

June 20, 1961

E. M. WEGH
CIRCUIT BREAKER

2,989,604

Filed April 4, 1957

5 Sheets-Sheet 1

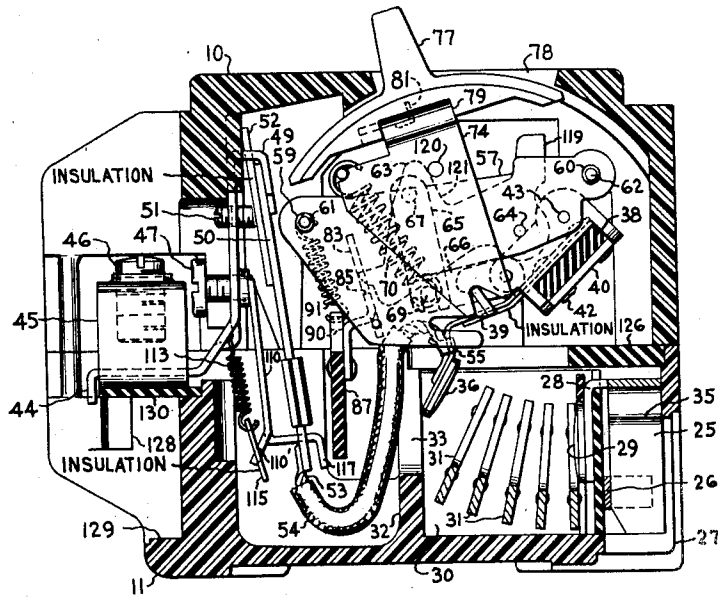


Fig. 1

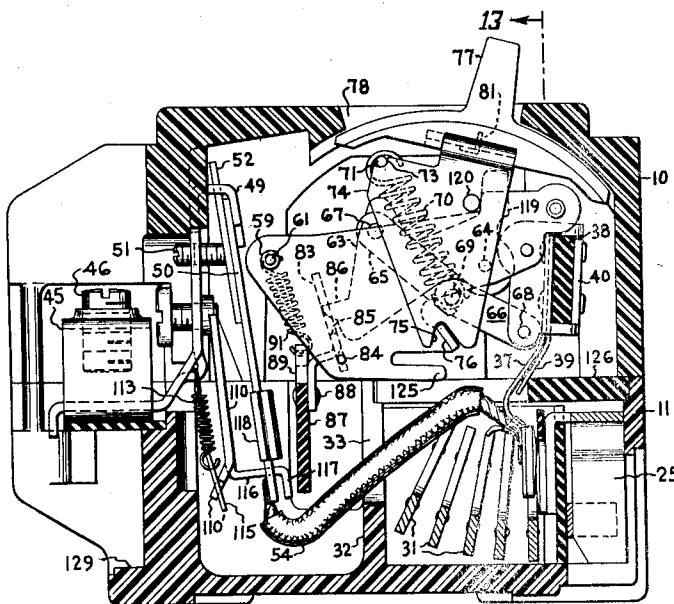


Fig. 2

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5 Sheets-Sheet 2

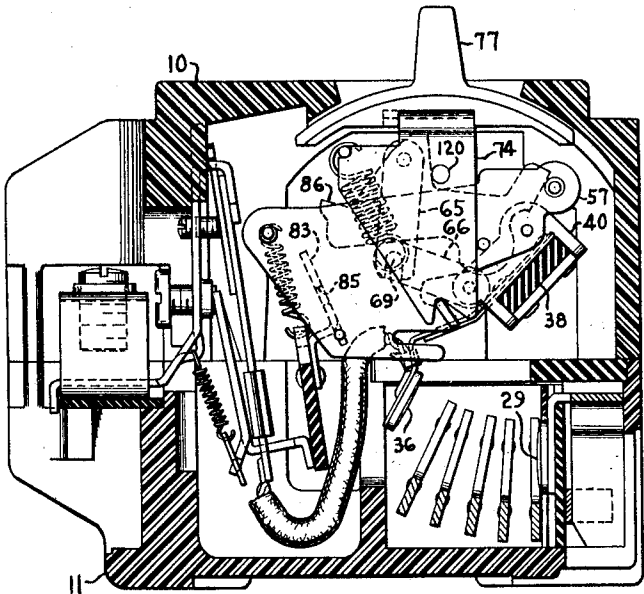


Fig. 3

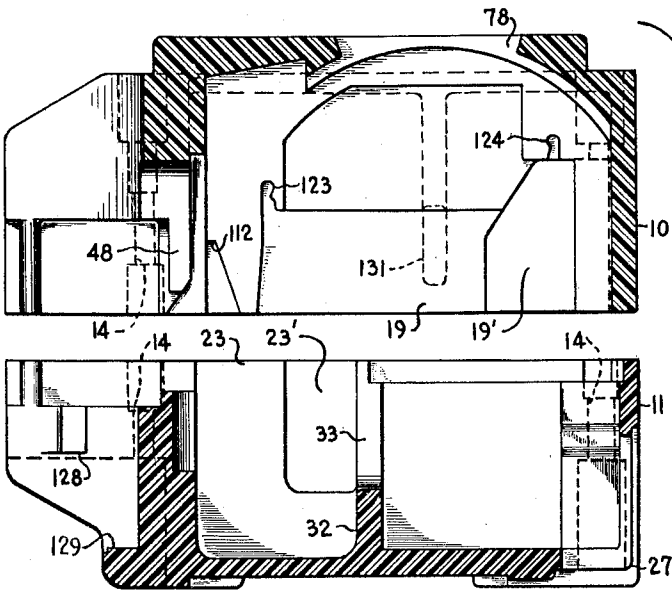


Fig. 4

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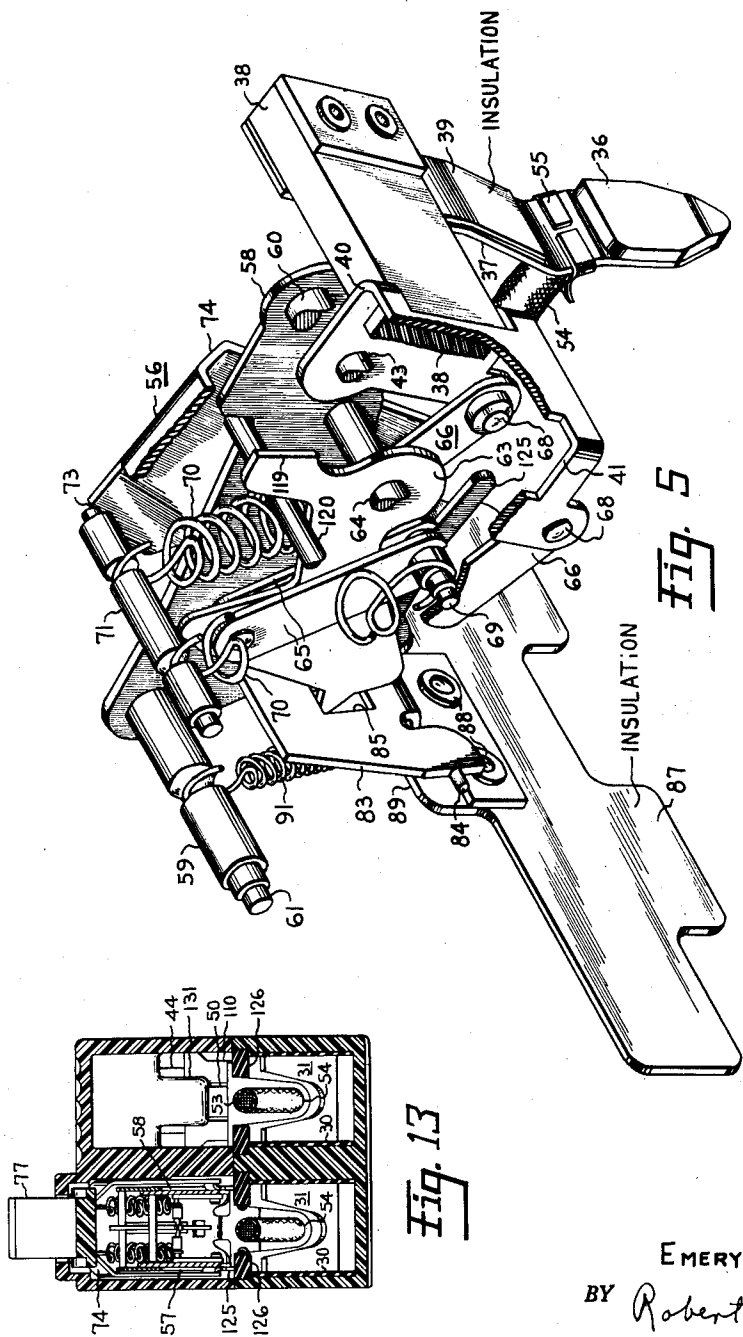
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5 Sheets-Sheet 4

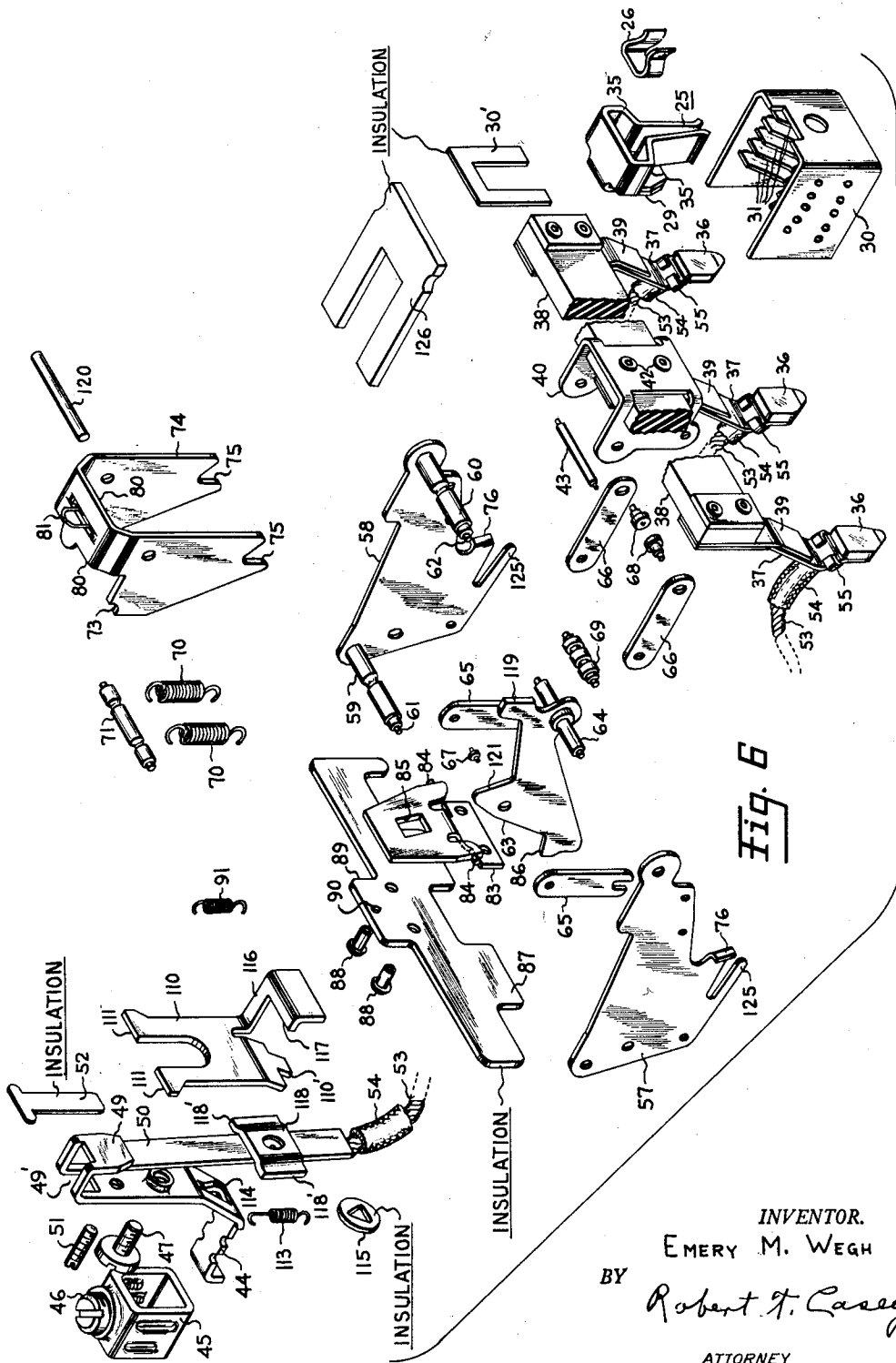


Fig. 6

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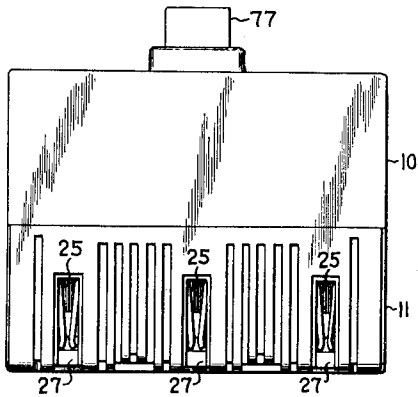


Fig. 7

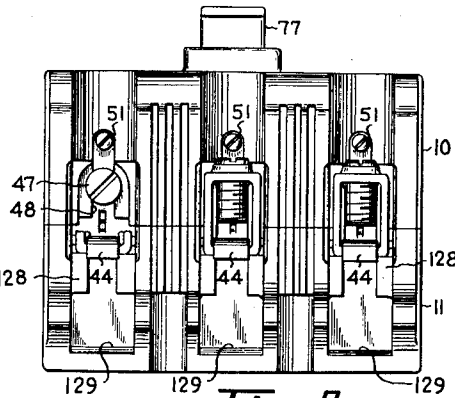


Fig. 8

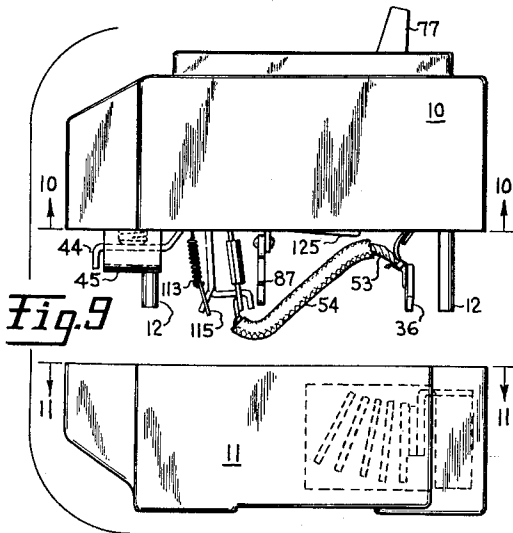


Fig. 9

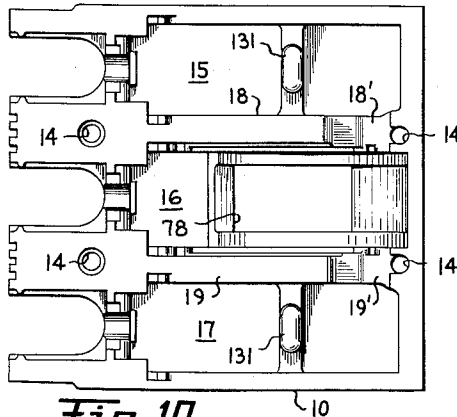


Fig. 10

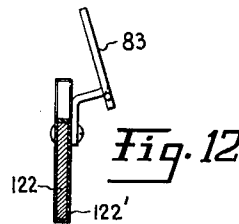


Fig. 12

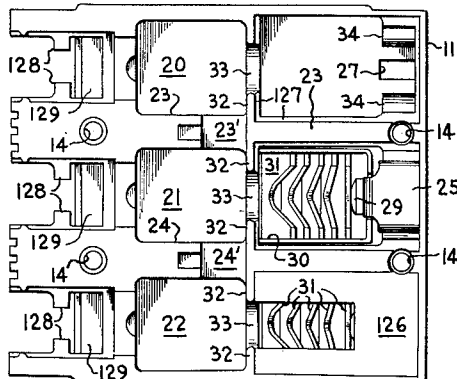


Fig. 11

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2,989,604

CIRCUIT BREAKER

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Filed Apr. 4, 1957, Ser. No. 650,600

9 Claims. (Cl. 200—88)

My invention relates to electric circuit breakers and particularly to multipole electric circuit breakers of the type including a molded insulating casing and adapted for use, either singly or in panelboards, for the control of electric light and power circuits in residential, commercial, and industrial buildings.

In recent years, relatively small, compact, plug-in type single-pole circuit breakers have become popular for use in residential, commercial, and industrial buildings. A circuit breaker of the type referred to is shown, for instance, in Patent No. 2,627,563, issued February 3, 1953, to W. A. Thomas and assigned to the same assignee as the present invention. Panelboards of the type containing contacts adapted to receive such plug-in circuit breakers, also in wide use, are shown in Patents Nos. 2,738,445, and 2,738,446, issued March 13, 1956, to H. J. Hammerly et al. and to W. J. Fleming, respectively, and also assigned to the same assignee as the present invention.

Such compact plug-in circuit breakers have heretofore been available only in single-pole and two pole forms, rated 10 to 50 amperes at 125 volts. There has for some time been a need, however, for three-pole circuit breakers of this type and size, which can also be plug-in mounted in such panelboards. Such three-pole circuit breakers have heretofore not been available because of the difficulty of providing one which will meet the electrical requirements in the small space available. Such a breaker must, for instance, be rated at subsequently double the voltage of the single and two-pole devices, i.e., 240 volts, and at currents of the same or greater value, i.e., 10–70 amperes, while occupying substantially the same space per pole as the single-pole version.

The problem is further illustrated by comparing the size of the required three-pole plug-in breaker with that of a three-pole breaker of similar rating in general use heretofore. Such a prior three-pole circuit breaker, generally as shown in Patent No. 2,455,753, to B. E. Getchell, and assigned to the same assignee as the present invention, has the following dimensions: $4\frac{1}{4}'' \times 6'' \times 3\frac{3}{8}''$ or a volume of 83.5 cubic inches. The three-pole breaker required by the plug-in panelboards referred to above, and which is provided by applicant's present invention, has the following dimensions: $3'' \times 3\frac{1}{4}'' \times 2\frac{1}{8}''$ or a volume of 27 cubic inches. It will be seen that the prior breaker is approximately three times the size of the breaker of the present invention.

It is, therefore, a general object of my invention to provide an extremely compact and efficient multipole circuit breaker and especially a compact and efficient plug-in type multipole circuit breaker, suitable for use in existing plug-in type panelboards.

In providing such a compact multipole circuit breaker of increased rating, it is necessary to provide a high amount of contact pressure in a relatively small space. In circuit breakers of the type shown in the above mentioned Thomas patent, the contact pressure normally provided is in the neighborhood of 14 to 17 ounces between the contacts in the closed circuit position. In applicant's subject invention, however, the contact pressure for each of three sets of contacts is in the neighborhood of 28 to 32 ounces, making a total of 84 to 96 ounces of pressure developed by the operating mechanism. The provision of such high contact pressure has heretofore required relatively large and bulky mechanisms such as shown in the

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above-mentioned Getchell patent, which would be completely impractical in the present instance.

In addition, the size of the compact plug-in type circuit breakers involved herein is such that more than one-half the interior space is taken up by the necessary arc extinguishing chambers and current responsive trip devices. These two components, which are normally positioned at opposite ends of a circuit breaker, with the mechanism therebetween (see Getchell patent) are, in compact breakers of the type of the Thomas patent, virtually brought adjacent each other, leaving no room to mount a mechanism therebetween and making it necessary to utilize the upper portion of the housing for the mechanism.

It is therefore an object of my invention to provide a circuit breaker mechanism which is extremely compact yet capable of providing relatively high contact pressures.

It is a further object of my invention to provide a high contact pressure type of circuit breaker mechanism which is able to be contained in the top portion of a circuit breaker housing and adapted to operate a movable contact moving within the bottom portion of such circuit breaker housing.

Another object of my invention is the provision of an electric circuit breaker operating mechanism including operating spring means which is removed from the portion of the circuit breaker casing where arc interruption takes place, to minimize the possibility of damage to such spring means by arc gases.

It is a further object of my invention to provide such an electric circuit breaker mechanism which provides a quick make and quick break or "snap" action, which cannot be retained during tripping in the "on" position by manual force, which indicates by a unique position of its operating handle that an automatic opening operation has occurred, and which is capable of controlling contacts for two or three circuits simultaneously.

In accordance with my invention, I provide a circuit breaker mechanism including a movable switch member pivotally supported on a fixed pivotal axis, a manually operable handle member pivotally supported on another fixed pivotal axis, a releasable trip member pivotally supported on a third fixed pivotal axis and retained in a normal latched position by a current responsive latch member, and means interconnecting the handle and the switch member including a pair of toggle links and an operating spring, all of the aforesaid fixed pivotal axes being arranged in a novel compact arrangement, whereby the length of travel of the movable contact and the amount of contact pressure are both maintained relatively high while the over-all size of the mechanism is drastically reduced. I further provide a circuit breaker mechanism of the type described above in which the pivotal axis of the releasable trip member and the pivotal axis of the movable switch member are both on the same side of the line formed by the toggle links in their set condition, and relatively close together resulting in a mechanism which is very compact and which also can be mounted in the upper part of a circuit breaker housing while operating a movable contact in the lower part of the housing.

In accordance with another aspect of my invention, I provide a circuit breaker including a generally rectangular casing with a handle at the top and relatively stationary contacts adjacent the bottom, the housing is split into substantially equal top and bottom portions with the aforesaid pivotal axes all being contained in the top portion.

In accordance with a still further aspect of my invention, the operating mechanism is preassembled in its own supporting frame and is merely inserted into the corresponding recess in the top. It is accurately positioned by projections carried by the outer sides of the frame and received in tapering grooves in the casing walls. The

assembled mechanism is retained in the recess, when the top and bottom are assembled, by retaining means carried by the bottom part acting on compressible portions of the side frames.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed the invention will be better understood from the following detailed description taken in connection with the accompanying drawings in which:

FIGURE 1 is a side elevation view of a three-pole circuit breaker constructed in accordance with my invention, the side of the enclosing housing being removed to show the parts, and the circuit breaker being shown in the normal open-circuit condition;

FIGURE 2 is a side elevation view similar to FIGURE 1 but with the circuit breaker shown in the closed-circuit condition;

FIGURE 3 is a side elevation view similar to FIGURE 1 but with the circuit breaker shown in the automatically opened or "tripped" condition;

FIGURE 4 is an exploded view of the insulating housing of the circuit breaker of FIGURE 1, shown as in FIGURES 1-3;

FIGURE 5 is a perspective view of the operating mechanism and movable contact assemblage of the circuit breaker of FIGURE 1 parts thereof being broken away;

FIGURE 6 is an exploded view of the parts of the circuit breaker of FIGURE 1, including the operating mechanism, movable contact assemblage, and one line terminal, arc chute, trip device and load terminal;

FIGURE 7 is an end elevation view of the circuit breaker of FIGURE 1 as viewed from the line terminal end;

FIGURE 8 is an end elevation view of the circuit breaker of FIGURE 1 as viewed from the load terminal end, a portion of one of the load terminal clamping members being broken away;

FIGURE 9 is an exploded view of the circuit breaker of FIGURE 1 as viewed from the side thereof;

FIGURE 10 is a view of the top housing member, taken on the line 10-10 of FIGURE 9, the operating mechanism and trip devices being omitted;

FIGURE 11 is a view of the bottom housing member taken on the line 11-11 of FIGURE 9, one of the arc extinguishing structures being omitted and two arc extinguishing chamber covers being omitted;

FIGURE 12 is a detail view showing a modified form of common trip bar for use in the circuit breaker of FIGURE 1; and

FIGURE 13 is a sectional view of a modified form adapted for two-pole circuits.

Certain aspects of the circuit breaker disclosed herein other than the mechanism per se, are disclosed and claimed in an application filed concurrently herewith by Emery M. Wegh and George W. Kiesel and assigned to the same assignee as the present invention.

In the drawings, I have shown my invention as embodied in a three-pole electric circuit breaker having a generally rectangular insulating housing comprising a top housing member 10 and a bottom housing member 11 adapted to be connected together by suitable means such as by tubular rivets 12, FIGURE 9, passing through holes 14, FIGURES 10 and 11, in the top and bottom housing members respectively. Referring to FIGURES 10 and 11, the top housing member 10 has three elongated recesses 15, 16 and 17 extending substantially from end to end thereof and separated by barriers 18 and 19 integral with the top housing member. The bottom housing member 11 is also provided with three elongated generally parallel recesses 20, 21 and 22 therein separated by barriers 23 and 24 also integral with the bottom housing member. The recesses in the top and bottom housing members are contiguous when the housing members are

assembled together and define three side-by-side generally rectangular pole chambers, there being one such pole chamber for each pole of the circuit to be controlled.

Each of the recesses 20, 21 and 22 has supported within it at one end thereof a plug-in type line contact socket 25. The socket 25 comprises a generally U-shaped member (see FIGURE 6) having the legs thereof brought closer together at their extremities than at the bight of said U, and a generally U-shaped resilient reinforcing clip member 26 embracing the sides of said U-shaped line contact member adjacent their extremities. The bottom housing member 11 is provided with three L-shaped corner slots 27 providing access to said line contact socket 25 by suitable means such as by a blade-type contact (not shown).

The line contact socket 25 further includes a contact supporting portion 28 integral therewith and extending from the bight of said U and having a stationary contact 29 fixedly attached thereto by suitable means such as by welding.

For the purpose of cooling and extinguishing arcs adjacent said stationary contact 29, I provide arc extinguishing means adjacent each of the stationary contacts 29 and including a generally U-shaped insulating support 30, (see particularly FIGURES 6 and 11). The U-shaped insulating member 30 is preferably formed of a strong sheet insulating material such as vulcanized cellulosic fiber, and supports between the sides thereof a plurality of notched metallic arc extinguishing plates 31. The U-shaped insulating piece 30 is supported in place by the corresponding outer walls of the bottom insulating housing member 11, by portions of the barriers 23 and 24, and also by short transversely extending barriers 32 integral with the outer walls and the barriers of the bottom housing member 11. The transversely extending barriers 32 are cut away or notched to provide an entrance portion 33 to each of the arc extinguishing chambers.

The stationary contact supporting portion of the line contact 25 extends over the top edge of the bight wall of the U-shaped member 30, thereby supporting the line contact member 25 in place in the recess 20. The line contacts 25 are further supported in their respective chambers by shoulders 34 integral with the bottom insulating housing member 11 which are adapted to engage corresponding shoulders 35 on the line contact member. The contact support 28 is shielded from the effects of arcing by a generally U-shaped fiber insulating piece 30'.

Three movable contacts 36 are provided, each being rigidly attached to the outer end of resilient contact arms 37 which in turn are rigidly attached to an insulating contact cross arm 38. The contact supporting arms 37 are preferably shielded by insulation strips 39 as shown.

The insulating contact cross arm is supported for movement by a generally U-shaped contact operating member 40. The contact operating member 40 is provided with two aligned slots 41 adjacent the bight thereof, and the contact cross arm 38 extends through the aligned slots 41 and is rigidly attached to the bight of the contact operator 40 by suitable means such as by rivets 42. It will be observed however that the contact cross arm 38 is supported on the operating member 40 at three points, i.e., against the bight portion of the contact operator 40 and against the edges of the slots 41 formed in the side portions of the contact operator 40. This supporting arrangement not only distributes the stress exerted on the contact cross arm 38 by the contact operator 40, but also restrains any tendency of the contact cross arm 38 toward warping or twisting. The contact operating member 40 is supported in the top housing member 10 for rotation about a fixed pivot 43 and is adapted to be operated between open and closed circuit positions in a manner and by means to be described.

The circuit breaker of my invention also includes three load connecting terminals each comprising a load terminal strap 44 which is generally L-shaped and has its outer

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extremity bent downwardly to retain thereon a generally tubular wire clamping member 45 which may be of steel, and which carries a wire clamping screw 46. The load terminal strap 44 has its inner portion extending within each of the recesses 15, 16 and 17 of the top housing member 10 respectively and is anchored to the top housing member by a clamping screw 47 extending through a slot 48 in the end wall of the top housing member 10 (see particularly FIGURES 8 and 10) and into threaded engagement with the vertical portion of the load terminal strap 44. The extreme inner end 49 is return-bent, and has fixedly attached thereto an elongated bimetallic strip 50. For the purpose of adjusting the normal position of the bimetallic strip 50 with respect to the insulating housing member 10, I provide a calibrating screw 51 threadedly engaging the vertical portion of the terminal strap 44 and adapted to exert a pressure against the upper portion of the bimetallic strip 50. For the purpose of preventing current flow through the calibrating screw 51, an insulating member 52 is provided which is generally T-shaped and adapted to extend through an opening 49' in the bight portion of the return-bent portion 49 of the terminal strap 44. The lower end of the bimetallic strip 50 is connected by a flexible electrical conductor 53 to the movable contact 36. For the purpose of protecting the flexible conductor 53 from the effects of arcing, I provide an insulating sheath of woven glass fiber material 54.

The flexible braid 53 is attached to the contact supporting arm 37 directly behind the movable contact 36. It will be observed, especially by reference to FIGURE 1, compared to FIGURE 2, that the flexible braid undergoes a severe sharp bending immediately adjacent the movable contact 36. This bending is so sharp that, with ordinary methods of attachment, breakage would occur in the flexible conductor at this point after a number of operations of the breaker. Such breakage is prevented in the present design however by means of a supplementary supporting clip 55. The clip 55 includes a generally U-shaped portion, the outer ends of the U being bent over the edges of the contact supporting arm 37, and the intermediate portion of the U encircling the flexible connector immediately adjacent the point at which it is welded to the movable contact. The clip 55 further includes a return-bent portion extending from the bight of the U and adapted to engage the flexible connector and to prevent the connector from bending too sharply at this point of connection, (see particularly FIGURE 1 and FIGURE 3).

The current path may now be traced through the circuit breaker in the following sequence:

Current enters at the line contact 25 and goes to the stationary contact 29, to the movable contact 36, through the end portion of the contact supporting arm 37 to the flexible conductor 53, to the bimetallic strip 50, to the load terminal strap 44.

For the purpose of moving the contact operator 40 about its pivot 43 to move the movable contacts between open and closed circuit positions, and to releasably retain such contacts in the closed circuit position, I provide a circuit breaker operating mechanism 56 shown in perspective in FIGURE 5 and shown in exploded relation in FIGURE 6.

The operating mechanism includes two opposed side frame members 57 and 58, supported in spaced-apart relation by spacer pins 59 and 60. The spacer pins 59 and 60 include shouldered portions for supporting and spacing apart of the side frame members and also integral extensions 61 and 62 adapted to project through the side frame members and to extend outwardly from the outer side of such frame members for a purpose to be described.

A releasable carrier member 63 is supported for pivotal movement between the side frames 57 and 58 on a carrier pivot pin 64. The carrier pivot pin 64 is also shouldered and aids in spacing the side frames 57 and 58. Upper and lower pairs of toggle links 65 and 66 respective-

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ly are also provided. The upper pair of toggle links 65 extend one on each side of the carrier 63 and are pivotally supported thereon at one end by a pivot pin 67. The lower pair of toggle links 66 are more widely spaced apart and are individually pivoted on the U-shaped contact operator 40 by short pivot pins 68. The upper and lower pairs of toggle links 65 and 66 have their mutually adjacent ends connected and supported by a toggle knee pin 69. The upper toggle links 65 are pivotally supported on a central enlarged portion of the pivot pin 69, and the more widely spaced lower toggle links 66 are pivotally supported on reduced outer portions of the pivot pin 69. The pivot pin 69 is terminated at the outer surface of the lower toggle links 66 and is headed over to retain the links 66 thereon.

A pair of tension-type operating springs 70 are supported at one end in grooves in a relatively stationary spring anchor pin 71 which extends from side-to-side of the mechanism and has reduced end portions 72 resting in notches 73 cut in the corners of a projecting portion of the manually operating member 74. The lower ends of the operating springs 70 are attached to the toggle knee pivot pin 69, on the portion of the pin between each of the adjacent ends of the upper and lower toggle links. The manual operating member 74 is pivotally supported on knife-edge type pivots by means of notches 75 therein adapted to rest on outwardly bent lug portions 76 integral with the side frame members 57 and 58 respectively. The manual operating member 74 is provided with a manually engageable insulating handle portion 77 having a portion adapted to project through an aperture 78 in the top wall of the top housing member 10 and having an arcuate enlarged portion within the casing housing adapted to close the remaining portion of the aperture 78 in all positions of the handle. The insulating handle member 77 is adapted to be carried by the operating member 74 and to operate the member 74 by means of interfitting portions including shoulders 79 on the insulating handle 77 and edge portions 80 of the operating member 74. For the purpose of facilitating assembly of the operating mechanism and the insulating handle 77 into the top housing member 10 in a manner to be described, a temporary holding clip 81 (see FIGURE 6) is provided, comprising a generally U-shaped length of resilient wire having portions bent over so that its side portions are L-shaped, and hooked in under the top bight portion of the handle member 74. The handle member 74 has a portion of the bight thereof lanced out and offset from the general plane thereof thereby providing an opening to receive the clip 81 and also a support to prevent the clip 81 from falling within the operating member 74.

Assuming the carrier member 63 to be stationary in the position shown in FIGURES 1 and 2, the switching action of the operating mechanism may be described as follows. In FIGURE 1 the parts are shown with the movable contact in the open circuit position and the toggle links 65 and 66 in the collapsed condition. As the handle member 77 is moved forward to rotate the operating member 74 in a clockwise direction, the upper ends of the operating springs 70, carried by the spring anchor pin 71 are carried in a clockwise direction until the line of action of the springs 70 passes across the pivot pin 67 of the upper toggle links 65. When this occurs, the springs 70 exert a force on the toggle knee pin 69 urging it to the right as viewed in FIGURES 1 and 2, toward a toggle straightened position. The parts then quickly move to the position shown in FIGURE 2, with a snap action. In this position, the resilient contact arms 37 are slightly deformed, exerting a predetermined contact pressure between the movable contact 36 and the stationary contact 29. Conversely, when the handle member 77 is moved to the left as viewed in FIGURES 1 and 2, the upper ends of the operating springs 70 are carried in a counterclockwise direction and when the line of action of the spring 70 passes across the pivot pin 67, the toggle links move to a collapsed position with a

snap action and the parts return to the normal "off" position shown in FIGURE 1. For the purpose of releasably restraining the carrier member 63 in the normal or latched position shown in FIGURES 1 and 2, I provide a retaining latch 83, pivoted between the side frame members 57 and 58 at 84, and having an aperture 85 adapted to receive a latching portion 86 of the carrier 63.

For permitting the operation of the latch member 83 by any one of two or more trip devices in a manner to be described, I provide an insulating common-trip bar 87 which extends transversely across all three pole compartments 20, 21 and 22 of the bottom housing member 11. The common-trip bar 87 is preferably formed of a highly arc resistant and heat resistant material so as to withstand the effects of arcing from the arc chambers and to shield the current responsive trip assembly (to be described). Suitable materials for the trip bar 87 include glass-bonded mica or Mycalex, polyester and epoxy molding compounds reinforced by glass fiber, plastic resin bonded asbestos, and ceramic materials such as porcelain and bonded alumina. The common-trip bar 87 is rigidly attached to the retaining latch 83 by suitable means such as by rivets 88, and has a central portion 89 provided with a hole 90 adapted to receive one end of a trip bar biasing spring 91, the other end of which is anchored on the frame spacer pin 59. The action of the trip bar biasing spring 91 is such as to constantly bias the common-trip bar and the latch member 83 in a clockwise direction into latching engagement with the latch portion 86 of the releasable carrier 63.

It will be observed that in the normal "off" and "on" conditions shown in FIGURES 1 and 2 respectively, the operating springs 70 are under tension, placing the upper toggle links 65 in compression and exerting a force on the releasable carrier 63 through the pin 67, which tends to move the releasable carrier 63 in a clockwise direction as viewed in FIGURES 1 and 2. Such movement of the carrier 63 is normally restrained by the latching engagement of the projection 86 with the retaining latch 83.

For the purpose of providing both thermal and magnetic current responsive tripping action, I provide each pole of the circuit breaker with a bimetallic strip 50 described above, adapted to carry current therethrough, and, in addition, a magnetic armature member 110. The armature 110, shown more clearly in exploded view FIGURE 6 includes a bifurcated main portion terminating in upper bearing surfaces 111 each adapted to pivot in knife-edge fashion in molded bearings 112 (see FIGURE 4) in the top housing member 10. The armature 110 is retained in mounted engagement in the V-shaped pivot bearings 112 by means of an armature biasing spring 113, which has one end hooked into a lanced-out portion 114 of the load terminal strap 44, and has the other end connected by an insulating link 115 to a projecting tongue 110' integral with the lower portion of the armature 110. The magnetic armature 110 is further provided with an integral offset flag-shaped portion 116 having its outermost portion bent downwardly so as to present an edge 117 which is adapted to extend in front of the lower extremity of the bimetallic strip 50. The armature biasing spring 113 biases the armature 110 in a clockwise direction and normally maintains the edge 117 against the forward surface of the bimetallic strip 50.

A magnetic core member 118 is also provided, being attached to the lower portion of the bimetallic strip 50 by suitable means such as by welding, and is generally U-shaped to present pole portions 118' at either side of the bimetallic strip 50.

The operation of the thermal and magnetic trip device is as follows. Assuming the breaker to be in the closed circuit condition of FIGURE 2, during a continued overload condition which is below a short circuit value, the bimetallic member 50 is heated by the action of current passing therethrough, and deflects or warps in a way to cause the lower end thereof to move to the right as viewed in FIGURES 1 and 2. As the lower end of the

bimetallic strip 50 moves to the right, it engages the edge 117 of the armature 110 and carries the armature 110 with it, until the toe portion of the armature extension 116 engages the common-trip bar 87. Continued movement of the bimetal 50 and the armature 110 to the right moves the lower end of the trip bar 87 to the right, rotating the latch member 83 in a counterclockwise direction and withdrawing the retaining edge of the aperture 85 from the latch portion 86 of the carrier 63. Upon release of the latch portion 86, the operating springs 70 move the carrier member 63 in a clockwise direction until the extension 119 on the carrier 63 strikes the spacer pin 60.

As this rotation of the carrier member 63 occurs, the pivot pin 67 of the upper toggle links is carried across the line of action of the operating springs 70, thereby reversing the rotational bias of the operating springs 70 on the upper toggle links, collapsing the toggle links and moving the movable contacts to the open circuit position as shown in FIGURE 3. The movement of the movable contact operator and contact arms toward the open circuit position is limited by the contact operator 40 striking the pivot pin 64 of the carrier member 63. This tripping action occurs regardless of whether the movable operating handle 77 is forcibly restrained in the "on" position such as by an operator's hand. When the operating handle 77 is released, however, the handle member 77 is automatically returned to a central position as indicated in FIGURE 3 by further action of the operating spring 70. This handle-return action takes place because the lower ends of the operating springs 70 have been moved to the left by the collapsing action of the toggle links, and therefore the line of action of the operating springs 70 now passes to the left hand side of the handle pivot point 75 as viewed. This return movement of the manual operating member 77 counterclockwise as described, is limited by the engagement of a resetting pin 120 carried by and extending from side-to-side of the manual operating member 74, which pin engages a resetting cam portion of the edge of releasable member 63.

In order to reset the circuit breaker, (assuming that the bimetallic member 50 has cooled sufficiently to permit the latch biasing spring 91 to return the latch member 83 to proper position) the manually engageable handle portion 77 is moved manually from the central position or trip position of FIGURE 3 to the normal "off" or resetting position of FIGURE 1. During this movement, the resetting pin 120 rides along the resetting cam portion 121 of the carrier 63 and rotates the carrier 63 counterclockwise about its pivot 64 until the latching projection 86 once again enters the aperture 85 in the latch 83. At this point, the latch biasing spring 91 returns the latch 83 to its extreme clockwise position, such clockwise movement being limited by the engagement of the portion of the latch 83 immediately below the aperture 85 with the edge portion of the carrier member 63 immediately below the latching projection 86, assuring a fixed, predetermined maximum latch engagement.

Instantaneous or magnetic tripping action occurs when currents of a short circuit magnitude pass through the circuit breaker and through the bimetallic strip 50. When this occurs, the magnetic field associated with such current forms magnetic poles at 118' of the core member 118, thereby creating an attraction between the armature 110 and the magnet 118. Since the bimetallic strip 50 is relatively stiff compared to the resilience of the magnetic armature biasing spring 113, the armature 110 moves toward the bimetallic strip 50 and toward the magnet 118. When this occurs, the toe portion of the armature extension 116 engages the common trip bar 87 and rotates the latch member 83 in counterclockwise direction, causing tripping in the same manner as described above. Resetting following such magnetic tripping is

accomplished in the same manner as previously described in connection with thermal tripping.

As mentioned above, the exact calibration of the circuit breaker may be altered by adjusting the calibrating screw 51 which exerts a force between the main portion of the terminal strip 44 and return-bent portion 49 which carries the bimetallic strip, either opening it out wider or allowing it to return to a more nearly closed position by reason of its resilience. This adjusts the angular position of the bimetallic strip 50 with respect to the remaining parts of the circuit breaker and particularly with respect to the common trip bar 87.

In FIGURE 12 I have shown a modified form of common trip bar. In this modification, the common trip bar 122 instead of being formed entirely of insulating material, is formed of a metallic material such for instance as aluminum, which is coated with a suitable coating 122' of insulating material comprising an epoxy resin plastic.

In order to support the operating mechanism of my improved circuit breaker in such a manner as to protect it from the effects of arc interruption in the closely-adjacent arc interrupting chamber, I have devised an arrangement and supporting means whereby the completely assembled mechanism is inserted and supported in the upper half of the insulating housing, that is, in housing member 10, and I have likewise devised means whereby the trip devices for each of the three poles of the circuit breaker is also supported in the upper half of the insulating casing, that is in housing member 10, and particularly is supported in such housing member with respect to the operating mechanism and its associated latch and trip bar. Accordingly the operating mechanism is provided with relatively short projections 61 and 62 described above extending outwardly from the outer surfaces of the side frame portions 57 and 58. In addition, the central chamber 16 of the upper housing member 10 is provided with two pairs of recesses or slots 123 and 124 adapted to receive the projections 61 and 62, respectively. The slots 123 and 124 are also provided with in intermediate portion which is slightly constricted so as to afford a defeatable resistance to the entry of the projections. In addition, each of the side frame members 57 and 58 is provided with integral vertically deformable portions 125 for a purpose to be described.

The distance between the side frames 57 and 58 is preferably made less than the corresponding distance between the barriers 23 and 24 of the lower housing member 11, so that in the two pole form the width of the circuit breaker may be reduced to effectively two-thirds that of the three pole form without interfering with the mounting and support of the operating mechanism thus permitting the same mechanism to be used for both the two and three pole forms. For the purpose of supporting the mechanism in the upper housing member 10 and in the downwardly opening slots 123 and 124, as well as for the purpose of further isolating the operating mechanism from the arcing products produced in the lower chambers, I provide arc extinguishing chamber covers 126. Each of the arc extinguishing chamber covers 126 is supported on ledges 127 in each of the recesses 20, 21 and 22, and has a slot cut therein to permit the entry of the contact operating arms 37 in the outer pole chambers 20 and 22, the arc extinguishing covers 126 serve primarily to isolate the effects of arcing in each of the associated chambers. In the central chamber 21, the arc extinguishing cover 126 performs this same function and in addition provides a supporting base which is adapted to engage the deformable portions 125 of the side frame members 57 and 58 and to thereby hold the operating mechanism in its proper location in the upper housing member 10.

The two deformable portions 125 are initially formed so as to extend below their finally assembled position,

so that as the housing members are placed together and sufficient force is exerted, the portions 125 are deformed slightly, thereby providing a resilient retaining force to retain the mechanism in position.

The assembly of the complete three pole circuit breaker therefore preferably follows the following sequence. First the operating mechanism is assembled between the side frames 57 and 58 with the movable contact arms and movable contacts, and also with the flexible conductors 53 and each of the bimetallic strips 50 and load terminal straps 44 and connectors 45 attached thereto. The handle member 77 is inserted in place on the manual operating member 74 being resiliently retained thereon by the retaining clip 81. The top housing member 10 may then be inverted and the assembled mechanism inserted therein so that the projections 61 and 62 rest in the entrance portion of the slots 123 and 124. Additional manual pressure upon the side frames 57 and 58 causes the projections 61 and 62 to snap into their final location in the extreme portion of the slots 123 and 124. This subassembly may therefore be conveniently handled before the addition of the lower housing member 11 without the mechanism falling out. The trip devices including the bimetallic strips and load terminal straps are then inserted into corresponding recesses in the top housing member 10, the load terminal strap mounting screw 47 being already inserted in its threaded hole therein, such assembly being permitted by the entrance slot 48. The load terminal strap mounting screw 48 is then tightened mounting the load terminal member and bimetal in fixed position in the upper housing member. Following this, the armature members 110 are assembled by hooking the extension portions 116 around the extreme end of the bimetallic strips 50 and placing the bearing edges 111 in the corresponding molded bearings 112 in the casing, and by hooking the armature biasing spring in position between the terminal strap and the armature. It will be observed that the armature biasing spring 113 serves not only to bias the armature member 110 into mounted condition in its inverted V-shaped bearings in the upper housing member, but also to bias it clockwise so that the edge 117 is normally maintained in proper engagement with the surface of the bimetallic strip 50. Following assembly of the parts in the upper housing member 10, the arc extinguishing assemblies comprising the support member 30, the arc plates 31, and the line contact member 25 carrying the stationary contact 29 are assembled as one unit into the corresponding recesses in the lower housing member 11. The arc extinguishing cover members 126 are then placed over the arc extinguishing assemblies. The circuit breaker is then ready for the final assembly operation and is in the condition shown in FIGURE 9. The top and bottom housing members are then brought together and sufficient force exerted to deform the deformable portions 125 of the side frames 57 and 58 and rivets 12 are passed through the aligned holes 14 in the top and bottom housing members and spun over to retain the parts together. It will be observed that following such final assembly, the clamping member 45 encircling the load terminal strap 44 and the tubular clamping member 45 are supported by an insulating piece 130 which in turn is supported by projecting bosses 128 projecting from extensions of the side wall portions and of the barrier portions 23, 24 of the bottom housing member 11. In the form shown in FIGURE 8, the strap 44 and the member 45 are supported directly by the bosses 128 and the piece 130 is omitted.

The completed circuit breaker is adapted to be held in mounted condition by suitable retaining means (not shown) adapted to engage projecting ledges 129 below the load terminal members 45. The design of the ledge members 129 and the bosses 128 is such as to remove the necessity for "undercutting" in the molding of the bottom housing member 11. Accordingly the design is such that no part of the lower housing member 11

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projects directly above the ledge surface 129, the bosses 128 being offset to one side of such vertical location. It will be observed that the design of the housing is such that top and bottom mating housing members 10 and 11 are provided each including three registering longitudinal recesses 15, 16, 17 and 20, 21, 22 separated by registering barriers 18, 19 and 23, 24, and that these recesses each of which serves as a separate pole chamber, are crossed by a transverse passageway, the transverse passageway being offset longitudinally and located at opposite ends of the circuit breaker proper. In this manner maximum isolation and maximum compactness is achieved.

The tapering construction of the slots 123 and 124 provides for easy and rapid insertion of the assembled mechanism in place in the top housing member 10 and also provides accurate final positioning. By means of the assembly shown the operating mechanism including its supporting frame members is mounted in the insulating casing without being positively fastened thereto. This construction saves a considerable amount of time and expense in assembly of the circuit breaker. In addition, it provides a safer construction than those utilizing screws going through the housing which need to be insulated from outside the housing.

The manual operating member 74 is generally U-shaped and the sides thereof extend alongside of the mounting side frames 57 and 58 of the operating mechanism. Space or clearance must therefore be provided between the inner walls of the mounting chamber 16 and the sides of the frame members 57 and 58 to allow free movement of the manual operating member 74. This spacing is also provided by the extended projections 61 and 62.

It will be observed that, although the operating mechanism, the trip devices and the arc extinguishing chambers are all contained in a very small volume of space, the critical parts of the operating mechanism and trip devices such as the operating springs and the bimetallic strips, are well protected from the effects of the nearby arcing by the placement and configuration of other parts.

The common trip bar 87, for instance, is preferably made in the form of a relatively wide, thin, flat member so that it is adapted to act as a shield interposed between the entrance portions 33 of the arc extinguishing chambers and each trip device including bimetallic strips 50 and magnetic core 118.

The contact cross-arm 38 and the contact arms 37 are likewise relatively wide, thin, and flat, and act as shielding means to assist in shielding the mechanism from the effects of arc interruption. It will be observed for instance that the central contact arm is always between the arc extinguishing chamber and the operating springs 70.

The design of the circuit breaker housing and especially the lower housing member 11 is such as to provide substantially no venting from the arc extinguishing chamber outside of the casing. This total enclosure affords maximum safety to surrounding apparatus while much of the hot air and gases generated by arc interruption are forced out of the entrance 33 against the flexible conductor 53 and toward the trip device, serious damage is prevented to these parts. Damage to the flexible conductor 53 is prevented although it is directly in the stream of arc extinguishing gases by reason of the flexible woven glass sheath 54. It has been found that although the temperature of the flame and gases is sufficient to melt such glass and produce a sizable hole in such a sheath, that even thereafter the affect of such flame and gases on the conductor 53 is not further destructive. This is assumed to be because the melted glass coats the individual strands of the flexible conductor affording it protection.

In FIGURE 13 I have shown my invention as embodied in a two-pole circuit breaker. The construction of this form is substantially identical to that of FIGURE

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1 excepting that the casing includes only two pole chambers, and the contact cross-arm 37 and the common trip bar 87 are shortened accordingly.

While I have shown only two embodiments of my invention, it will be readily appreciated that many modifications thereof may easily be made, and I intend therefore, by the appended claims, to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric circuit breaker comprising a generally rectangular insulating casing having an apertured top wall, a bottom wall, front and rear walls and opposed side walls, a stationary contact supported in a corner of said casing adjacent said front and bottom walls, a movable contact arm pivotally supported on a fixed pivotal axis said fixed pivotal axis being closer to said top wall than to said bottom wall, said contact arm extending generally downwardly from said pivotal support toward said bottom wall and moving about said support along an arcuate path toward and away from said front wall, a movable contact carried by said contact arm and movable thereby into and out of engagement with said stationary contact, operating mechanism comprising a manually operable handle member pivotally supported on a fixed pivotal axis and including an insulating handle portion projecting through said aperture in said top wall, a releasable trip member pivotally supported on a fixed pivotal axis, a toggle linkage connected at one end to said releasable trip member and at the other end to said movable switch arm, spring means interconnecting said manually operable handle member and the knee of said toggle linkage, latch means normally restraining said releasable trip member from movement in a predetermined direction, and current responsive means including a portion adapted to engage said latch means to cause movement thereof to release said releasable means upon the occurrence of predetermined electrical conditions.

2. An electric circuit breaker as set forth in claim 1 wherein the pivotal axis of said movable switch arm is also closer to said front wall than to said rear wall of said casing.

3. In a multipole electric circuit breaker comprising a generally rectangular insulating housing comprising a top wall having a handle-receiving aperture therein and a bottom wall opposite said top wall, a plurality of side-by-side pole chambers in said housing, an arc extinguishing chamber in the portion of each of said pole chambers adjacent said bottom wall, a pair of relatively movable contacts in each said arc chamber, operating mechanism for said relatively movable contacts comprising a manually operable handle supported on a fixed pivotal axis in said housing, a movable trip member supported on a fixed pivotal axis in said housing and movable to cause automatic opening of said contacts, a contact operating member supported on a fixed pivotal axis in said housing between said arc extinguishing chambers and said top wall, a pair of interconnected toggle links connected at one end to said contact operating member and at the other end to said movable trip member, and overcenter spring means interconnecting said handle member and said toggle links.

4. The invention as set forth in claim 3 wherein the operating mechanism is contained in one of said pole chambers, and the contact operating member includes a portion extending across all of said pole chambers.

5. An electric circuit breaker comprising a switch member pivotally supported on a fixed pivotal axis at one end and carrying a relatively movable contact at the other end, a stationary contact adapted to be contacted by said movable contact, means for operating said movable switch member between open and closed circuit positions including a toggle linkage operatively connected to said movable switch arm at one end, a releasable trip member pivotally supported on a fixed piv-

total axis and having a latch projection, latch means for releasably restraining said latch projection in latched position, means supporting the other end of said toggle linkage on said releasable trip member, the pivot point of said releasable trip means and the pivot axis of said movable switch member lying on the opposite side of the line joining the ends of said toggle linkage from said latch projection when said toggle linkage is in said straightened condition.

6. An electric circuit breaker comprising a relatively stationary contact, a movable switch member pivotally supported on a stationary pivotal axis, a movable contact carried by said movable switch member and adapted to be moved thereby into and out of engagement with said stationary contact, manually operable handle means supported on a relatively stationary pivotal axis, and movable between "on" and "off" circuit positions, a releasable trip member pivotally supported on a relatively stationary pivotal axis at one end and having a latch projection, latch means normally engaging said latch projection and restraining said releasable trip member from movement in a predetermined direction, current responsive means for causing releasing movement of said latch member to cause release of said releasable member, a toggle linkage operatively connected to said movable switch arm and operable between collapsed and straightened conditions to operate said movable switch arm between open and closed circuit conditions respectively, means operatively connecting said manually operable handle means and said toggle linkage to permit operation of said toggle linkage between said collapsed and straightened conditions by said manually operable handle member, the pivotal axis of said releasable trip means and of said movable switch member both lying on the side of said toggle linkage opposite from said latch projection when said linkage is in said straightened condition.

7. An electric circuit breaker comprising an insulating housing, at least one pair of relatively movable contacts in said housing, operating means in said housing for operating said contacts comprising a manually operable handle member pivotally supported for movement about a fixed pivotal axis, a contact operating member pivotally supported for movement about a fixed pivotal axis, a releasable member supported for movement about a fixed pivotal axis and having a latch projection, a pair of toggle links interconnecting said contact operating member and said releasable member, overcenter spring means interconnecting said manually operable member and the knee of said toggle, the pivot point of said contact operating member and the pivot point of said releasable member being on the side of the line generally defined by

said toggle links opposite from said latch projection in their straightened condition.

8. An electric circuit breaker comprising an insulating housing, a manually operable handle member pivotally supported on a fixed pivotal axis in said housing, a releasable trip member pivotally supported in said housing on a fixed pivotal axis at one point and releasably latched against movement relative to said housing at another point, a movable switch member pivotally supported on a fixed pivotal axis in said housing, an operating linkage including a pair of interconnected toggle links connected at one end to said movable switch member and at the other end to said releasable member, resilient spring means connected between the knee of said toggle links and said manually operable member, the fixed pivotal axis of the movable switch member being immediately adjacent the fixed pivotal axis of said releasable member, said switch member axis and said releasable member axis being on the side of the line generally defined by said toggle links in their straightened condition opposite from said latched point of said releasable member.

9. An electric circuit breaker comprising an insulating housing, a manually operable handle member supported in said housing on a fixed pivotal axis, a movable switch member supported in said housing on a fixed pivotal axis, a releasable trip member supported on a fixed pivotal axis in said housing at one point and releasably latched against movement with respect to said housing at another point, an operative connection between said manually operable handle member and said movable switch member including a pair of toggle links and resilient spring means, said toggle links being movable between straightened and collapsed positions to move said movable switch member between closed and open positions, the fixed pivotal axes of said movable switch member and said releasable member being on the opposite side of the line defined by said toggle links when in their straightened condition, said latched point of said releasable trip member.

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