March 2, 1965 D. B. POWELL 3,171,928

ELECTRIC CIRCUIT BREAKER WITH CAM SURFACES AND WEDGING ROLLER

Filed Dec. 5, 1962 2 Sheets-Sheet 1

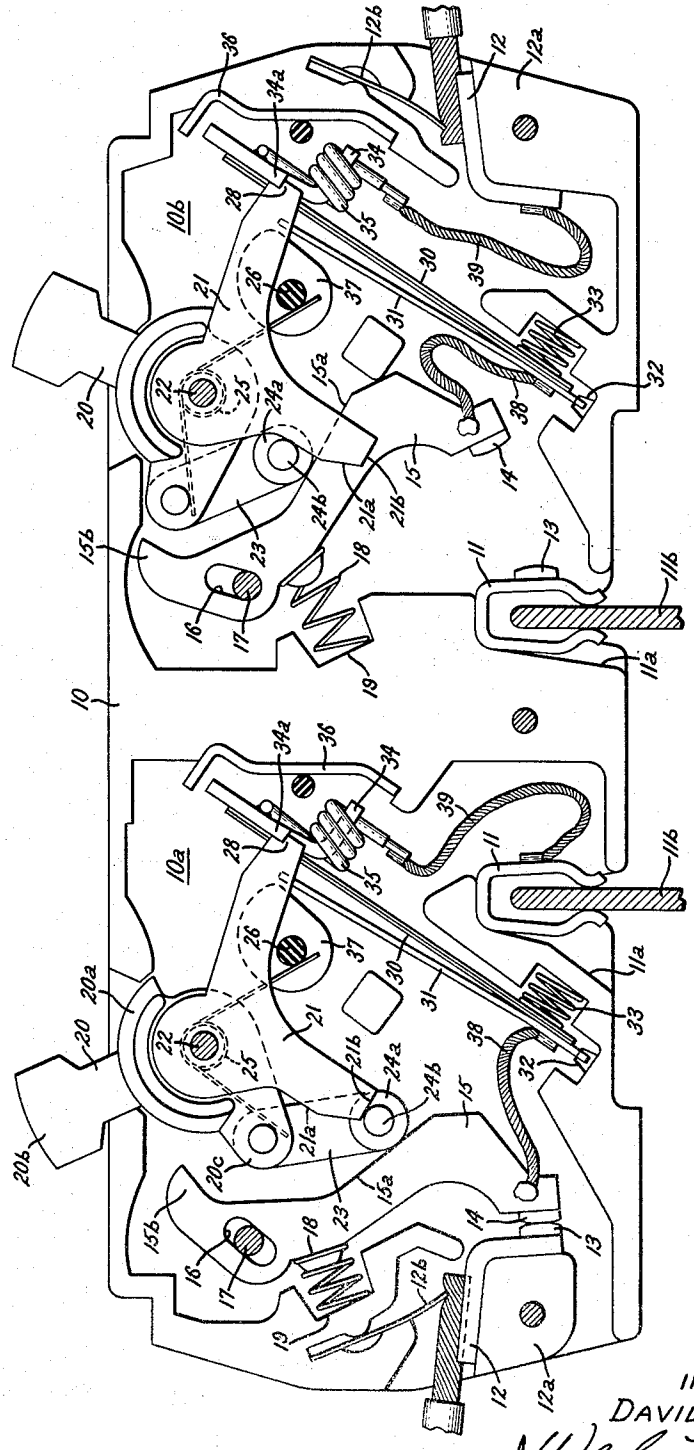


FIG. 1.

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FIG. 2.

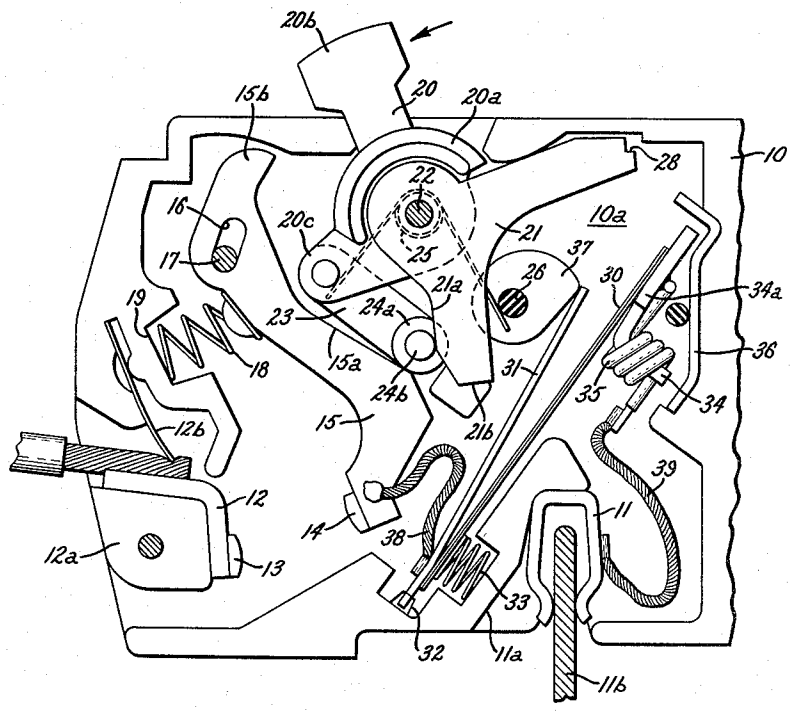
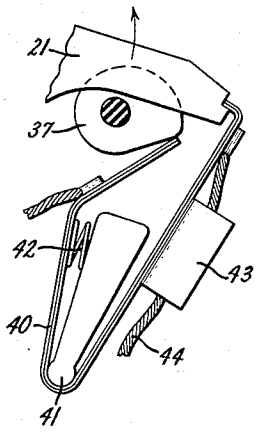


FIG. 3.



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ELECTRIC CIRCUIT BREAKER WITH CAM SURFACES AND WEDGING ROLLER

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7 Claims. (Cl. 200—116)

My invention relates to electric circuit breakers, and particularly to improved operating mechanism for small manually operable, current responsively tripped air circuit breakers of a type well adapted for multiple mounting in distribution panelboards and loadcenters. Such circuit breaker loadcenters and panelboards are in wide use in residential and commercial service entrance installations to control lighting and power circuits.

In order that small air circuit breakers may be economically used in service entrance and other distribution panelboards, it is necessary that the individual breakers be of simple and inexpensive construction and adapted to low cost, large scale assembly from a minimum number of inexpensive punched or molded parts. On the other hand, such breakers must be strong, dependable and long-lasting in operation despite extended periods of service without contact opening action of any kind. They must provide positive quick-break action in both manual and automatic operation and dependable accurate overload response despite long periods of inactivity. Preferably, such breakers should be adapted for single or multipole construction in casings adapted for close side-by-side and endwise juxtaposition. It is desirable that mounting and connection be simplified by simple plug-in line connection and quick detachable load circuit connection.

Accordingly, it is a principal object of my invention to provide an improved electric circuit breaker of the manually operable, automatically tripped type having an inexpensive but reliable quick-acting operating mechanism adapted for disposition in a casing of very small dimension.

It is another object of my invention to provide an improved overcenter actuating mechanism for small manually operable air circuit breakers formed of a small number of parts and providing positive quick-break action in both manual and automatic operation.

It is a more specific object of my invention to provide an improved manually operable, overcurrent responsively tripped electric circuit breaker having a cam and wedge type mechanism providing overcenter action and strong contact "wiping" action in manual operation.

It is still another object of my invention to provide in a manually operable current responsively tripped circuit breaker, a simple, inexpensive and easily assembled operating mechanism which is trip-free and automatically resets in overload operation.

In carrying out my invention in one preferred embodiment, I provide a side opening casing of suitable molded plastic insulating material integrally formed to provide in one part of the casing means for mounting all operative parts of the breaker in cooperating relation. One such simplified mechanism comprises a rotary operating handle and a releasable cam member separately mounted upon a common pivot, and a current-responsive overload tripping member pivotally mounted at a second point in the casing and biased into normal latching engagement with the releasable cam. Adjacent the camming surface of the releasable cam member is a movable contact arm pivotally mounted in th casing by a pin and slot connection and having a substantially linear lateral surface which in open circuit position of the arm converges toward and preferably angularly intersects the cam

surface of the releasable cam. For manual action of the contact arm between open and closed circuit position, there is provided an actuating link pivotally mounted eccentrically upon the operating handle and disposed to be forceably driven as a prop or wedge between the converging cam surfaces of the contact arm and releasable cam to force them apart.

In the foregoing cam and wedge mechanism, the cam surface of the releasable cam is formed to provide an angular high spot or apex over which the roller passes with an overcenter locking action in closing and snap action in opening action. The cam surface of the contact arm and the pin and slot connection of that arm are so angularly disposed with respect to each other and with respect to the plane of the fixed contact surface that a strong sliding or wiping contact action occurs after engagement and before manual disengagement. By suitable shaping and disposition of parts, the sliding contact action may be made to provide a "scrubbing" or to-and-fro movement. In addition, a positive weld breaking action in manual and automatic operation is preferably provided by biasing the pivoted handle to open position and providing it with a portion disposed to engage a projection upon the contact arm and to exert an opening impact in the event of contact welding.

Further objects and advantages of my invention will be apparent to those skilled in the art from the following detailed specification taken in conjunction with the accompanying drawings in which:

FIG. 1 is an elevational view of two separate circuit breakers embodying my invention disposed in end-to-end or tandem relation in a single casing, one side of the casing being removed to show one breaker mechanism in closed position and the other mechanism in the manual open position;

FIG. 2 is an elevational view of one of the circuit breaker mechanisms shown at FIG. 1 showing the parts in tripped position but with the operating handle forceably held in the "on" position; and

FIG. 3 is an elevational detail view of a current responsive latching member of modified configuration.

Referring now to the drawing, and particularly to FIG. 1, the two circuit breakers **10***a* and **10***b* there illustrated are disposed in end-to-end relation in a simple casing **10** which is preferably formed of a suitable molded plastic insulating material. The breakers are of substantially identical construction and are shown, respectively, in their closed and manual open positions. Each breaker comprises a plug-in type line terminal clip **11** mounted within a slot **11***a* in the lower wall of the casing **10**, and a load terminal member **12** mounted upon an internal casing abutment or support member **12***a* and disposed adjacent an opening in an end wall of the casing. The line terminal clips **11** are shown in position on a pair of bus bars **11***b* forming part of a suitable panelboard base (not shown). The load terminal **12** is shown as a quick detachable type formed of an L-shaped conductor having one leg longitudinally notched to receive a straight load wire which is held in place by an angularly disposed locking spring **12***b*. Such a terminal is more fully described and claimed in Patent 2,705,785—Benander.

The electrical circuit between the line and load terminals include a pair of separable switch contacts **13** and **14**. In the circuit breaker **10***a* of FIG. 1, the contact **13** is fixedly mounted upon one arm of the L-shaped load terminal member **12**, and the contact **14** is mounted upon a movable contact arm **15**. At is end remote from the movable contact **14**, the contact arm **15** is provided with an elongated slot **16** by means of which it is pivotally and slidably mounted upon a fixed pivot pin **17** supported by the casing **10**. The contact arm **15** is sub-

stantially inflexible or rigid and is biased to open circuit position by means of a compression spring **18** disposed between an intermediate point of the arm **15** and a recessed seat of abutment **19** formed in the molded casing **10**. In the circuit breaker **10***b* the line and load terminals are reversed relative to the mechanism so that when the breakers **10***a* and **10***b* are mounted end to end, both load terminals are at the outside ends and the handles move in the same directions to open and close the contacts.

For manually actuating the movable contact arm **15** between open and closed circuit positions and automatically releasing the arm for movement to open circuit position in response to overcurrent conditions, I provide an operating mechanism comprising a manually operable rotary handle member **20** and a releasable cam member **21** separately and pivotally mounted upon a common fixed pivot pin **22** carried by the casing **10**. The manually operable handle member **20** is formed as a centrally apertured substantially circular disk having about part of its periphery an arcuate laterally overhanging rim **20***a* from which there extends radially through an aperture in the casing a handle lever **20***b*. Adjacent one end the arcuate rim **20***a*, there is pivotally and eccentrically mounted on the handle member **20** an actuating link **23** which carries at its other end a pair of ocaxial cam rollers **24***a*, **24***b*. The opposite end of handle rim **20***a* provides a shoulder or abutment for use in automatic resetting after overcurrent operation as will be more fully described hereinafter. The handle member **20** is biased to its switch-opening or "off" position (clockwise as shown in the drawing) by means of a torsion spring **25** which encircles the pivot pin **22** and has one end engaging a pin **26** in the casing and another extended end engaging a shoulder on the handle member **20**.

The releasable cam member **21** is swingably mounted upon the pivot pin **22** and provided with a latching shoulder **28** engageable by a current responsive overcurrent trip unit thereby normally to restrain the cam member against movement in one direction. As shown in the drawing, the cam member **21** is latched against counterclockwise movement. One side of the cam member **21** is disposed in proximate spaced relation to the movable contact arm **15** and is formed to provide a camming surface cooperable with the roller **24***b*. The cam surface of the member **21**, while essentially linear, is formed of two adjacent angularly disposed sections **21***a* and **21***b* terminating in an intermediate high point or apex extending toward the pivoted contact arm **15**. The adjacent lateral surface of the rigid contact arm **15** provides a substantially linear cam surface **15***a* for simultaneous cooperation with the cam roller **24***a*. The essentially linear cam surfaces **15***a* and **21***a*, **21***b* are relatively angularly disposed so that they mutually converge in the direction of closing movement of the actuating link **23**, the surfaces preferably intersecting in the open position as shown at FIG. 1. In operation, the rollers **24***a* and **24***b* are driven with a wedging action between the contact arm surface **15***a* and the normally fixed cam surface **21***a*, **21***b* thereby to force the contact arm **15** into contact-closing position with an overcenter or snap action as the roller **24***a* moves over the apex between the cam surfaces **21***a* and **21***b*.

The pivoted handle member **20** is provided with stop means, as by engagement between the operating lever **20***b* and the end of the casing slot through which it protrudes, so positioned that in contact-closing movement the cam roller **24***b* is stopped in a position just slightly beyond the apex of the cam surface **21***a*, **21***b*. In order to permit this overcenter movement after engagement of the contacts **13** and **14**, the pivotally mounted upper end of the rigid contact arm **15** is provided with an elongated aperture or slot **16** allowing slight lateral sliding movement upon its pivot pin **17**. The slot **16** extends in a direction generally transverse of the contact arm **15** so that after engagement of the contacts **13** and **14**, the spring **18** may be further compressed by sliding movement of the pivoted end of the contact arm as the roller **24** passes over center on the apex.

In addition to its function in permitting overcenter action of the wedging actuator, the pin and slot mounting of the contact arm **15** is utilized to provide a sliding or wiping action of the contacts **13** and **14** in closing movement. To this end the substantially linear cam surfce **15***a* of the contact arm **15** is disposed at an appreciable angle with respect to the plane of the contact surfaces, and the contact arm slot **16** is disposed non-perpendicular to these surfaces. Preferably the contact arm slot **16** extends at an angle of about 45 degrees with respect to the plane of the contact surfaces when the contact arm **15** is in its closed position, and the cam surface **15***a* is substantially perpendicular to the longitudinal axis of the slot **16**. With this disposition of the contact arm **15**, the roller **24***a* exerts upon the arm in its position of initial contact engagement a transverse force having a component parallel to the plane of the contact surfaces, and the sliding overtravel movement of the contact arm **15** upon its pivot pin **17** constrains the arm **15** to move slightly downwardly. Accordingly, as the roller **24***b* approaches its cam apex, the contact arm **15** first engages the contacts **13**, **14** and then overtravels slightly by sliding of its other end on the pin **17**. In this sliding movement the contact-carrying end of the arm **15** moves parallel to the plane of contact engagement and thus engages the contacts with a sliding action. After the roller **24***b* passes beyond its cam apex, the contact spring **18** causes a slight reverse sliding movement on the pivot pin **17** and a consequent reverse sliding of the contacts. This to-and-fro sliding or wiping movement in contact engagement is referred to as "scrubbing" engagement and is very effective to minimize contact sticking and welding. The amount of reverse slide or wipe depends upon the amount of cam overtravel and the amount of lateral lost motion in the pin and slot connection **16**, **17**.

To permit the overcenter wedging action in manual contact closing operation as described above, the releasable cam member **21** is normally latched against rotational movement away from the cam roller **24***b*. For this purpose I provide an overcurrent responsive trip unit including a thermally deformable bimetallic strip **30** and a rigid mounting bar **31** fixed together at one end and extending in substantially parallel spaced-apart relation to form a generally V-shaped structure. The thermally deformable strip **30** is so disposed that when heated, its free end moves away from the bar **31** thereby to open up the V-shaped trip unit. The trip unit is loosely pivotally mounted at its connected end in a recess or seat **32** in the casing **10** and biased toward the cam member **21** by means of a compression spring **33**. At its free or movable end the thermal strip **30** carries an L-shaped magnetizable bar **34** having on one leg a latch finger **34***a* to cooperate with the latching shoulder **28** of the cam **21**. The other leg of the bar **34** extends outwardly from the bimetal strip **30**, and serves as a magnetizable frame for a magnet coil **35**. For magnetic trip action on high overloads the electromagnet **34**, **35** is attracted to a fixed armature piece **36** carried by the casing **10**.

The upper or free end of the trip mounting bar **31** is disposed adjacent an adjustable casing abutment shown as a rotatable cam **37** mounted upon the pin **26**. By adjusting the cam **37** when the thermal strip **30** is cold, the initial position of the biased trip unit may be set to provide a desired latch overlap and thermal overload setting.

The electrical circuit through the breaker **10***a* extends from the load terminal **12** through the contacts **13** and **14** to the contact arm **15**. From the arm **15** a flexible electrical connector **38** is connected to one end of the bimetallic member **30**, and from the remote end of the member **30**, the coil **35** and a flexible connector or braid **39** in series connect to the line terminal **11**. In the

breaker 10*b* of FIG. 1, the line and load terminals are reversed, as previously pointed out, but the two breaker mechanisms are otherwise identical.

It will now be evident to those skilled in the art that in manual operation the circuit breaker mechanism described is actuated between open and closed circuit positions by movement of the handle 20. As shown in the drawing, the breaker contacts are open when the handle lever 20*b* is in its clockwise position, as illustrated in the breaker 10*b* of FIG. 1. When the handle 20 is moved counterclockwise as shown in the drawing, the pivoted actuating link 23 is moved downwardly, and the rollers 24*a*, 24*b* forced with wedging action between the linear cam surface 15*a* on the contact arm 15 and the apexed cam surfaces 21*a*, 21*b* on the releasable cam member 21. The quick-make overcenter action and scrubbing contact engagement resulting from this closing movement have been described in detail above. In closed position the wedging roller 24*b* is held strongly against the cam surface 21*b* by means of the strong contact arm bias spring 18 and with sufficient force to overcome the return bias of the handle spring 25. For manual opening of the contacts 13 and 14, the handle lever 20*b* is moved in a clockwise direction as shown in the drawing, thus raising the actuating link 23 and removing the rollers 24*a*, 24*b* from wedging relation between the contact arm 15 and releasable cam 21. In this reverse or opening movement, passage of the wedging roller 24*b* over the apex between the cam surfaces 21*a* and 21*b* produces an overcenter or snap action resulting in quick break of the contacts.

Tripping action of the circuit breaker mechanism is independent of the operating handle position, i.e. the breaker is trip-free. To best illustrate this action, FIG. 2 shows the parts in tripped position with the operating handle held in the "on" position. It will be understood that since the handle 20 is strongly biased to its "off" position, the trip-free position shown at FIG. 2 is not a stable or normal position of the parts.

In tripping operation the mechanism is initially in the "on" position shown at the left side of FIG. 1. In this position, force exerted by the contact biasing spring 18 against the contact arm 15 holds the arm 15 firmly against the wedging roller 24*a* and presses the wedging roller 24*b* against the cam surface 21*b* of the releasable cam member 21. This force, being eccentric to the pivot point of the cam 21, tends to rotate the cam 21 in a counterclockwise direction as shown in the drawings, but such rotation is normally prevented by latching engagement of the cam with the latching finger 34*a*. When the latching finger 34*a* is removed from engagement with the shoulder 28, either by thermal action deforming the bimetallic member 30 or by a magnetic action moving it bodily out of engagement with the shoulder 28, the releasable cam member 21 is rotated about the pivot 22 to the position shown at FIG. 2 under the action of the contact arm bias spring 18. In so moving, the cam 21 permits the actuating link 23 to swing about its pivot on the handle member 20 and thus release the contact arm 15 for opening movement under direct action of the spring 18. It will be observed that in this releasing movement there is no tendency for the opening spring 18 to produce any return movement of the handle member 20. However, unless held manually in the trip-free position of FIG. 3, the handle member 20 does return to its "off" or open circuit position under the influence of its own biasing spring 25 as soon as the wedging relation between the contact arm 15, the rollers 24*a*, 24*b* and the cam 21 is released.

When the circuit breaker is tripped as described above, automatic return movement of the operating handle 20 under the influence of its biasing spring 25 effects automatic reset of the breaker parts. This is accomplished by reason of the fact that one end of the arcuate rim 20*a* on the handle member 20 engages the upper edge surface of the releasable cam member 21 and carries that member in a clockwise direction as shown back toward its latching position as shown in the breaker 10*b* of FIG. 1. Thus the open or "off" position of breaker 10*b* is also the automatic "reset" position of the breaker mechanism. In actual tripping operation when the handle 20*b* is not held in closed position, the cam member 21 moves in a counterclockwise direction only sufficiently to permit passage of the roller 24*b* over the cam apex. It is not necessary for this purpose that the cam 21 move all the way to the position of FIG. 2, and prior to any such displacement, the biased operating member 20 engages the cam 21 to press again into latching position to await return of the latch finger 34*a*.

An additional feature of my improved switch operating mehcanism resides in means provided to impart an opening impact blow to the contact arm 15 in both manual and automatic opening operation in the event of contact sticking or welding. To this end the pivoted handle member 20 is formed to provide a radial arm 20*c* upon which the roller link 23 is eccentrically pivoted. As previously described the handle member 20 is biased to "off" or open circuit position (10*b* of FIG. 1) by a spring 25. In addition, a projection 15*b* of the contact arm 15 extends upwardly beyond its pivot 16, 17. The projection 15*b* is so shaped that when the arm 15 is in closed position, the projection extends into the arcuate path of movement of the handle arm 20*c* between the "on" and "off" handle positions. Thus if the contacts 13, 14 stick to hold the contact arm in closed position in either manual or automatic opening operation, the handle arm 20*c* strikes the contact arm projection 15*b* to ensure positive separation of the contacts.

At FIG. 3 I have shown a fragmentary side elevational view of another embodiment of my invention in which the trip unit is formed of a single U-shaped strip or hairpin 40 bimetal loosely pivotally mounted at its bight on a casing abutment 41. One leg of the bimetal 40 is turned over to form a latch finger, and the other leg is biased by a spring 42 against the adjusting cam 37. A U-shaped magnetizable frame 43 mounted on the latch leg cooperates in well known manner with a conducting lead 44 to provide magnetic tripping action.

While I have described a preferred embodiment of my invention by way of illustration, many modifications will occur to those skilled in the art, and I therefore intend in 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 casing having a fixed contact mounted therein, an elongated contact arm pivotally mounted in said casing for movement between open and closed circuit positions, said contact arm having a first cam surface at one side thereof and carrying remote from its pivot a movable contact engageable with said fixed contact, means biasing said contact arm to open circuit position, a manually operable rotary handle member pivotally mounted in said casing and movable between "on" and "off" positions, a releasable cam member pivotally mounted in said casing coaxially with and closely adjacent said pivotally mounted handle member, said cam member being movable between a normal latched position and a released position, said releasable cam member having a second cam surface adjacent said contact arm and converging toward said first cam surface when said cam member is in said latched position and said arm is in said open circuit position, an actuating link pivotally and eccentrically mounted on said handle member and having at its free end a cam follower interposed between said cam surfaces in wedging relation to move said contact arm to circuit closing position against its bias when said handle member is moved to said "on" position, said handle member having a portion engaging said releasable cam member and moving said cam member from said released to said latched position when said

handle member is moved from said "on" to said "off" position.

2. An electric circuit breaker as set forth in claim 1 wherein said contact arm includes a portion extending beyond its pivotal support in said casing in a direction generally opposite to said movable contact, said handle member having a portion engaging said extending portion of said contact arm when said handle is moved to said "off" position and said contact arm is in said "on" position, to forcibly move said contact arm away from said "on" position if abnormally held in said "on" position such as by contact welding or sticking.

3. An electric circuit breaker as set forth in claim 2, said circuit breaker also including means biasing said handle to contact opening position, said handle member engaging said releasable cam member when released to return it automatically to said latched position.

4. In an electric circuit breaker, a casing having a fixed contact mounted therein, a rigid contact arm slidably and pivotally mounted in said casing for movement between open and closed circuit positions, said contact arm providing along one side thereof a first cam surface and carrying remote from its pivot a movable contact engageable with said fixed contact, means biasing said contact arm to open circuit position, a releasable cam member pivotally mounted in said casing, said cam member being movable between a latched position and a released position, and having a second cam surface adjacent said contact arm and converging toward said first cam surface when said cam member is in said latched position and said arm is in said open circuit position, current responsive latch means normally retaining said releasable cam member in said latched position, a rotary handle member pivotally mounted in said casing, said handle member having a shoulder engageable with said releasable cam member, an actuating link pivotally and eccentrically mounted on said handle member and having at its free end a cam follower interposed between said cam surfaces in wedging relation to move said contact arm to circuit closing position against its bias, and means biasing said rotary handle to a contact opening position, said handle member engaging said releasable cam member when released to return it automatically to said latched position.

5. In an electric circuit breaker, a casing having a fixed contact mounted therein, a rigid contact arm slidably and pivotally mounted in said casing intermediate its ends for movement between open and closed circuit positions and carrying at one end a movable contact engageable with said fixed contact, said arm having at its other end a movable projection and providing along one side thereof a first cam surface, means biasing said contact arm to open circuit position, a releasable cam member pivotally mounted in said casing, said cam member being movable between a latched position and a released position, and having a second cam surface adjacent said contact arm and converging toward said first cam surface when said cam member is in said latched position and said arm is in said open circuit position, current responsive latch means normally retaining said releasable cam member in said latched position, a rotary handle member pivotally mounted in said casing, said handle member having a radially extending arm and providing a shoulder engageable with said releasable cam member, an actuating link pivotally mounted upon said radial arm and having at its free end a cam follower interposed between said cam surfaces in wedging relation to move said contact arm to circuit closing position against its bias, said contact arm projection being movable into the path of said radial arm in closed circuit position, and means biasing said rotary handle to a contact opening position, said handle arm striking said contact arm projection to positively open said contacts and said handle shoulder engaging said releasable cam member when released to return it automatically to said latched position.

6. In an electric circuit breaker, a casing having a fixed contact mounted therein, a rigid contact arm slidably and pivotally mounted in said casing for movement between open and closed circuit positions, said contact arm providing along one side thereof a first cam surface and carrying remote from its pivot a movable contact engageable with said fixed contact, means biasing said contact arm to open circuit position, a releasable cam member pivotally mounted in said casing, said cam member being movable between a latched position and a released position, and having a second cam surface adjacent said contact arm and converging toward said first cam surface when said cam member is in said latched position and said arm is in said open circuit position, said second cam surface forming an apex adjacent one end thereof, current responsive latch means normally retaining said releasable cam member in said latched position, a rotary handle member pivotally mounted in said casing, said handle member having a shoulder engageable with said releasable cam member, an actuating link pivotally and eccentrically mounted on said handle member and having at its free end a cam follower roller means interposed between said cam surfaces in wedging relation to move said contact arm to circuit-closing position against its bias, said roller means being movable over said cam apex to lock said contact arm in closed circuit position and provide quick break manual opening operation, and means biasing said rotary handle to a contact opening position, said handle member engaging said releasable cam member when released to return it automatically to said latched position.

7. In an electric circuit breaker, a casing having a fixed contact mounted therein, a rigid contact arm slidably and pivotally mounted in said casing for movement between open and closed circuit positions, said contact arm being slidable on its pivotal mounting in a direction transverse to its lengthwise direction and non-perpendicular to the surface of said fixed contact and providing along one side thereof a first cam surface, a movable contact mounted on said contact arm at a point remote from its pivot for engagement with said fixed contact, means biasing said contact arm to open circuit position, a releasable cam member pivotally mounted in said casing, said cam member being movable between a latched position and a released position, and having a second cam surface adjacent said contact arm and converging toward said first cam surface when said cam member is in said latched position and said arm is in said open circuit position, said second cam surface forming an apex adjacent one end thereof, a rotary handle member pivotally mounted in said casing and having a shoulder engageable with said releasable cam member, an actuating link pivotally and eccentrically mounted on said handle member and having at its free end roller means interposed between said cam surfaces in wedging relation to move said contact arm to circuit-closing position against its bias, said roller means moving over said cam apex after initial contact engagement to provide a contact-wiping action and to lock said contact arm in circuit-closing position, and means biasing said rotary handle member to a contact opening position, said handle member engaging said releasable member when released to return it automatically to said latched position.

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