

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) COMPACT CIRCUIT BREAKER CONSTRUCTION

(71) We, GENERAL ELECTRIC COMPANY, of 1 River Road, Schenectady 12305, State of New York, United States of America; a corporation organised and existing under the laws of the State of New York, United States of America do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Over the past several years, there has been a growing demand for reduction in the width of circuit breakers so as to facilitate minimization of the panel board assemblies or the utilization of a pair of circuit breakers side-by-side on a single line stub of a panel board which might otherwise seat only a single larger width breaker. Efforts to reduce the size of the operating elements have produced many problems due to the fact that the breakers must still be capable of handling the short circuit currents without damage and must still be capable of effective, sure-fire and rapid operation to terminate the flow of current therethrough. Further difficulties have been encountered in the diminution of size by reason of the problems attendant to assembling various parts which have been redesigned in an effort to reduce the width of the assembly.

It is an object of the present invention to provide a novel circuit breaker construction readily adapted to casings of relatively small width and nevertheless able to carry short circuit currents effectively while affording long-lived operation.

It is also an object to provide such a circuit breaker construction utilizing operating elements which may be fabricated and assembled with relative facility and economy.

Another object is to provide such a circuit breaker construction wherein the casing co-operates in large measure with the operating elements to minimize the number of parts, the size thereof and the optimum inter-relationship therebetween.

According therefore to our invention an electric circuit breaker comprises a casing having a top wall and opposed generally planar side walls; an operating handle pivotally supported in said casing on a pivot axis adjacent said top wall and having a lower portion thereof extending inwardly of said casing, said lower portion being positioned closer to one of said side walls of said casing than to the other; a releasable cradle of relatively thin sheet metal pivotally supported in said casing at one end and having a latch surface at its other end and having its intermediate portion extending close to said lower portion of said handle at the side thereof opposite said one side of said casing; a latch member pivotally supported in said casing and releasably engaging said latch surface of said releasable cradle, a contact arm of relatively thin sheet metal having an upper portion extending along the side of said lower portion of said handle opposite said intermediate portion of said releasable cradle between said lower portion of said cradle and said one side of said casing and having a pivotal engagement with said lower portion of said handle, said engagement providing the sole support of said contact arm on said handle; said contact arm having its lower portion offset in a direction away from said one wall of said casing toward said other wall, both of said upper and lower portions of said contact arm comprising generally planar sheet metal portions having their major flat surfaces extending generally parallel to said casing side walls and being joined by an intermediate portion extending at an angle to said casing side walls; a tension spring extending between said intermediate portion of said releasable cradle and said intermediate portion of said contact arm to provide a toggle-action assembly comprising said contact arm and said operating handle; said contact arm having a contact portion at the end thereof opposite said upper portion, said contact portion extending substantially perpendicular to the planes of said side walls of

said casing, and guide means carried by said other one of said side walls of said casing maintaining the path of pivotal movement of said contact arm generally parallel to the major planes of said side walls.

The aforescribed assembly permits significant diminution in width of the casing and operating mechanism while at the same time providing rapid and effective opening and closing of the contacts. This arrangement also permits the use of ribs on the casing to substantially divide the interior thereof into three relatively isolated compartments separating the arcing area about the path of relative movement of the two contacts from the operating mechanism and from the thermal-magnetic tripping mechanism so that the effect of hot gases generated by arcing upon other components may be minimized and separation of the operation of the operating mechanism from the thermal-magnetic tripping mechanism also permits minimization of the possible effect of hot gases passing from a coupled circuit breaker into the casing.

In operation of the mechanism, pivoting of the operating handle between "on" and "off" positions will produce a toggle action on the contact arm rapidly opening and closing the movable and stationary contacts by reason of the powerful nature of the spring which may be employed. However, the guide means ensures proper alignment of the contact arm with the stationary contact and with the spring so as to achieve maximum efficiency therefrom.

Upon release of the cradle by the latch member, the cradle will be pivoted downwardly by action of the spring and the line of action of the spring will move past the pivot point between the contact arm and the operating handle. As a result, the spring will rapidly open the contacts by pulling upwardly on the contact arm. Thus, the configuration of the several elements and their relative disposition enables the use of a powerful toggle spring and optimum interaction both in manual operation of the breaker and in tripping as a result of thermal-magnetic operation.

The interconnection and form of the several elements may be varied as will be pointed out more fully hereinafter in the succeeding section of the specification.

The invention will become more readily apparent from the following description of a preferred embodiment thereof shown, by way of example, in the accompanying drawings, in which:

Figure 1 is a side elevational view of an electric circuit breaker embodying the present invention with one side of the insulating casing removed to show internal construction;

Figure 2 is a sectional view of the circuit

breaker of Figure 1 generally along the line 2—2 thereof;

Figure 3 is an exploded view of the circuit breaker of Figure 1;

Figure 4 is a front end elevational view thereof;

Figure 5 is a sectional view thereof generally along the line 5—5 of Figure 4;

Figure 6 is a fragmentary sectional view to an enlarged scale generally similar to the sectional view of Figure 2;

Figure 7 is a fragmentary sectional view generally along the line 7—7 of Figure 5;

Figure 8 is a fragmentary sectional view of a circuit breaker employing an alternate embodiment of guide construction for the contact arm;

Figure 9 is a perspective view of the contact arm guide insert of Figure 8;

Figure 10 is a fragmentary, partially diagrammatical view showing the operating mechanism in the "on" condition; and

Figure 11 is a similar view showing the operating mechanism in the "tripped" condition.

Referring now to Figures 1—7 of the drawings in detail, an electric circuit breaker embodying the present invention has a molded insulating casing provided by a pair of inter-fitting sections generally designated by the numerals 10, 12 which are secured together by fasteners (not shown) seated in apertures 14 therein. Each of the sections has a complex interior surface configuration providing ribs, shoulders, apertures and recesses as will be described more fully hereinafter in connection with the various parts of the operating mechanism.

At the front end of the casing is a line terminal generally designated by the numeral 16 which has at one end a pair of clamping jaws 18 biased together by a spring clip 20 and extending through an aperture in the wall of the sections 10, 12 for engagement with a stab or contact of a panel board (not shown). The terminal 16 fits over a shoulder or rib 21 formed on the casing sections 10, 12 and has a stationary contact 22 at its other end.

A movable contact 24 is carried by the lower end of the contact arm generally designated by the numeral 26 for movement into and from electrical engagement with the stationary contact 22. As best seen in Figures 2 and 6, the contact arm 26 is fabricated from sheet metal to minimize thickness of the breaker and has a laterally extending finger 28 at its upper end which is pivotably mounted in the aperture 30 of the operating handle generally designated by the numeral 32. The upper portion 34 of the contact arm 26 is generally planar and extends adjacent the sidewall 36 of the casing section 12 and to the side of the operating handle 32. At its center is an offsetting portion 38 with a pair of apertures 40 therein and extending transversely

of the casing below the operating handle 32. The lower portion 42 of the contact arm 26 is generally L-shaped with its vertical portion extending generally planar adjacent the sidewall 44 of the casing section 10 and its horizontal portion carrying the movable contact 24.

Engaged at one end in the apertures 40 of the contact arm 26 is a tension spring 46 which has its other end engaged in a notch or recess 48 in the upper edge of the cradle generally designated by the numeral 50. In this manner, the spring 46 applies biasing pressure on the contact arm 26 toward the handle 32 and cradle 50 which ensures rapid snap action into open or closed contact position as it pivots about the handle 32. As best seen in Figure 6, by having the upper edge of the finger 28 cut at a slight angle to the horizontal (about 8 to 15 degrees) and a co-operating taper in the aperture 30 of the handle 32, the upper portion 34 of the contact arm 26 is drawn toward the side surface of the handle 32 for sliding movement thereon to avoid friction on the casing sidewall 12 and also facilitate retention of the elements during assembly. The lower portion 42 slides along the surface of the rib 45 and on the sidewall 44 of the casing section 10.

The operating handle 32 (fig. 3) has a hub portion 52 with diametrically extending ribs 54 on either side having a notch 56 in the upper edge thereof and which pivotably seat in cooperatively configured and dimensioned generally butterfly-shaped recesses 58 in the sidewalls 36, 44 of the casing sections 10, 12 so as to be pivotably supported thereby. A grip portion 60 extends outwardly of the casing through an aperture 62 in the top wall 64 of the casing sections 10 for manual engagement. A depending portion or extension 68 extends forwardly of the casing and has the aperture 30 therein pivotably supporting the contact arm 26.

The cradle 50 is a relatively thin member disposed between the operating handle 32 and the sidewall 44 of the casing 10. It has a generally inverted U-shaped configuration with a pair of legs 70, 72 and a center portion 74 having the notch 48 in its upper edge into which the spring 46 is hooked. The forward leg 70 has a generally circular end portion 76 which is pivotably retained in cooperatively configured recesses 78 formed in the sidewalls 36, 44 of the casing sections 10, 12 so that the cradle 50 may pivot thereabout. To prevent binding of the cradle 50 between the casing sections 10, 12 due to deflecting pressure on the sidewalls, a spacing boss 80 is provided on the sidewall 44 of casing section 10 which extends through an elongated slot 82 in the cradle rear leg 72 and bears against the rib 74 on the sidewall 36 of the casing section 12. As the cradle 50 pivots about the end portion

76, the boss 80 will slide freely within the slot 82 thereof.

At its upper end, the cradle front leg 70 has a laterally inwardly extending tab 84 at its front edge which is adapted to be engaged by the depending portion 68 of the operating handle 32 when it is moved to the "off" position shown in Figure 1 so as to produce pivoting of the cradle 50 from the "tripped" condition shown in Figure 11. The further pivoting of the handle 32 in the clockwise direction past the "off" position lifts the cradle 50 into the latched condition. Similarly, when the cradle 50 is released and pivots upon tripping of the breaker mechanism, the line of action of the spring 46 crosses the pivot point 28 of the contact arm 26 on the handle 32 as this occurs, the rotational bias of this spring on the handle is reversed, rotating the handle clockwise as viewed until the portion 68 of the handle strikes the tab 84 of the cradle 50. A second laterally inwardly extending tab 86 is provided on the rear edge of the front leg 70 at a point spaced downwardly from the tab 84 so that it will strike the contact arm 26 upon tripping of the breaker in the event that the stationary contact 22 and movable contact 24 are fused together by a short circuit current and, thus break them apart.

The rear leg 72 of the cradle 50 has a latch portion 88 at its lower end providing a shoulder or edge which is latched or engaged with a tab 90 adjacent the lower end of the latch member, generally designated by the numeral 92, in the normal operating or untripped condition of the breaker. The upper end portion of the latch member 92 has laterally extending shoulder portions 94a, 94b with rearwardly extending arms 96a, 96b at the lower end thereof, and the shoulder portion 94a seats in the recess 98 in the sidewall 44 of the casing section 10. The arms 96a, 96b slidably seat on a downwardly tapering shoulder 100 of the recess 98 in the sidewall 44 of the casing section 10.

As shown in fig. 3, engaging the arms 96a, 96b of the latch member 92 is a laterally extending finger 110 of a magnet member generally designated by the numeral 112. The finger portion 110 slants with respect to the plane of the latch member 92. The latch member pivots on and is biased about the bottom edge of the finger 110 of the magnet member 112 in a clockwise direction and into latching condition by a compression spring 106. A recess 108 in the sidewall 44 of the casing section 10 provides a seat for one end of the spring 106 and the other end fits over a forwardly extending tang 10 (fig. 3) upon the upper end of the latch member 92 spaced above the point of its pivot with the magnet member 112.

The magnet member 112 pivots about a point on a rearwardly angled shoulder 113

of the recess 98 in the sidewall 44 which is spaced slightly above the pivot point between the magnet member 112 and latch member 92. As a result, the spring pressure on the latch member 92 above its pivot with the magnet member 112 produces a scissors-type action with the result that the latch member 92 tends to rotate in a clockwise direction and the magnet member 92 tends to pivot in a counter-clockwise direction. The pivot point for both members to act in unison is the pivot point of the magnet member 112 on the shoulder 113 of the recess 98.

The magnet member 112 is fabricated from a magnetically susceptible metal and has a field portion 114 of generally U-shaped cross section opening toward the latch member 92 adjacent the lower end thereof and an arm portion 116 extending upwardly from one leg of the field portion 114 along the sidewall 36 of the casing section 12 with the finger 110 at the upper end thereof. A generally U-shaped hook element 118 of non-magnetic metal extends forwardly from the other leg of the field portion 114 and engages the lower end of the latch member 92 in the normal operating condition.

An elongated bimetallic strip 120 extends through the field portion 114 of the magnet member 112 from a recess 122 in the casing sidewall 44 spaced rearwardly of the recess 98 having a rearwardly tapering rear wall 123 and wherein its upper end is joined to the terminal strap 124 by brazing, welding or the like. A flexible conductor 126 extends between its lower end below the field portion 114 and the center portion 38 of the contact arm 26 to provide the electrical path through the breaker from the terminal strap 124. The terminal strap 124 extends through a slot 128 in the casing section 10 after passing about an inwardly projecting boss 129 (fig. 1) on the casing section 10 so that it and the wall 123 provide a two point support for the strap 124 maintaining an intermediate portion thereof in spaced relation to the wall surface of the casing section 10 therebetween. The outer end of the conductor strap 124 has a load terminal 130 thereon disposed in cooperatively configured recesses 132, 134 in the casing section sidewalls 36, 44 to secure a conductor (not shown) from a load thereto. The terminal strap 124 is secured in the casing by a retaining screw 136 which is threadably engaged therein and extends through a slot 138 (fig. 3) in the casing section 10. By turning the screw 136, the center portion of the strap 124 between the wall portion 123 and boss 129 can be drawn toward the wall surface adjacent the screw 136 to produce deflection. Thus, the upper end of the terminal strap 124 and the bimetallic strip 120 may be displaced forwardly within the recess 122, thus altering the support point of the bimetallic strip and thereby permitting calibration to

a desired temperature rise before it will act upon the magnet member 112 to effect tripping of the breaker.

To assist in heat dissipation and extinguishing of an arc drawn between the contacts 22, 24 upon opening thereof, a metal arc chute 140 is provided which is trapped in position by bosses 142 on the sidewalls 36, 44 of the casing sections 12, 10. Hot gases are vented through the channel 144 provided in the sidewalls 36, 44 of the casing sections 12, 10. An insulating element 146 is fitted over the line terminal 16 and tends to isolate the line terminal 16 from the surrounding structure and provide a better dielectric path.

As best seen in Figure 5, the interior of the breaker casing is effectively divided into three relatively distinct and isolated compartments. The first compartment, indicated by the letter A, is that containing the stationary contact 22 and in which the movable contact 24 moves into and from contact therewith. It is defined by the rib 45 (fig. 3) on the casing sidewall 44 and the cooperating rib 47 on the casing sidewall 36 and the ribs 148 on the casing sidewalls 36, 44 spaced from the bottom walls 150, 152 of the casing sections 10, 12 which define the vent channel 144. Above the ribs 45, 47 in the chamber designated by the letter B which contains the principal portion of the operating mechanism. Dividing the chamber B from the chamber C, which contains the tripping mechanism, are cooperating ribs 154, 156 on the casing sections 10, 12. The degree of isolation of the several segments is highly desirable since it minimizes the effect of hot gases generated by arcing upon the operating mechanism, upon the tripping mechanism and upon the tripping mechanism of an adjacent breaker in the event that a multi-pole break arrangement is employed so that hot gases might pass from one breaker casing to another.

By having the contact arm 26 extend upwardly along the side of the operating handle 32 for pivoting in that side which is opposite to the side along which the cradle 50 extends and by disposing the operating spring 46 therebetween, the operating mechanism is thus reduced to a relatively small width while at the same time permitting the use of a relatively highly powered tension spring of optimum operation of the breaker. Similarly, the remaining operating mechanism may be formed from elements which are relatively small in the dimension transversely of the casing to permit a compact circuit breaker construction.

Since the upper portion 34 of the contact arm 26 is pivoted to one side of the operating handle 32 and thereby at a point spaced from the line of action of the spring 46 which extends between it and the cradle 50, the spring 46 exerts a torque upon the contact arm 26 tending to rotate it toward the side-

wall 44 of the casing section 10. Since it is important that the contact arm 26 be maintained in proper parallel alignment with the line of action of the spring 46 and other elements for proper operation, the rib 45 provides a bearing support along which the lower portion 42 may slide and thus maintain it in the proper alignment. Assembly of the contact arm 26, cradle 50, spring 46 and operating handle 32 is facilitated by the cooperating tapers of the finger 28 on the contact arm 26 and the wall of the recess 30 in the operating handle 32 since these tapers under action of the spring 46 will tend to maintain the elements in assembly within the casing section 10 until the casing section 12 is applied to complete the closure.

In operation of this embodiment, current flows from the line terminal 16 to the contact arm 26 through the closed contacts 22, 24 and thence to the bimetallic strip 120 through the flexible conductor 126. As the current flow upwardly through the bimetallic strip 120 to the terminal strap 124, a magnetic field is generated in the field portion 114 of the magnetic member 112 which attracts the latch member 92 toward it. The biasing pressure of the compression spring 106 is sufficient to offset the magnetic attraction thus generated during normal operation of the breaker. The normal spacing or magnetic gap of the two members is determined by the hook element 118 which engages the two and prevents them from pivoting apart to a greater distance. However, upon generation of a sudden high overload current of predeterminable magnitude, the magnetic field will be increased sufficiently to overcome the pressure of the spring 106 and pivot the latch member 92 and magnet member 112 relatively to each other. Initially, the magnet member 112 will tend to pivot toward the latch member 92 until further movement is blocked by the bimetallic strip 120. Thereafter pivoting of the latch member 92 toward the magnet member 112 will take place until the latch portion 88 of the cradle 50 slides from the tap 90 on the latch member 92.

Upon release of the latch portion 88 of the cradle 50, the spring 46 pivots the cradle 50 downwardly or clockwise as seen in Figures 10 and 11 about the pivoted circular end portion 76. As the cradle 50 pivots, the line of action of the spring 46 passes the pivot point for the contact arm 26 in the operating handle 32 with the result that the toggle action snaps the contact arm 26 about its pivot in a counterclockwise direction to open the contacts 22, 24, and produce the tripped condition indicated in Figure 11. Pivoting of the contact arm 26 is limited by the ribs 148 on the casing sidewall 44. Since the line of action of the spring 46 crosses the pivot point 28 of the contact arm 26 on the handle 32 as this occurs, the rotational

bias of this spring on the handle is reversed, rotating the handle clockwise as viewed until the portion 68 of the handle strikes the tab 84 of the cradle 50.

Resetting of the breaker mechanism is effected by pivoting the operating handle 32 from the tripped position shown in Figure 11 in the clockwise direction to the full extent permitted which produces pivoting of the cradle 50 by reason of the abutment of the depending portion 68 against the front tab 84. This elevates the rear leg 72 until the latch portion 88 clears the tab 90 on the latch member 92 which is biased by the spring 106 toward the cradle 50 to produce latching thereof and the condition illustrated in Figure 1. Tripping of the breaker can also be effected by a sustained short-circuit current of low magnitude which will produce bending of the bimetallic strip 120 in the direction of the transverse web of the field portion 114 of the magnet member 112. As the bending continues, the bimetallic strip 120 will bear against the field portion 114 and pivot the magnet member 112 in a counterclockwise direction which, in turn, will draw or pivot the latch member 92 in the same direction by reason of the engagement of the hook element 118 therewith. As pivoting continues, the tab 90 disengages from the latch portion 88 of the cradle 50 and tripping occurs.

In the illustrated embodiment, there is also shown means for effecting common tripping action with another breaker in a multi-pole arrangement. A common tripping member, generally designated by the numeral 158 (fig. 3) is of elongated nature and has ears 160 adjacent the upper end thereof which pivotably seat in recesses 162 in the sidewalls 36, 44 of the casing sections 12, 10. At its lower end it has a transversely extending bar 164 adapted to bear against the latch member 92 upon pivoting thereof in the counterclockwise direction so as to effect release of the cradle 50 in the event of pivoting thereof by action of another breaker through a trip interlock (not shown) seated in the slot 166 therein. Upon tripping of the breaker through action of either the thermal or the magnetic tripping means, the cradle 50 will strike against the lower portion of the common tripping member 158 to produce pivoting thereof in the counterclockwise direction which is thereby translated into equivalent movement of a common tripping member in another breaker coupled therewith.

Manual operation of the breaker between "on" and "off" positions is readily effected through pivoting of the operating handle 32 between the positions shown in Figure 1 and Figure 10. As the depending portion 68 pivots the upper end of the contact arm 26 through the line of action of the spring 46, the resultant toggle action opens or closes the contacts 22, 24.

In the embodiment of Figures 8 and 9, the lower portion 42 of the contact arm 26 slides in the L-shaped slot 268 of a separate insulating element 270 which is frictionally engaged between a pair of ribs 272 on each of the sidewalls 236, 244 of the casing sections. In this manner, a material may be employed which has higher dielectric properties than that of the casing sections. The ribs 272 and insulating element 270 generally function similarly to the ribs 45 and 148 in the embodiment of Figures 1 through 7 in separating the two chambers A and B and providing a guide for maintaining the desired alignment of the contact arm 26 against the torque produced thereon by the spring 46.

In the illustrated embodiments, the contact arm has had a laterally projecting finger or tab pivotally seated in a cooperating recess formed in the operating handle. However, it will be appreciated that the contact arm can also be pivotally mounted at the side of the operating handle upon a laterally projecting boss or shoulder formed in the handle albeit with lesser effectiveness in operation and assembly. Similarly, a pivot portion on the contact arm can be trapped between cooperating surfaces at the side of the operating handle and the casing sidewall. The illustrated embodiment is considered to be most advantageous in that it tends to maintain the parts in assembly prior to mounting the cover section of the casing and also minimizes the amount of surface contact between the contact arm and the casing sidewalls.

The cradle can be pivoted about a pin or have a lateral projection pivoted in an aperture in one sidewall of the casing rather than utilizing the cooperating recesses in both sidewalls of the casing. The illustrated embodiment minimizes the number of parts and facilitates assembly while generally conforming to the desirable concept of providing some isolation between the several subassemblies of the breaker mechanism.

Although the thermal-magnetic tripping mechanism illustrated is optimum from the standpoint of compactness and ease of construction and assembly, it will be appreciated that conventional thermal-magnetic mechanisms may be substituted therefor with some loss in benefits or possible reduction in efficiency of operation. If so desired, the common tripping member may be omitted from the assembly and the interior configuration of the casing modified to reflect the omission. However, most desirably versatility in the use of the circuit breaker is afforded by providing the illustrated configuration with means for mounting the common tripping members when desired.

Thus, it can be seen from the foregoing detailed specification that the circuit breaker of the present invention is readily adapted to relatively small widths while still affording

a highly effective means for handling substantial short circuit currents. The components thereof are readily fabricated from relatively economical materials and may be assembled rapidly and easily. The parts themselves enjoy a highly beneficial interrelationship which permit minimization of the number of parts and their size while affording optimum coaction therebetween.

Other features of the invention hereinbefore described are claimed in co-pending application No. 37389/68 (Serial No. 1,227,806).

WHAT WE CLAIM IS:—

1. An electric circuit breaker comprising a casing having a top wall and opposed generally planar side walls; an operating handle pivotally supported in said casing on a pivot axis adjacent said top wall and having a lower portion thereof extending inwardly of said casing, said lower portion being positioned closer to one of said side walls of said casing than to the other; a releasable cradle of relatively thin sheet metal pivotally supported in said casing at one end and having a latch surface at its other end and having its intermediate portion extending close to said lower portion of said handle at the side thereof opposite said one side of said casing; a latch member pivotally supported in said casing and releasably engaging said latch surface of said releasable cradle, a contact arm of relatively thin sheet metal having an upper portion extending along the side of said lower portion of said handle opposite said intermediate portion of said releasable cradle between said lower portion of said cradle and said one side of said casing and having a pivotal engagement with said lower portion of said handle, said engagement providing the sole support of said contact arm on said handle; said contact arm having its lower portion offset in a direction away from said one wall of said casing toward said other wall, both of said upper and lower portions of said contact arm comprising generally planar sheet metal portions having their major flat surfaces extending generally parallel to said casing side walls and being joined by an intermediate portion extending at an angle to said casing side walls; a tension spring extending between said intermediate portion of said releasable cradle and said intermediate portion of said contact arm to provide a toggle-action assembly comprising said contact arm and said operating handle; said contact arm having a contact portion at the end thereof opposite said upper portion, said contact portion extending substantially perpendicular to the planes of said side walls of said casing, and guide means carried by said other one of said side walls of said casing maintaining the path of pivotal movement of said contact arm



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In the embodiment of Figures 8 and 9, the lower portion 42 of the contact arm 26 slides in the L-shaped slot 268 of a separate insulating element 270 which is frictionally engaged between a pair of ribs 272 on each of the sidewalls 236, 244 of the casing sections. In this manner, a material may be employed which has higher dielectric properties than that of the casing sections. The ribs 272 and insulating element 270 generally function similarly to the ribs 45 and 148 in the embodiment of Figures 1 through 7 in separating the two chambers A and B and providing a guide for maintaining the desired alignment of the contact arm 26 against the torque produced thereon by the spring 46.

In the illustrated embodiments, the contact arm has had a laterally projecting finger or tab pivotably seated in a cooperating recess formed in the operating handle. However, it will be appreciated that the contact arm can also be pivotably mounted at the side of the operating handle upon a laterally projecting boss or shoulder formed in the handle albeit with lesser effectiveness in operation and assembly. Similarly, a pivot portion on the contact arm can be trapped between cooperating surfaces at the side of the operating handle and the casing sidewall. The illustrated embodiment is considered to be most advantageous in that it tends to maintain the parts in assembly prior to mounting the cover section of the casing and also minimizes the amount of surface contact between the contact arm and the casing sidewalls.

The cradle can be pivoted about a pin or have a lateral projection pivoted in an aperture in one sidewall of the casing rather than utilizing the cooperating recesses in both sidewalls of the casing. The illustrated embodiment minimizes the number of parts and facilitates assembly while generally conforming to the desirable concept of providing some isolation between the several subassemblies of the breaker mechanism.

Although the thermal-magnetic tripping mechanism illustrated is optimum from the standpoint of compactness and ease of construction and assembly, it will be appreciated that conventional thermal-magnetic mechanisms may be substituted therefor with some loss in benefits or possible reduction in efficiency of operation. If so desired, the common tripping member may be omitted from the assembly and the interior configuration of the casing modified to reflect the omission. However, most desirably versatility in the use of the circuit breaker is afforded by providing the illustrated configuration with means for mounting the common tripping members when desired.

Thus, it can be seen from the foregoing detailed specification that the circuit breaker of the present invention is readily adapted to relatively small widths while still affording

a highly effective means for handling substantial short circuit currents. The components thereof are readily fabricated from relatively economical materials and may be assembled rapidly and easily. The parts themselves enjoy a highly beneficial interrelationship which permit minimization of the number of parts and their size while affording optimum coaction therebetween.

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1. An electric circuit breaker comprising a casing having a top wall and opposed generally planar side walls; an operating handle pivotally supported in said casing on a pivot axis adjacent said top wall and having a lower portion thereof extending inwardly of said casing, said lower portion being positioned closer to one of said side walls of said casing than to the other; a releasable cradle of relatively thin sheet metal pivotally supported in said casing at one end and having a latch surface at its other end and having its intermediate portion extending close to said lower portion of said handle at the side thereof opposite said one side of said casing; a latch member pivotally supported in said casing and releasably engaging said latch surface of said releasable cradle, a contact arm of relatively thin sheet metal having an upper portion extending along the side of said lower portion of said handle opposite said intermediate portion of said releasable cradle between said lower portion of said cradle and said one side of said casing and having a pivotal engagement with said lower portion of said handle, said engagement providing the sole support of said contact arm on said handle; said contact arm having its lower portion offset in a direction away from said one wall of said casing toward said other wall, both of said upper and lower portions of said contact arm comprising generally planar sheet metal portions having their major flat surfaces extending generally parallel to said casing side walls and being joined by an intermediate portion extending at an angle to said casing side walls; a tension spring extending between said intermediate portion of said releasable cradle and said intermediate portion of said contact arm to provide a toggle-action assembly comprising said contact arm and said operating handle; said contact arm having a contact portion at the end thereof opposite said upper portion, said contact portion extending substantially perpendicular to the planes of said side walls of said casing, and guide means carried by said other one of said side walls of said casing maintaining the path of pivotal movement of said contact arm

generally parallel to the major planes of said side walls.

2. A circuit breaker as claimed in claim 1, wherein said contact arm upper portion has a finger extending laterally into a recess in said lower portion of said operating handle to provide the pivotal engagement therebetween.

3. A circuit breaker as claimed in claim 2, wherein said finger and said recess have cooperating abutting upper surfaces tapering upwardly and inwardly of said recess.

4. A circuit breaker as claimed in claim 1 or 2, wherein said guide means on said casing provides a bearing support for the lower portion of said contact arm.

5. A circuit breaker as claimed in claim 4, wherein said guide means is provided by at least one rib extending longitudinally of said casing.

6. A circuit breaker as claimed in claim 4 or 5, wherein said guide means is provided by an insulating member having a longitudinally extending slot therein receiving said lower portion of said contact arm and wherein said insulating member is mounted between the sidewalls of said casing.

7. A circuit breaker as claimed in any one of claims 1 to 4, wherein said circuit breaker has a line terminal providing a stationary contact into electrical engagement with which said movable contact is pivotable and a thermal-magnetic tripping mechanism operable to pivot said latch member and release said cradle and wherein the sidewalls of said casing have ribs thereon substantially dividing the interior of said casing into three relatively isolated compartments, the first of said compartments receiving the lowermost portion of the contact arm with its movable contact and said line terminal with its stationary contact,

the second of which contains the major portion of the contact arm, said operating handle and the major portion of said releasable cradle and the third of which contains said thermal-magnetic tripping mechanism, said latch member and the latched end portion of said releasable cradle, said contact arm lower portion extending through a slot in the rib between said first and second compartments and said releasable cradle extending through a slot in the rib between said second and third compartments.

8. A circuit breaker as claimed in claim 7, wherein said releasable cradle has a tab portion extending transversely of said casing and engageable with said lower portion of said operating handle upon release of said cradle from said latch member to retain said handle in a trip indicating position and to facilitate relatching of said cradle by pivoting of said operating handle.

9. A circuit breaker as claimed in any one of the preceding claims, wherein said circuit breaker includes a pivotably mounted common trip member in said casing between said cradle and said latch member, said common trip member having a portion thereon engageable with said latch member to effect release of said cradle upon tripping of another breaker with which it is coupled and having a surface engageable by said releasable cradle upon release thereof by said latch member in response to operation of the circuit breaker to effect tripping of another circuit breaker with which it is coupled.

10. An electric circuit breaker substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

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