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Heft

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[54] **METHOD FOR CALIBRATING AN ELECTRIC CIRCUIT BREAKER**

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[73] Assignee: **General Electric Company**, New York, N.Y.

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[52] **U.S. Cl.** ..... **219/121 LM**; 29/203 J; 29/203 P; 29/467; 29/602; 29/622; 335/36; 335/176

[51] **Int. Cl.²** **B23K 9/00**

[58] **Field of Search** ..... 219/68, 121 L, 121 LM, 219/121 EM, 121 EB; 335/35, 36, 42, 176; 29/602, 622, 467, 203 J, 203 P

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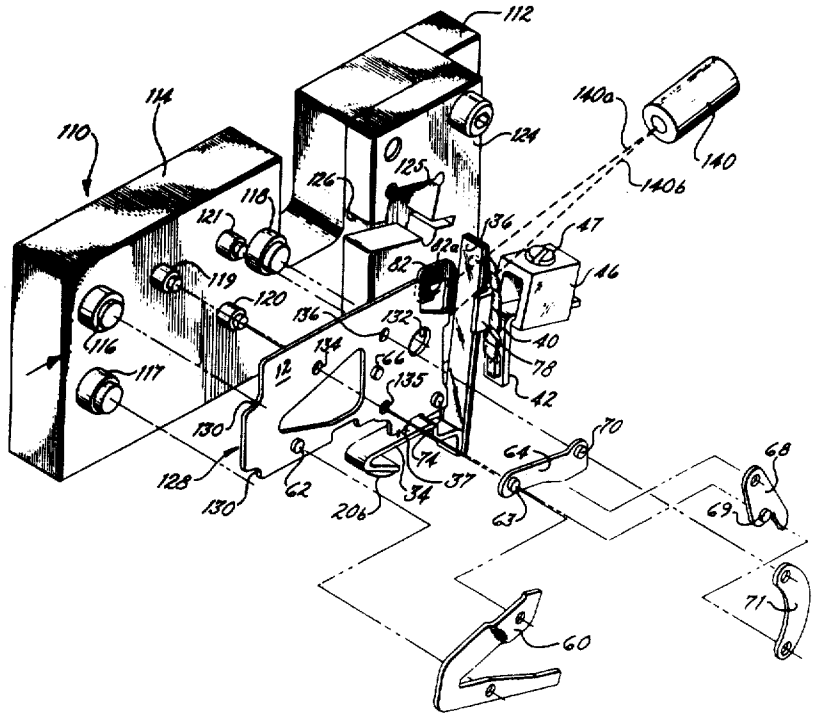
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Primary Examiner—Carl E. Hall
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[57] **ABSTRACT**

A circuit breaker designed for automated assembly includes pairs of fixed and movable contacts, the latter carried by a carrier mounted for reciprocating movement in the breaker case. Operating and trip mechanism parts are mounted on a frame positioned in the case. A handle slideably mounted by the case actuates the operating mechanism to open and closed circuit positions. A fixture is utilized with the frame for calibrating the thermal trip setting and for partial assembly of the operating mechanism.

6 Claims, 6 Drawing Figures



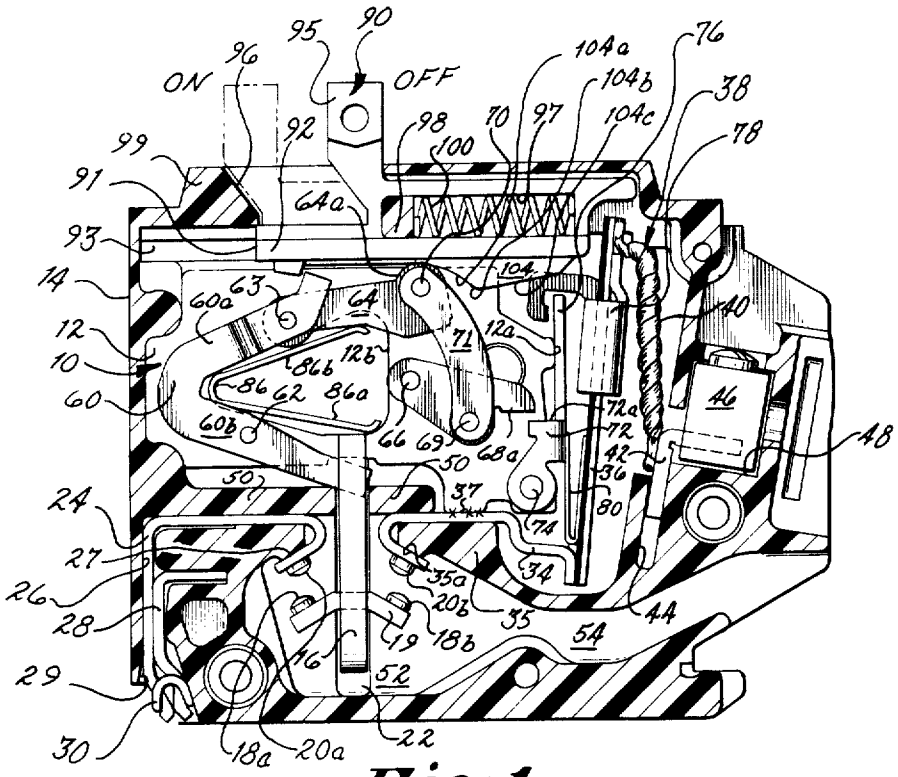

ON
OFF
95
90
96
104a
104b
104c
76
38
78
70
97
98
100
99
91
92
64a
93
14
60a
63
64
104
40
12
10
12a
71
12b
86b
86
62
86a
60
60b
66
69
72a
72
42
36
46
48
68a
50
37
80
74
24
27
26
28
35a
20b
35
34
44
18b
19
54
16
29
52
30
18a
20a
22

Fig. 1.

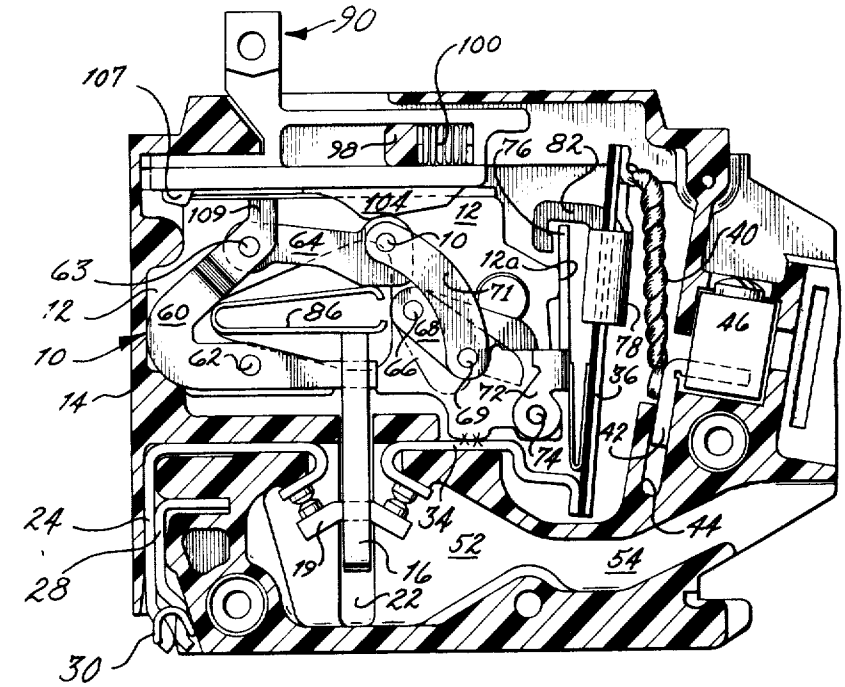

90
100
107
98
76
82
109
104
12
64
10
40
12a
63
12
60
71
86
46
68
78
10
62
66
36
72
14
69
42
74
24
34
52
44
28
19
16
54
22
30

Fig. 2.

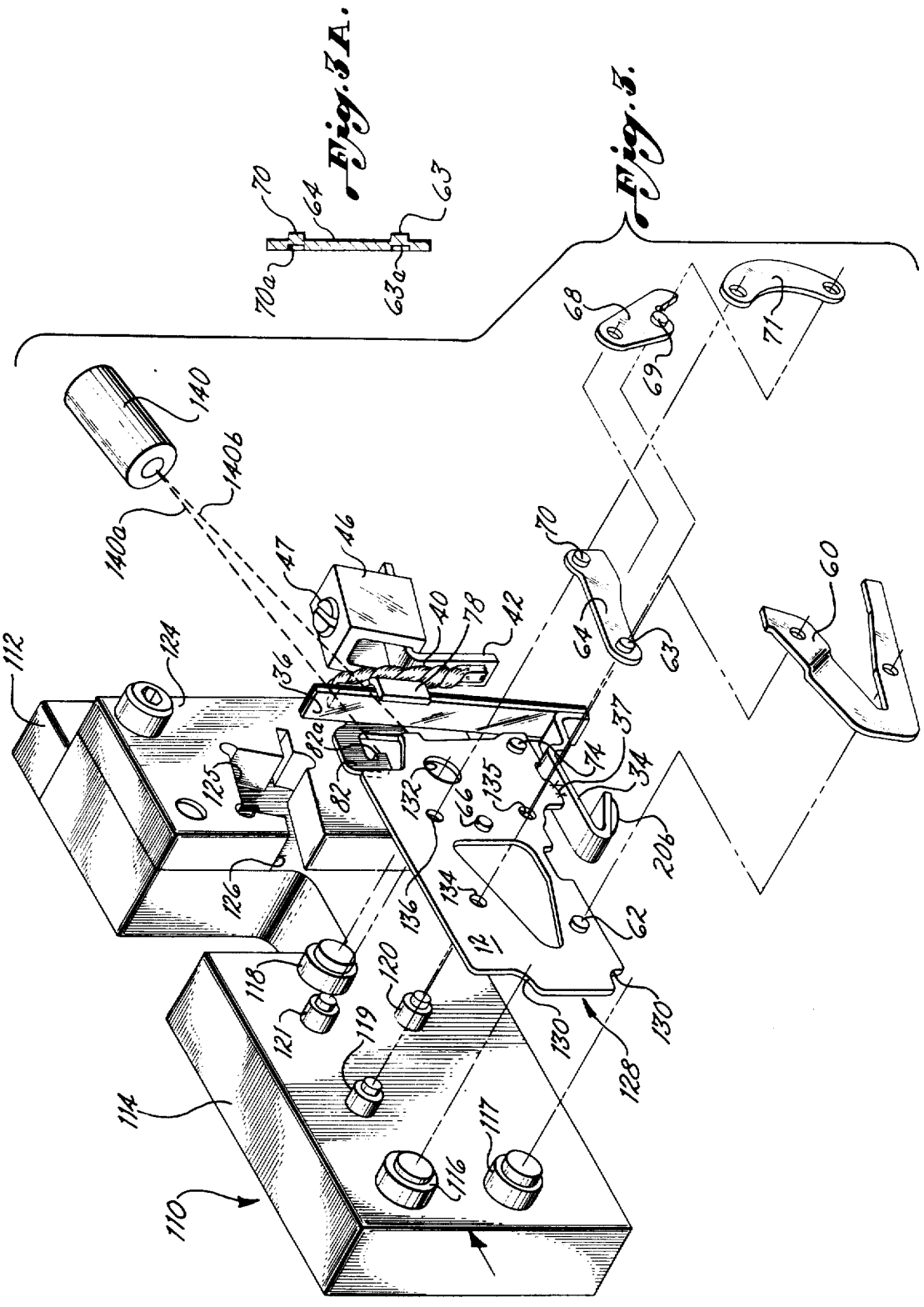
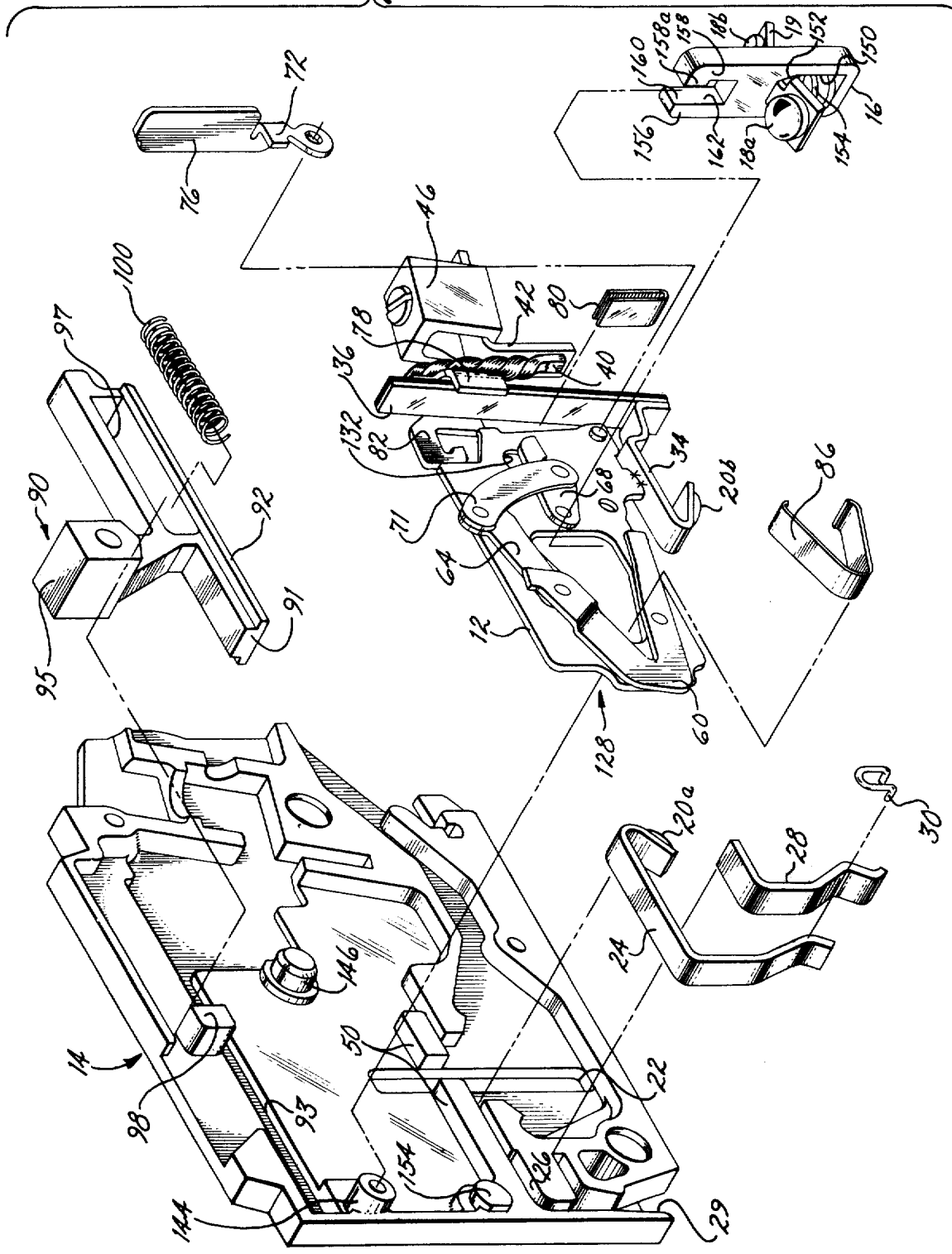

Fig. 5A.
70
64
63
70a
63a
Fig. 5.
68
69
71
140
140b
140a
47
46
40
78
42
70
64
63
60
112
124
36
92a
37
74
34
206
125
82
132
166
135
126
134
136
62
12
118
120
121
119
130
128
130
114
117
116
110

Fig. 4.


72
76
46
100
97
90
92
91
95
42
80
78
36
40
132
82
34
68
71
64
12
206
86
128
60
160
158a
158
186
19
152
150
16
156
162
180
154
20a
28
30
24
14
98
93
146
50
22
154
144
29

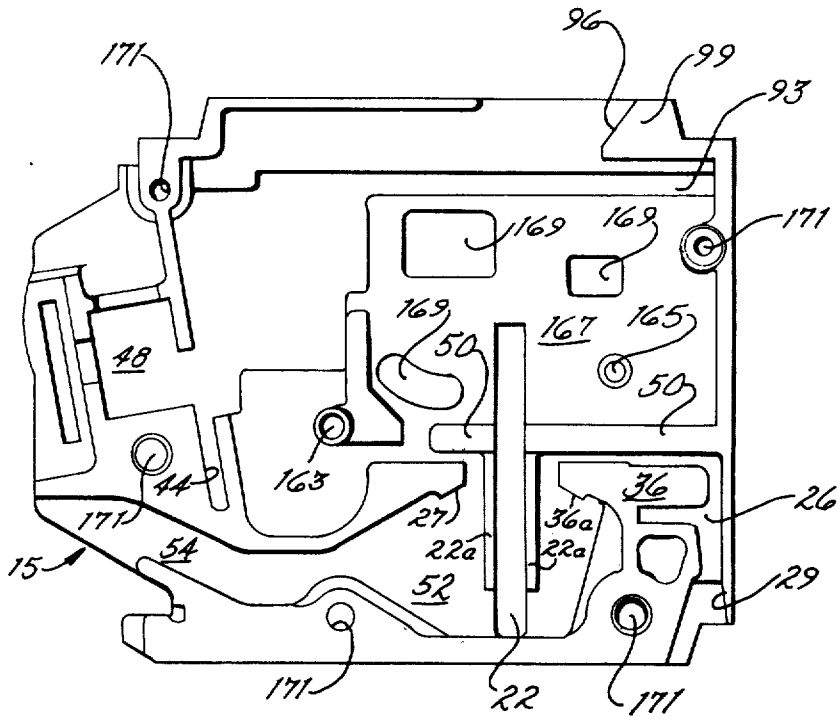

96
99
93
171
171
169
169
171
169
167
165
50
50
48
44
163
36
26
27
36a
22a
22a
54
52
15
129
171
22
171

Fig. 5.

METHOD FOR CALIBRATING AN ELECTRIC CIRCUIT BREAKER

BACKGROUND OF THE INVENTION

Current molded case circuit breaker designs do not lend to assembly by machines, and thus are assembled largely by hand. The operating mechanisms of these circuit breakers are almost universally designed as a toggle or overcenter mechanism using spring force to sustain the ON and OFF circuit breaker conditions. The assembly of such mechanisms is not conductive to automation since the operating spring must be loaded incident to assembly and the ends thereof hooked to or otherwise engaged with elements of the mechanism. Moreover, mechanism elements of currently available circuit breakers are invariably designed with portions extending over and under or otherwise partially encompassing other elements, thus necessitating intricate manipulations of the parts to effect interconnection and assembly. Equipment to automate the assembly of such parts would be prohibitively complex and expensive.

It is accordingly an object of the present invention to provide a method for assembling molded case circuit breakers.

An additional object of the invention is to provide a method of the above character wherein calibration of the circuit breaker is accomplished prior to completion of assembly.

Yet another object of the present invention is to provide a method for calibrating a molded case circuit breaker as an intermediate step in the assembly thereof.

Still another object is to provide an assembly method of the above character which may be performed by machine on an essentially automated basis.

Other objects of the invention will in part be obvious and in part appear hereinafter.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a method for calibrating and assembling, which method lends itself to being carried out with a minimum of hand labor and, in fact, can readily be performed by machine in an essentially automated fashion. To this end, the component parts of the circuit breaker are adapted for mounting and operative interconnection in a convenient and facile manner, fully within the capability of relatively non-complex material handling equipment.

Generally stated, the method of the present invention utilizes a fixture to temporarily positionally mount a frame to which some of the circuit breaker component parts are assembled. Additional component parts are then assembled on the frame, and then subassembly is transferred, en masse, to the base half of the circuit breaker case. The base then serves as a fixture for the completion of assembly.

The instant invention further includes the method of calibrating the thermal trip setting of the circuit breaker during the assembly process while the strip mechanism is mounted by the fixture. The fixture is referenced to a predetermined fixed spatial position, which also references the trip mechanism parts in space. A selected part of the trip mechanism is machined to remove manufacturing tolerances and thus establish a precise positional relationship between the trip mechanism parts acting in response to overload currents. As an important feature of the invention the machining is accomplished using a laser which has the capability of removing material without disturbing the position of the part.

For a further 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 plan view, with cover removed, of an embodiment of the present invention showing the positions of the various parts when the circuit breaker is in the open-circuit or OFF condition;

FIG. **2** is a plan view, with cover removed, showing the positions of the various parts when the circuit breaker is in the closed circuit or ON condition;

FIG. **3** is an exploded perspective view illustrating the initial assembly of various circuit breaker components into a subassembly using a fixture;

FIG. **3A** is a longitudinal, sectional view of an operating mechanism link, illustrating its unique configuration adapting it for assembly on the fixture of FIG. **2**;

FIG. **4** is an exploded perspective view illustrating the assembly of the sub-assembly of FIG. **3** and the remaining circuit breaker components into the base of the circuit breaker case.

FIG. **5** is a plan view of the cover of the circuit breaker case.

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

DETAILED DESCRIPTION

Referring now to the drawings, the circuit breaker, as best seen in FIGS. **1** and **2**, includes an operating mechanism, generally indicated at **10**, mounted by a plate **12** positioned within a circuit breaker case consisting of a base **14** (FIGS. **1** and **2**) and a cover **15** (FIG. **5**). Operating mechanism **10** reciprocates a member **16** carrying a pair of movable contacts **18***a*, **18***b* between positions of engaging and disengaging relation with a corresponding pair of fixed contacts, **20***a*, **20***b*. Movable contacts **18***a*, **18***b* are mounted on opposite ends of a conductive bridge member **19** supported by carrier **16**. The carrier member is, in turn, mounted for reciprocating movement in opposed grooves **22** molded in the case **14** and cover **15** (FIG. **5**). Fixed contact **20***a* is mounted on the turned-back end portion of a generally L-shaped line strap **24** lodged in opposed grooves **26** formed in the base **14** and cover **15**. The contact carrying, turned-back end portion of line strap **24** is backed by shoulders **27** molded in the base and cover. A conductive stab **28**, also lodged in groove **26**, cooperates with line strap **24** to provide a line terminal stab connector where the two parts exit the circuit breaker case at **29**. A spring clip **30** urges the stab connector portions of the line strap and stab together, so as to insure good electrical contact with a male line stab (not shown) in a circuit breaker panelboard.

The other fixed terminal **20b** is carried by the turned-back end portion of a load strap **34** which is positionally located within the case by opposed barriers **35** molded in the base and cover. Shoulders **35***a* of barriers back the contact carrying portion of load strap **34**. Load strap **34** is also affixed to frame **12** at **37** by suitable means, such as welding, and is also electrically connected to and serves to mount a bimetallic element **36**, included in a trip mechanism, generally indicated at **38**. The other upper end of bimetallic element **36** is

electrically connected by flexible conductive element **40** to an L-shaped terminal strap **42** having one leg lodged in opposed base and cover grooves **44.** The other leg of terminal strap **42** extends into the open interior of a load terminal lug **46** which is captured in opposed cavities **48** formed in the base and cover.

From the description thus far, it is seen that the circuit through the circuit breaker can be traced from the line stab terminal through line strap **24,** fixed contact **20***a*, movable contacts **18***a*, bridge **19,** movable contact **18***b*, fixed contact **20***b*, load strap **34,** bimetallic element **36,** braid **40,** and L-shaped terminal strap **42** to terminal lug **46.** It will be noted that mounting the fixed contacts on the turned-back end portions of the line and load straps is effective to generate magnetic blowout forces during an interruption which are operative to propel the arc from and arc chamber **52** out through a vent passage **54,** both molded in the circuit breaker base and cover. This magnetic blowout feature coupled with the double break contacts affords the circuit breaker of the present invention materially increased circuit interrupting capability. In addition, the base and cover are formed with cooperating barrier sections **50** on each side of the grooves **22** accommodating carrier member **16,** which are effective to prevent the arc from propagating up into the operating mechanism **10** of the circuit breaker.

Still referring to FIGS. **1** and **2,** the operating mechanism **10** includes a V-shaped operating arm **60** having an upper arm segment **60***a* and a lower arm segment **60***b*, the latter being apertured at a location approximate its mid-length to receive a pivot post **62** carried by frame **12** for pivotally mounting the arm **60.** The terminal portion of arm segment **60***b*, as seen in FIGS. **1** and **2,** engages the upper end of the movable contact carrier member **16** (best seen in FIG. **4**), while the terminal portion of arm segment **60***a* is apertured to receive a pivot post **63** carried adjacent the left end of a cam link **64,** thus pivotally interconnecting the operating arm **60** and the cam link.

Frame **12** carries a second post **66** adapted to pivotally mount a latch link **68.** The latch link carries a pivot post **69,** as does the right end of cam link **64,** as indicated at **70.** An arcuate link **71** is apertured adjacent each end to receive posts **69** and **70,** pursuant to interconnecting the latch link and the cam link. Under normal conditions, pawl tip **68***a* of latch link **68** abuts a latch **72** pivotally mounted on a third pivot post **74** carried by frame **12.** Latch **72,** in turn, carries an armature **76** which is attracted by an electromagnet **78** mounted in partial embracing relation with the bimetallic element **36.** A hairpin spring **80** positioned between the bimetallic element **36** and the latch **72** biases the armature **76** against a stop **12***a* formed on frame **12** so as to establish a maximum air gap between the armature and the electromagnet **78.** As will be seen, in the event of a short circuit, armature **76** is attracted toward electromagnet **78,** thereby pivoting latch **72** in the clockwise direction to release latch link **68** and trip the circuit breaker. A hook **82** is also mounted by bimetallic element **36** in position to engage and pivot the armature upon deflection of the bimetallic element in response to an overload condition, thereby disengaging the latch **72** from latch link **68** and causing a trip function.

Armature **76** is preferably coated with an insulative material, such as phosphate, silicone, varnish, etc., so as to preclude the possiblity of establishing a low impedance current path including hook **82** and armature **76** which would shunt the lower portion of bimetallic element **36,** including that portion about which the electromagnet is disposed. It will be appreciated that, should this be permitted to occur, the magnetic trip function of the circuit breaker would be defeated.

Upon release of latch link **68** by latch **72,** the operating mechanism **10** is released to enable an operating mechanism spring, in the form of a V-shaped leaf or hairpin spring **86,** to power the trip and reset functions of the circuit breaker. Spring **86,** as seen in FIGS. **1** and **2,** is retained in its operative position in a triangular-shaped aperture **12***b* in frame **12.** As will be described, resilient leg **86***a* of spring **86** acts on carrier **16** to separate the contacts and thus trip the breaker, and then resilient leg **86***b* acts to reset the operating mechanism **10** preparatory to reclosure of the circuit breaker contacts.

To accommodate manual operation of the circuit breaker, an operating handle, generally indicated at **90,** is slidingly mounted by the circuit breaker case. To this end, operating handle **90** is formed having a base **91;** the lateral edges thereof being formed as runners **92** which are received in opposed, elongated runner grooves **93** molded in the circuit breaker base and cover. A knob **95** extends upwardly through an opening **96** in the circuit breaker case so as to be accessible for digital handle manipulation. Handle **90** is further provided with an elongated central opening **97** in which is received an abutment **98** molded on the circuit breaker base. This abutment serves to define the extreme rightward, OFF position of handle **90.** A coil spring **100** is positioned in the central opening **97** between the right end thereof and the abutment. As seen in FIG. **1,** when the handle is in its rightmost, OFF position, spring **100** is essentially relaxed and unloaded. When the handle **90** is moved to its leftmost or ON position, against case abutment **99,** spring **100** is compressed between the abutment **99** and the right termination of the handle slot, thus acting to bias the handle toward its OFF position.

As best seen in FIGS. **1** and **2,** depending from the bottom of handle **90** is a cam **104** having a relatively steep leading cam face **104***a* to the left of a peak **104***b* and gradually sloping, trailing cam face **104***c* to the right of the peak. This cam, movable with handle **90,** operates on the right end of cam link **64** which is enlarged and rounded to provide a cam follower **64***a*. As seen in FIG. **2,** with handle **90** in the left or ON position, cam link follower **64***a* is bearing against the trailing cam surface **104***c* under the urgence of resilient leg **86***b* of operating mechanism spring **86,** thus maintaining the ON position of the handle against the bias of handle spring **100.**

With handle **90** in its rightmost OFF position, as seen in FIG. **1,** the handle cam **104** is to the right of the cam follower **64**a of cam link **64.** Resilient leg **86***b* of operating spring **86** therefore is capable of elevating the cam link, which is effective to pivot the latch link **68** counterclockwise to insure that its pawl tip **68***a* is above the level of the latching surface **72***a* of latch **72.** This OFF condition is also the reset condition the components assume immediately following a trip function.

As the handle **90** is moved to the left toward the ON position, the cam follower **64***a* of cam link **64** begins riding down on leading cam surface **104***a*. Cam link **64** is thus depressed, forcing, via link **71,** latch link **68** to

swing clockwise on its fixed pivot post **66** through a brief arc to the point where its pawl tip engages latching surface **72***a* of lattch **72.** With further clockwise pivotal movement of latch link **68** being constrained by latch **72,** continued movement of the handle **90** to the left forces the cam link **64** to also propagate downward and to the left. This causes the operating arm **60** to swing counterclockwise about its fixed pivot post **62,** raising arm segment **60***b* and with it the contact carrier **16.** Elevation of carrier **16** forces resilient leg **86***a* upwardly to load operating spring **86.** Depression and leftward movement of cam link **64** by handle cam **104** also forces resilient leg **86***b* of operating spring **86** downwardly. When the cam follower end **64***a* of the cam link reaches the peak **104***b* of handle cam **104,** carrier member **16** has been elevated to the point where the movable contacts engage the fixed contacts in slow-make fashion. At the conclusion of the leftward movement of handle **90** on its ON position, the cam follower end **64***a* of cam link **64** rides over the peak **104***b* of handle cam **104** onto the trailing cam surface **104***c* thereof. As previously noted, operating spring **86** presses the cam link follower **64***a* against the handle cam **104** with sufficient pressure to offset the bias of handle spring **100** urging the handle toward its OFF position, thus achieving a stable closed circuit condition.

In the event of an overcurrent condition sensed by bimetallic element **36** or a short circuit condition by electromagnet **78,** armature **76** is pivoted in the clockwise direction about pivot post **74,** causing latch **72** to release latch link **68.** The components of the operating mechanism are thus released to swing around generally in the clockwise direction under the urgence of operating spring **86.** More specifically, resilient leg **86**a of the operating spring forces the contact carrier **16** down to abruptly initiate contact separation. Operating arm **60** is thus pivoted about pivot post **62** in the clockwise direction, forcing cam link **64** to the right as seen in FIG. **2.** Latch link **68** swings clockwise about its pivot post **66** (as indicated in phantom in FIG. **2**), and the cam link follower **64***a* rides up on the trailing cam surface **104***c* of handle cam **104.** Movement of cam link **64** to the left is further assisted by the free end of resilient leg **86***b* of operating spring **86** acting against a sloping cam surface **64***b* provided along the lower edge of cam link **64.** The assistance of resilient leg **86***b* afforded to leg **86***a* is effective to accentuate the abruptness of contact separation in true quick-trip fashion. It should be noted that contact separation during a trip function is achieved without movement of the handle **90,** thus rendering the circuit breaker trip free. That is, the circuit breaker will trip under abnormal current conditions even though handle **90** is restrained in the ON position.

At this point, the trip function has been concluded, and a reset function is now initiated. Resetting of the circuit breaker is commenced by the return of handle **90** to its OFF position by handle spring **100.** As the cam link follower **64***a* rides down on the trailing cam surface **104***c* of handle cam **104,** cam link **64** is pivoted downwardly about its pivotal connection with operating arm **60.** The unrestrained latch link **68** pivots further in the clockwise direction to accommodate depression of the right end of cam link **64.** On continued movement of handle **90** toward its OFF position, the cam link follower **64***a* rides over the peak **104***b* of handle cam **104** and up the leading cam surface **104***a*. At this point, resilient leg **86***b* of the operating spring **86** raises the right end of cam link **64,** thereby pivoting latch link **68** in a counterclockwise direction about its pivot post **66.** When handle **90** reaches its OFF position, cam link follower **64***a* is to the left of leading cam surface **104***a* and the pawl tip **68***a* of latch link **68,** the operating mechanism **10** can be manipulated by handle **90** toward its closed circuit condition. If, however, the latch **72** is not returned to its latching position, it is seen that movement of the handle **90** toward the ON position merely depresses cam link **64,** resulting in clockwise rotation of latch link **68** without counterclockwise rotation of operating arm **60** about its pivot post **62.** As previously noted, the circuit breaker is trip free such that unlatching movement of latch **72** collapses the operating mechanism **10** should an attempt be made to close the circuit breaker on an abnormal circuit condition, such as short circuit.

To open the circuit breaker using handle **90,** it is seen that rightward movement of the handle from its position in FIG. **2** causes the cam link follower **64***a* to ride over the cam peak **104***b* and up the leading cam surface **104***a*. Cam link **64** is forced upward and to the right by leg **86***b* of operating spring **86,** causing operating arm **60** to swing clockwise. Arm segment **60***b* is lowered, releasing carrier **16** and spring arm segment **86***a* forces the carrier downward to separate the contacts.

Handle **90,** as seen in FIGS. **1** and **2,** carries a depending projection **107** which serves as a kicker for impacting against an upwardly extending projection **109** at the termination of arm segment **60***b* of operating arm **60** as the handle is returned to its OFF position by handle spring **100** should the contacts not initially separate during a trip function. It is seen that should the contacts become welded as the circuit breaker is attempting to execute a trip function, such that contact separation cannot be effected by operating spring **86** alone, release of latch link **68** by latch **72** will nevertheless permit handle **90** to return toward its OFF position. In so doing, kicker **107** will impact against projection **109** of operating arm **60** generally with sufficient force to break the contact weld and precipitate initial contact separation; full separation being effected by operating spring **86.** Under normal conditions, operating arm **60** will have been rotated about its pivot **62** in separating the contacts and thus the movement of projection **109** to the right precedes the rightward movement of kicker **107** so that impact therebetween is avoided.

The method of assembly of the circuit breaker is illustrated in the exploded assembly views of FIGS. **3** and **4.** Referring first to FIG. **3,** initial assembly, in accordance with the present invention, is carried out using a fixture, generally indicated at **110.** It will be appreciated that, in practice, fixture **10** is positioned horizontally against a reference stop, indicated at **112.** The fixture includes a block **114** mounting a series of upright, shouldered frame mounting posts **116, 117, 118** and a series of upright, shouldered link mounting posts **119,** 120, 121. A plate **124** secured to block **114** is suitably machined to provide a cavity **125** having a side entry, indicated at **126.**

The first assembly is, as illustrated in FIG. **3,** the mounting of the sub-assembly consisting of frame **12,** load strip **34,** trip mechanism **38,** flexible member **40,** terminal strap **42** and lugs **46** on the fixture **110.** This sub-assembly, generally indicated at **128,** is formed by welding fixed contact **20***b* to the turned-back end portion of load strap **34** and by welding the lower end of

the bimetallic element to the load strap. One end of flexible member **40** is welded to the upper end of the bimetallic element and the other end is welded to the L-shaped terminal strap **42.** Lug **46** is held captive on the other end of the terminal strap by the lug screw **47.** Electromagnet **78** and hook **82** are welded to the bimetallic element **36.** Load strap **34** is welded to the frame **37,** as previously described. Insofar as the present invention is concerned, the order of creation of this sub-assembly is not significant.

The corners at the left end of frame **12** are relieved, as indicated at **130,** such that the frame sits on the shouldered portions of mounting posts **116** and **117.** The necked-down terminations of these mounting posts engage the edge of the frame **12** to precisely locate this end of sub-assembly **128** on the fixture. The right end of frame **12** is seated on the shoulder of mounting post **118,** with the necked-down termination thereof projecting through an aperture **132** in the frame so as to precisely position the sub-assembly **128** on the fixture **110.** Thusly mounted, the necked-down terminations of link mounting posts **119, 120** and **121** project through apertures **134, 135** and **136,** respectively, in the frame **12.** Lug **46** is accommodated in cavity **125** of the fixture, with the extension of terminal strap **42** into the lug accommodated in the entry **126** into the cavity. It will be observed that mounting the frame on the shoulders of mounting posts **116–118** displaces the frame from the face of fixture block **114** in order that the lower edge of the load strap **34** and the lower portion of the trip mechanism **38** not rest on the fixture block.

It is an important feature of the present invention that the various parts of sub-assembly **128** are mounted on fixture **110** in precisely the same relative positions they ultimately assume in the circuit breaker case. Thus, while in the fixture, the bimetallic element **36** and hook **82** assume the same positions relative to the armature stop **12***a* carried by frame **12** as they will assume in the circuit breaker case. This makes it possible to calibrate the thermal trip setting of the circuit breaker at this point in the assembly. This is in dramatic departure from the existing practice of providing a calibrating screw in the circuit breaker case which, after completed assembly of the circuit breaker, is selectively turned to adjust the orientation of the bimetallic element so as to achieve the requisite coupling relationship between it and the latch for the thermal trip setting desired.

It will be appreciated that with the manufacturing tolerances permitted in each of the sub-assembly parts and the joining and mounting of the sub-assembly parts, the positional relationship of the hook tip **82***a* and the armature stop **12***a* of frame **12** will vary from sub-assembly to sub-assembly. As can be seen from FIGS. **1** and **2,** this positional relationship establishes the spacing between the armature **82** and the hook, and thus the extent of free travel of the armature to begin pivoting the latch **72** out from under the latch link **68** incident to an overload trip function. Obviously, deviations in this spacing of free travel of the bimetallic element will create corresponding deviations in the thermal trip setting of the circuit breakers.

To establish a uniform spacing between the hook tip **82a** and the armature **76** from circuit breaker to circuit breaker, it is an important feature of the present invention to utilize a laser **140** to trim away the hook tip while the sub-assembly is in fixture **110.** Since the fixture is spatially positioned against stop **112** and the sub-assembly **128** is precisely spatially positioned by the fixture, laser **140,** fixedly positioned to direct a beam **140***a* toward the hook tip, is capable of removing precisely the correct amount of material so as to achieve the requisite positional relationship between the hook tip and the armature stop **12***a*. Since, as seen in FIGS. **1** and **2,** armature **76** is biased against the armature stop **12***a*, the requisite amount of free travel for the thermal trip setting desired can thus be automatically established with precision from unit to unit. It will be appreciated that, if desired, the circuit breaker could be calibrated without bimetal free travel, in which case the hook tip **82***a* is trimmed such that the armature **76** is normally in essentially abutting relation with hook tip **82***a*. The use of the laser beam to calibrate the thermal trip setting has the distinct advantage of not creating any forces tending to deflect the bimetallic element **36** during the machining of the tip **82***a* of hook **82.** Thus, calibration uniformity from circuit breaker to circuit breaker is readily achieved.

It will be appreciated that calibration may also be accomplished by laser trimming the armature stop **12***a* rather than the hook tip **82***a*, as indicated by laser beam **140***b*. Alternatively, a projection on the armature which abuts the armature stop **12***a* could be trimmed.

After calibrating the thermal trip setting, cam link **64** is mounted on the necked-down terminations of link mounting posts **119** and **121** projecting through apertures **134** and **135** in frame **12.** To accommodate this mounting of cam link **64** on fixture **110,** this element, as seen in FIG. **3A** is formed with recesses **63***a* and **70***a* in its back surface in registry with pivot posts **63** and **70,** respectively, formed on the opposite surface. The registered recesses and pivot posts can be readily simultaneously formed on opposite sides of the cam link in a simple stamping operation effective to offset the link material. The necked-down terminations of link mounting posts **119** and **121** are received in the recesses **63***a* and **70***a*, respectively, of cam link **64** to locate this element relative to the frame **12.** Operating arm **64** to locate this element relative to the frame **12.** Operating arm **60** is then dropped into place with frame pivot post **62** received in the aperture formed in the terminal portion of arm segment **60***a*. It will be seen that the positional mounting of the cam link **64** by link mounting posts **119** and **121** establishes the requisite positional relationship between pivot posts **62** and **63** such that the operating arm **60** can be merely dropped into place by automated equipment.

Latch link **68** is then pivotally mounted on the frame pivot post **66.** In order to properly orient the latch link for assembly, a recess (not shown) formed in the back surface of the latch link in registry with pivot post **69** receives the necked-down termination of link mounting post **120** of fixture **110.** This recess is formed in the same fashion as previously described in connection with cam link **64** and illustrated in FIG. **3A**. With the pivot post **70** of cam link **64** and pivot post **69** of latch link **68** in proper relative positions, link **71** with apertures at each end to receive these pivot posts is merely dropped into place to pivotally interconnect the cam and latch links. It is seen that the link mounting posts **119–121** serve the important function of spatially orienting each operating mechanism link as it is dropped

into place such that interconnection of the links can be effected simply using automated equipment.

Once the operating mechanism links have been pivotally interconnected, the function of the link mounting posts **119–121** has been served, and the assembled parts of FIG. **3** can be transferred to the base **14** of the circuit breaker case, as illustrated in FIG. **4**. Base **14** is provided with molded, shouldered posts **144, 145, 146,** equivalent to posts **116, 117, 118** of fixture **110,** for positionally mounting the partial assembly transferred from the fixture of FIG. **3**. Thus, frame **12** rests on the shoulders of these case mounting posts, with the necked-down terminations of posts **144** and **145** accommodated in the left end corner reliefs **130** of frame **12** to locate that end of the partial assembly in the base **14,** and the necked-down termination of post **146** is received in frame aperture **132** to precisely locate the other end of the partial assembly. The lug **46** is dropped into base cavity **48** with load terminal strap **42** accommodated in base groove **44.**

The line strap **24** and stab **28** are dropped into groove **26** in the base **14,** and spring clip **30** is fitted about the stab termination of these two members. The latch **72**-armature **76** combination is placed on its pivotal mounting post **74** carried by frame **12.** Hairpin armature spring **80** is placed between armature **82** and bimetallic element **36** to bias the former against stop **12***a* on frame **12.** Handle **90** is dropped into place in its OFF or far right position with its lower runner **92** accommodated in runner groove **93** formed in base **14.** Handle spring **100** can then be dropped into the opening **97** in handle **90** between the abutment **98** on base **14** and the right end of the handle opening.

Contact carrier **16** is structured so as to permit its assembly in a facile manner fully within the capability of automated handling equipment. Thus, as seen in FIG. **4,** carrier **16** is in the form of an elongated rectangular member formed of insulating material having a lower elongated opening **150.** Bridge **19** bearing the movable contacts **18***a*, 18*b* is provided with opposed notches **152** located essentially at mid-length which engage the contact carrier **16** along the sides of the opening **150** therein. A spring **154** captured in opening **150** beneath the bridge **16** biases the movable contacts upwardly against the upper end of opening **150.** It will be appreciated that this resilient mounting of the movable contacts to contact carrier **16** serves, during contact closure, to insure proper seating of the movable contacts on the fixed contacts with adequate contact pressure.

The upper portion of carrier **16** is formed with spaced projections **156** and **158**; the former being essentially straight and the latter having its terminal portion turned inwardly to provide a hook **158***a*. The hooked end **158***a* of projection **158** terminates short of projection **156** to provide a gap **160** affording longitudinal entry into the opening **162** between projections. To assemble this movable contact carrier sub-assembly to the previously assembled parts, gap **160** is of a width slightly in excess of the combined thicknesses of the terminal portion of arm segment **60***b* of operating arm **60** and frame **12.** Thus, in assembling the movable contact carrier sub-assembly, carrier **16** is lined up with groove **22** in base **14** and, from a slightly elevated position below the end of arm segment **60***b* in its orientation shown in FIG. **1,** is moved upwardly. Terminal portion of arm segment **60***b* and the portion of the frame therebelow enter gap **160** in carrier **16.** Once the terminal portion of operating arm segment **60***b* moves into opening **162** beyond gap **160,** the contact carrier sub-assembly is released to drop into its operating position. So positioned, it will be noted that the terminal portion of operating arm segment **60***b* is caught under the hooked termination **158** and thus the operating arm **60** is capable of moving the carrier **16** upwardly to bring the contacts into engaging relation.

The cover **15** of FIG. **5** is essentially a mirror image of the base **14** of FIGS. **1, 2** and **4.** The major difference between the cover and base is the formation of molded pads **163** and **165** on the cover; which, with the cover in place, bear against the terminations of frame pivot posts **62** and **74,** respectively, to preserve the pivotal mountings of operating arm **60** and latch **72.** The wall **167** of cover **15** bears lightly against link **71** and the terminal portion of operating arm segment **60a** to preserve their pivotal connections with posts **69, 70** and **73.** Depressions **169** molded in cover wall **167** afford clearance for the terminals of these pivot posts as they move about during articulation of operating mechanism **10.** To further insure against arc propagation up into the operating mechanism area, the grooves **22** in the base and cover accommodating the reciprocating carrier **16** are provided with raised sides **22***a*, as best seen in FIG. **5.** Finally, the base and cover are provided with holes **171** registering upon application of the cover to the base for the acceptance of rivets (not shown) serving to maintain the circuit breaker case enclosure.

It will thus be seen that the objects set forth above, among those made apparent in the preceding description, are efficiently attained and, since certain changes may be made in the above method 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 the invention, what is claimed as new and desired to secure by Letters Patent is:

1. A method of calibrating the thermal trip setting of a thermalmagnetic trip mechanism utilized in an electric circuit breaker, wherein the trip mechanism includes a bimetallic element deflectable in response to overload current through the circuit breaker, an electromagnet mounted by the bimetallic element and responsive to high magnitude fault current levels for attracting an armature, movement of the armature unlatching the circuit breaker operating mechanism to trip the circuit breaker, an armature stop for establishing the quiescent position of the armature, and a hook mounted by the metallic element and having a tip for engaging and moving the armature to trip the circuit breaker upon deflection of the bimetallic element in response to sustained overload current levels, said method comprising the steps of:

A. placing the trip mechanism in a fixture with the parts thereof assuming relative positions identical to the relative positions they would normally assume in an operative circuit breaker;

B. referencing the fixture in a predetermined fixed spatial position; and

C. machining away a portion of a particular part of the trip mechanism so as to establish a predetermined operative positional relationship between

the hook and the armature when positioned against the armature stop.

2. The method defined in claim 1, wherein a portion of the hook tip is machined away.

3. The method defined in claim 1, wherein a portion of the armature stop is machined away.

4. The method defined in claim 1, wherein said machining step is performed by a laser beam trained on a particular part of the trip mechanism.

5. The method defined in claim 4, wherein the laser beam is trained on the hook tip.

6. The method defined in claim 4 wherein the laser beam is trained on the armature stop.

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