′, which urges this latch LM2′ into a released or unlatched position. As noted above, the trip solenoid is maintained energized continuously while breaker contact member 15 remains closed and will only be deenergized upon intermittent actuation of overload switch OS during tripping due to overload or by operation in the contactor mode by remote unit RC2. Only a low level energization current through trip solenoid TS′ is required to maintain slider assembly 35 latched.

In certain instances it may be desirable to provide for local manual actuation of the circuit breaker CB1 and FIG. 9 illustrates an exemplary embodiment including this feature. A spring-loaded pushbutton PB3 of insulating material is slidably mounted on housing H and coupled to a cam plate 125 by a connecting link 127. Another microswitch S2 similar to latch switch LS and overload switch OS is mounted on housing H and has an actuator arm 129, the end of which bears against the periphery of cam plate 125 in the neutral or rest position of this plate (shown in solid lines) and is biased so as to nest in a notch 131 of this plate by the internal biasing force of microswitch 52 and the spring action of the flexible actuator arm 129. Switch S2 is connected in the circuitry for reset and trip solenoids RS and TS. Thus, when cam plate 125 is moved in either direction around its pivot 133 from its solid-line rest position, actuator arm 129 is moved to the position indicated to its broken line position to actuate switch S2 and effectively disconnect or disable both solenoids so that neither can be actuated from the remote unit RC1.

To manually locally reset or reclose breaker CB1, pushbutton PB3 is pressed (upwardly as shown in FIG. 9) and tab 87 of slider plate 35*b* is moved by an edge of cam plate 125 from its solid line to its double-dot-dash-line position, thus manually closing the contacts of breaker CB1 (FIG. 4). As latch means LM2 is biased to an engaged latching position by spring 41, its arms 107 and 109 will move from their solid- to their double-dot-dash-line positions as shown and pushbutton PB3, when released, will return to its neutral rest position under the centering bias of its captive spring 137.

To manually trip breaker CB1, pushbutton PB3 is pulled down (as viewed in FIG. 9) so that cam plate finger 135 will contact and move latch arm 109 to its solid-line position and thus disengage latch means LM2 and permit slider assembly linkage 35 to release and open the breaker contacts, as represented by actuator tab 87 moving to its solid-line position. Thus in manual local actuation to either a contacts-open or a closed-contact position, there is a lost motion connection between PB3 and the operating components of breaker CB1, and when cam plate 125 is moved in either direction from its neutral rest solid-line position, switch S2 will be actuated to deenergize these solenoids to prevent any inadvertent override by concurrent actuation of remote control unit RC1.

If it should be desired to provide remote indication of the physical position of contact member 15, this is provided by a further switch S3 secured to housing H and having an actuator arm 139 which engages slider assembly actuator tab 87. In an open-contact position, tab 87 will be in its solid-line position and switch S3 will not be actuated, but when contact member 15 is moved to its closed position, tab 87 will move down to its double-dot-dash position and actuator switch S3 which will close a circuit to a remote indicator to signal that the breaker contacts are physically closed.

It is to be understood that remote control circuitry other than that specifically illustrated herein may be utilized for remote control of the breakers of this invention. It is also to be noted that latch means other than LM1 (such as one uncompensated for ambient temperature variations), LM2 and LM2′ are useful in the practice of this invention.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions 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.

What we claim is:

1. A circuit breaker comprising:

a fixed contact;

a movable contact member including a movable contact adapted for engagement with the fixed contact, said member being movable between a first position in which said contacts are separated and a second position in which said contacts are in conductive engagement;

motor means and a linkage extending from said means to said contact member for moving said contact member from its first position to its second position when the motor means is actuated;

biasing means urging said contact member toward said first position; and

condition-sensing latch means for retaining said contact member in its second position until the condition sensed varies beyond a predetermined value whereupon said latch means releases said contact member to open said contacts independently of the actuation of said motor means;

said linkage including a first driving member, an attachment between said first driving member and the motor means, a second driving member engageable with the movable contact member, a resilient connection between said first and second driving members to effect resilient engagement between the second driving member and the contact member as the latter is driven to contact-closing position and to effect lost motion between said driving members after contact engagement.

2. A circuit breaker comprising:

a fixed contact;

a movable contact member including a movable contact adapted for engagement with the fixed contact, said member being movable between a first position in which said contacts are in conductive engagement;

means comprising a solenoid and an armature, a linkage extending from said armature to said contact member for moving said contact member from its first position to its second position when the solenoid is energized;

biasing means urging said contact member toward said first position;

current-sensing latch means for retaining said contact member in its second position until the current sensed exceeds a predetermined value whereupon said latch means releases said contact member to open said contacts independently of the energization of said solenoid;

said linkage including a first driving member, an attachment between said first driving member and the armature, a second driving member engageable with the movable contact member, a resilient connection between said first and second driving members to effect resilient engagement between the second driving member and the contact member as the latter is driven to contact-closing position and to effect lost motion between said driving members after contact engagement.

3. A circuit breaker according to claim 2 including further latch means operative in connection with said first driving means for retaining said contact member in its second position.

4. A circuit breaker according to claim 2 wherein said current-sensing latch means comprises a catch, a finger extending from said movable contact member and supported by said catch in said second position, said engagement between the second driving member and said movable contact member being in the form of a loose rocking connection to permit rotary movement of the movable contact member in movements between its various positions.

5. A circuit breaker according to claim 2 wherein said first driving member is in the form of a first plate having a window from opposite sides of which extend tongues for the reception of a compression coil spring, and said second driving member is in the form of a second plate slidable on one side of the first plate and having a tongue portion within the coils of the spring and shoulders engaging one of its ends.

6. A circuit breaker according to claim 5 which includes a third plate on the opposite side of the first plate, said third plate having a window for reception of the spring and from one side of which extends a tongue portion within the coils of the spring to hold it axially straight.

7. A circuit breaker according to claim 6 wherein said engagement between the second driving member and said movable contact member is in the form of a loose rocking connection to permit rotary movement of the movable contact member in movement between its various positions.

8. A circuit breaker according to claim 7 wherein the loose rocking connection comprises a tongue on that end of the second driving member which engages said contact member, and a slot in the contact member into which said tongue projects.

9. A circuit breaker according to claim 2 which includes further latch means operative in connection with said first driving means for retaining said contact member in its second position, a second solenoid and a second armature, switch means for energizing the second solenoid, a second linkage connecting said second armature with said second latch means to release it when the switch means is actuated, said switch means being actuated upon movement of the contact member to a third position in response to release of the contact member by the current-sensing latch means.

10. A circuit breaker according to claim 9 including a fulcrum engageable by the contact member to rotate it in moving from its third to its first position so as to deactuate the switch means.

11. A circuit breaker according to claim 9 which includes second switch means for deenergizing the first said solenoid upon actuation thereof, said second switch means being actuated by said further latch means while it is retaining said contact member in its second position.

12. A circuit breaker according to claim 2 in which the solenoid is energizable by switch means remote from said circuit breaker.

13. A circuit breaker according to claim 9 in which said first and second solenoids are alternatively energizable by switch means remote from said circuit breaker respectively to move said contact member into its second position and to release the further latch means thereby to cause the contact member to move from its second position to its first position.

14. A circuit breaker according to claim 13 which further includes an indicator located with said remote switch means, said indicator being energizable by the first said switch means upon actuation thereof.

15. A circuit breaker according to claim 14 wherein said indicator comprises a bimetal type thermal motor.

16. A circuit breaker according to claim 9 which further includes manual means adapted to move said contact member to its second position and alternatively to move said further latch means to release said contact member from its second position and permit it to return to its first position, said manual means having a lost motion connection with said further latch means and a lost motion connection with said contact member.

17. A circuit breaker according to claim 16, said manual means having a neutral rest position in which it is not in engagement with said contact member or said further latch means, said breaker further including another switch means adapted to be actuated when said manual means is moved from its neutral rest position thereby to disconnect said remote switch means from the first said solenoid.

18. A circuit breaker according to claim 9 which includes means for ganging its further latch means to the further latch means of at least one additional like breaker for multiphase operation whereby the release of one of the further latch means releases all of said ganged latch means.