Feb. 21, 1967 A. R. NORDEN 3,305,806

AUTOMATICALLY RESETTABLE CIRCUIT BREAKER HAVING TWO SERIALLY CONNECTED TOGGLES

Filed Aug. 7, 1964

3 Sheets-Sheet 1

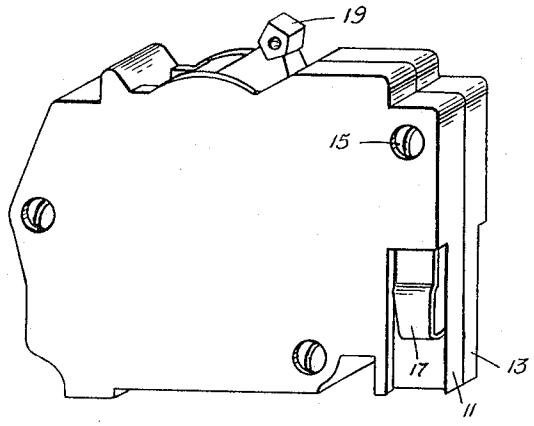


Fig. 1

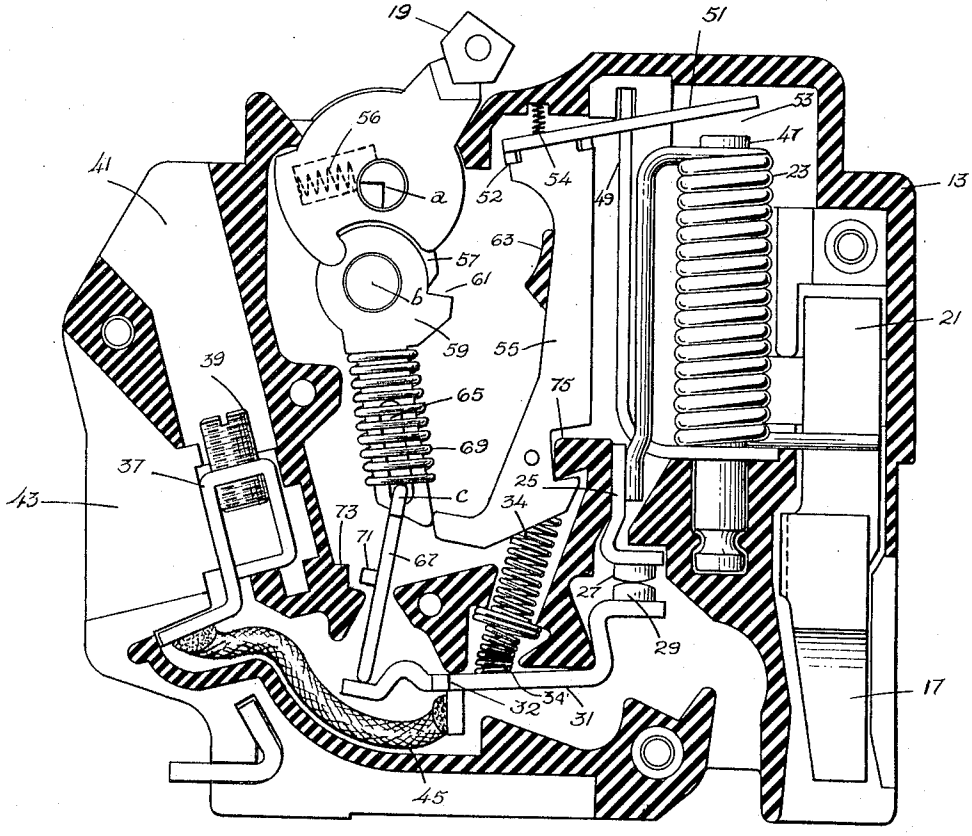


Fig. 2

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Fig. 2a

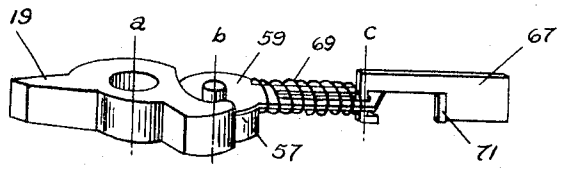
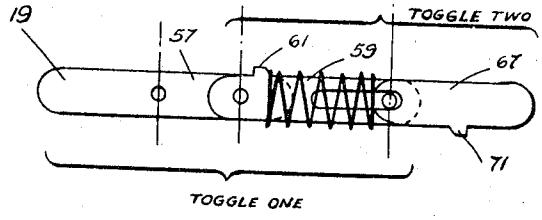


Fig. 2b



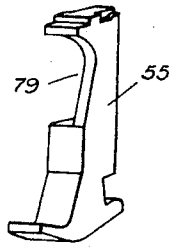


Fig. 2c

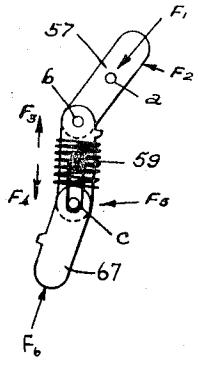


Fig. 3a

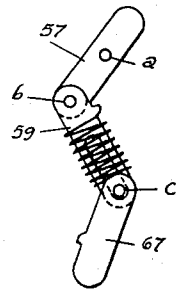


Fig. 4a

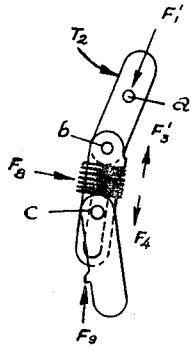


Fig. 6a

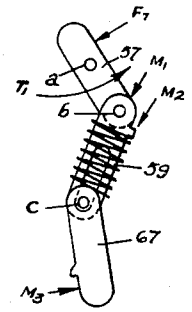


Fig. 5a

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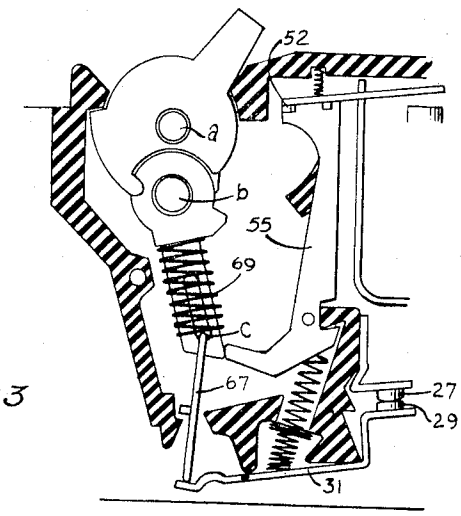


Fig. 3

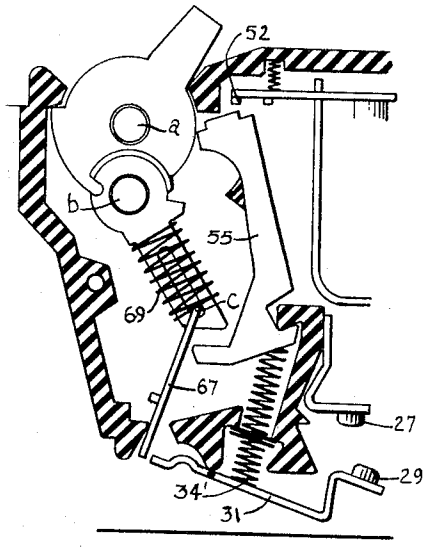


Fig. 4

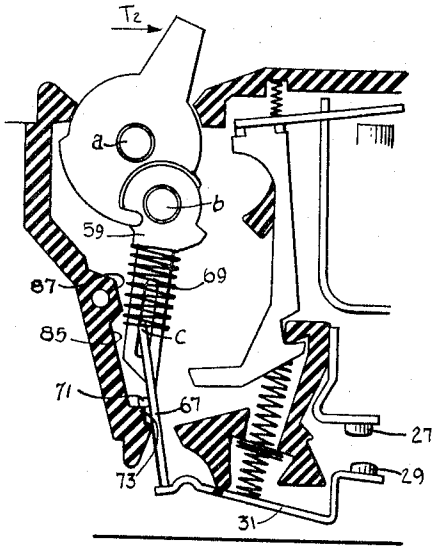


Fig. 6

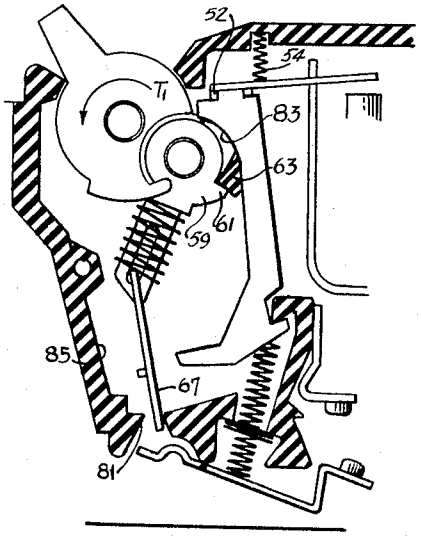


Fig. 5

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United States Patent Office 3,305,806
Patented Feb. 21, 1967

3,305,806

AUTOMATICALLY RESETTABLE CIRCUIT BREAKER HAVING TWO SERIALLY CONNECTED TOGGLES

Alexander R. Norden, New York, N.Y., assignor to Murray Manufacturing Corporation, Brooklyn, N.Y., a corporation of New York

Filed Aug. 7, 1964, Ser. No. 388,259
19 Claims. (Cl. 335—174)

This invention relates generally to a circuit controlling instrumentality serving the dual function of circuit overload protection and switch, and in particular to the trippable mechanism of a molded case circuit breaker.

It is often desirable, if not necessary, to protect electrical equipment against shorts and overload conditions as well as providing means for controlling the operational status of the associated equipment via a manually operable switch. Because a circuit breaker is capable of serving both these functions, it has enjoyed widespread commercial and household application.

The protection provided by a circuit breaker is automatic; the breaker responding to a predetermined current condition to open the contacts maintaining the line-to-load continuity. Breakers may be classified by the manner in which they respond to the current. Those which are responsive to the heat effect of current are known as thermal breakers, those which respond to a magnetic flux produced by the current are called electromagnetic breakers, and those which are responsive to both of the foregoing are designated thermal-magnetic breakers. While this invention applies to each of the foregoing types, the mode chosen for illustrative purposes is the second, hereinafter called a magnetic breaker, which will, for the sake of brevity, be referred to exclusively.

As a rule, a breaker is set by manually closing the electrical contacts through a trippable linkage, the linkage being actuated by a current responsive device to trip upon overload, either immediately or after a predetermined overload time, thereby opening the contacts. In magnetic breakers the tripping force is provided by the magnetic flux induced by a coil through which the load current passes; the flux acting upon a magnetic element which directly or indirectly latches the linkage. Reset, which is to be distinguished from the reclosing of the contacts, is either automatic or manual, and in the latter case, is effected by urging the breaker handle to the full OFF position. Subsequently, by placing the handle in the ON position, the circuit continuity is reestablished by the resultant closing of the contacts.

Conventional breakers of the molded case type possess a wide variety of trippable mechanisms operating on diversified principles. They suffer, however, from one or more of the following disadvantages which this invention is directed at obviating.

The most notable of the shortcomings found in conventional trippable mechanisms are their complexity and the excessive breaker dimensions they require. While the art has endeavored to eliminate both of these disadvantages, it has proven to be extremely difficult without sacrificing cost, reliability or some desirable feature such as automatic reset, or the ability of the contacts to both close and open quickly. Considerations such as the dependency of the necessary tripping force upon the size of coil required to develop the necessary magnetic field, and the dependency of reliability upon dimensional tolerances, particularly where the units are to be minimized in size, complicate the picture.

Accordingly, it is an object of the invention to provide a trippable mechanism which is simple, reliable, economical, and does not require stringent tolerances.

It is another object of this invention to provide such

a mechanism as may be embodied in a breaker, the external thickness of which may be maintained at a minimum commensurate with the functions and attributes desired.

It is another object of this invention to provide such a mechanism wherein the contacts snap closed, in contradistinction to breakers in which the contacts close with a velocity dependent upon the speed with which the handle is manually actuated.

It is a further object of this invention to provide such a mechanism as will automatically reset upon being tripped.

It is a still further object of this invention to provide a linkage capable of being tripped with a small tripping force.

It is a feature of this invention to provide a circuit breaker of external thickness one-half that occupied by a standard one inch breaker, and to provide such a breaker with a side wiping line contact for the load center (panelboard) busbar stabs, such as is disclosed in copending application Ser. No. 233,738, filed October 29, 1962 to the same assignee. This arrangement, as opposed to breakers which sit astride the stabs, doubles the pole capacity of conventional load centers without the necessity of bus bar modification. Further advantages of half-thickness breakers may be found in the just alluded to application.

Briefly, the invention is predicated upon a novel trippable mechanism characterized by a trippable linkage comprising a pair of toggles serially coupled to the breaker handle; the pair having a common lost motion arm capable of storing energy upon handle rotation and releasing the energy, at a predetermined handle displacement, as a thrust upon a biased movable contact, thereby closing the breaker; the second toggle assuming a knee-out position and resting upon a latched trip lever which, upon overload, unlatches, releasing the knee and allowing the movable contact to assume its open condition. An automatic reset function is provided by internally biasing the breaker handle. Since each component is designed to mount and operate in a common plane the resulting mechanism is laterally compact.

The above mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will best be understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a perspective view of the exterior of a molded case circuit breaker embodying the invention;

FIG. 2 is a side view, with cover removed, illustrating the internal arrangement of breaker parts;

FIG. 2(*a*) is a detail of the serial toggle pair of FIG. 2;

FIG. 2(*b*) shows the conventional symbolism to be employed in describing the toggle pair function;

FIG. 2(*c*) is a detail of the molded trip lever of FIG. 2;

FIGS. 3, 4, 5 and 6 illustrate the circuit breaker trippable mechanism in four sequential positions of operation: FIG. 3 is the normal ON position; FIG. 4 depicts the tripped condition with the handle held ON for purposes of illustration; FIG. 5 shows the reset position; and FIG. 6 illustrates the energy storage condition.

FIGS. 3(*a*), 4(*a*), 5(*a*) and 6(*a*) correspond to FIGS. 3, 4, 5 and 6 for illustrating in symbolic form the various positions of the toggle pair and the forces acting thereon.

FIG. 1 illustrates the exterior of the magnetic circuit breaker housing. The casing, which is preferably molded of insulator material such as Bakelite, consists of two parts **11** and **13** in interlocking engagement. Three countersunk bolts **15**, which pass through the casing to secure the opposing sections, are retained by a corresponding number of nuts (not shown). Needless to say,

in place of the bolts and nuts, rivets may be advantageously employed. The forward lower portion of the casing is cut away on both sides to expose a contact 17 adapted to engage, in side-wiping fashion, a bus bar stab carrying the line voltage, as will be described. The contact itself is removably mounted internally; a provision which allows it to be disposed on the side of the housing corresponding to that at which the bus bar stab appears. The necessity for such an arrangement becomes apparent when one considers that a feature of the present invention is the provision of a breaker having a one-half inch outside thickness and that such a breaker must conform to existing bus bar configurations where the stabs are separated by one inch.

A pivoted handle 19 is provided at the top of the casing, and emerges from a raised portion which fits into a complementary opening in a circuit breaker mounting panel. Thus, for example, in a load center a panel is provided to accommodate a plurality of juxtaposed breakers, only the raised portions and handles of which are apparent.

Removal of the forward casing portion reveals the internal mechanism illustrated in FIG. 2. Although the peripheral casing parts appear of equal thickness in FIG. 1, this is not necessarily true of the interior, and preferably one part is of sufficient internal thickness to receive and retain the various components. Since this is the part 13 in FIG. 2, it will be designated hereinafter the casing while part 11 will be referred to simply as the cover; the latter corresponding in internal configuration to the former.

In order to more clearly delineate the functions of the various breaker constituents, the electrical and mechanical components will be discussed, at first, separately; the interrelationship between the two will follow.

The input to the electrical circuit is via the side wiping contact 17. The wiping contact is retained by a laterally centered clip 21 from which the contact is removable for a similar mounting on the reverse side of the breaker. A more detailed description of the relationship and engagement of these elements may be had by reference to the previously alluded to application Serial No. 233,738. Affixed to the clip 21 for example by welding, soldering, brazing or a crimping arrangement, is the electromagnet coil 23, the output of which is led to the stationary contact member 25 bearing contact 27. A complementary movable contact 29 is borne by the contact member or lever 31, pivoted between its extremities at 32, and biased clockwise (open) by a portion 34' of the coil spring 34 disposed in a recess in the molding. The contact lever pivot may be simply formed of perpendicular lever extensions, disposed in corresponding casing and cover recesses. Alternatively, a pivot pin affixed to both the casing and cover may pass through an aperture in the lever.

A wire connector 37 is provided for the output lead. It is preferably formed of a single loop-shaped piece of copper having a tapped opening in the top for the pressure screw 39 and one in the side (not shown) for admitting the wire. Passageways 41 and 43 provide screwdriver and wire access, respectively, to the connector.

Coupling the wire connector 37 to the contact lever 31 is a flexible lead 45 which is affixed to each member by any of the methods previously mentioned. This completes the line-to-load electrical circuit, which is of course dependent upon the position of the movable contact lever 31 for continuity.

Before turning to the mechanical aspects of the breaker, the electromagnetic circuit will first be described. The coil 23, since it is in series with, and therefore carries the load current, generates a magnetomotive force (M.M.F.) directly dependent upon the value of this current. The magnetic path for the M.M.F. generated flux consists of the serial combination of core 47, side armature or yoke 49, movable armature 51 (pivoted on armature 49) and air gap 53. Except for the air gap the circuit is of low reluctance. The force upon the opposing surfaces at the gap is dependent upon the flux density which is in turn a function of the coil current. Under normal load conditions insufficient flux is generated to overcome the bias of the recessed spring 54. At overload, however, the force of attraction surmounts the spring force and the movable armature 51 rotates clockwise to eliminate the air gap. The resultant effect of the foregoing is the lifting of the retaining latch 52, which is formed by a lanced portion of the movable armature, and thus the freeing of the trip lever 55 for a purpose which will be described.

Although no mention of it has been made in the foregoing, the described magnetic circuit preferably acts with a predetermined time delay to preclude tripping of the mechanism upon instantaneous overloads; such as those found in high starting current devices. To effect this delay the electromagnet may employ as its core 47 the time delay tube described in U.S. Patent 2,890,306, granted June 9, 1959, to the same assignee. It is to be understood that with the preferred arrangement the term "overload" is a function of both current and time.

Other arrangements, both thermal and thermal-magnetic, for freeing the trip lever will also be apparent to those versed in the art.

The setting of the breaker to the ON condition, the condition in which it appears in FIG. 2, is accomplished by the clockwise rotation of the handle 19 (to stop) and is effected via a pair of toggle assemblies connected in series. Rather than describe the arrangement in a single quiescent condition which at best would prove difficult to understand, the set, trip, reset and energy storing sequence will be described with reference to FIGS. 3–6. Before doing so, however, the components and symbolism employed will first be explained in order to lay a foundation for that which follows.

The handle itself is internally biased counterclockwise by the combination of the spring 56 and its laterally offset engagement with a pivot "*a*"; the latter of which contains a pie-shaped cutout for accepting the torque. For a more detailed explanation of this torque biasing method, reference may be had to co-pending application Serial No. 340,055, filed on January 24, 1964 to the same assignee. Suffice to say that insofar as is here pertinent, it need only be noted that the handle is under a substantially constant counter-clockwise torque regardless of its attitude. Hereinafter, the particular arrangement will be omitted and an arrow will be substituted for indicating the torque (where necessary to the disclosure).

Pivotally mounted upon an extension 57 of the handle 19 is link 59. An integral shoulder 61 located on the right side of this link, operationally engages a molding abutment 63 and serves the reset function as will be explained. Slidably and pivotally mounted in a slot 65 of the link 59 is link 67. The precise nature of the engagement of these two links may be more readily visualized by reference to FIGURE 2(*a*). Coil spring 69 disposed around link 59, between that portion which flanges outwardly and the intersection of links 67 and 59, urges the greatest separation between the two link ends; that is, the spring force acts to urge the pivot "*c*," formed at the intersection of the links, to the extreme end of the slot. A lanced lip 71 is formed in link 67 for engagement with the molding shoulder 73 during the energy storing cycle (as will be explained).

The combination consisting of the handle 19, the extension 57, link 59, and link 67 constitutes a pair of toggles having a common lost motion arm capable of storing energy. Symbolically, it may be represented by the linkage shown in FIG. 2(*b*) in which corresponding parts and pivots are similarly denoted. The first toggle consists of the links 57 and 59 with the common pivot "*b*" (the handle 19 being an adjunct); and the second toggle consisting of the links 59 and 67 with the common

sliding pivot "c." Link 59 is the energy storing arm, previously alluded to, which is common to both toggles "one" and "two." Pivot "a," it is to be noted, is the only fixed pivot. In the toggle concept, this pivot is analogous to fixing the end of the toggle link 57.

Tripping of the breaker is via the trip lever 55, shown in detail in FIG. 2(c). This member, which is latched against counterclockwise rotation by lanced latch 52 of the movable armature 51, is pivotally mounted, by means of a shaped cutout, on the knife edge 75. The preferred knife edge principle has certain advantages over the more usually employed cylindrical pivot. Among the advantages are the fact that the tendency for dirt to frictionally interfere with the free floating lever is substantially obviated, and further, a more defined fulcrum is available. Insofar as the latter is concerned, it may be noted that the trip lever knee adjacent the toggle pivot "c" supplies a counterclockwise moment which is latched by the lip 52 of the movable armature. The ratio between these two moment arms of the lever is approximately 10 to 1; and it is highly desirable that this ratio be maintained during continued use to ensure that only a small tripping force is required of the electromagnet.

The main portion of the spring 34 urges the lever up against the knife edge and simultaneously biases the lever counterclockwise, thus providing a light frictional engagement between the lever and armature 51. A recessed portion 79 is included in the trip lever to permit clearance of the abutment 63.

Turning now to the sequence illustrations 3 through 6, where the details have been minimized to more vividly point out the invention, reference will be made to each of the figures in turn. For the sake of brevity, it will be assumed that with respect to each of FIGURES 3, 4, 5 and 6, reference is also made to the associated FIGURES 3(a), 4(a), 5(a), and 6(a), respectively.

FIG. 3 shows the breaker in the normal ON position; conditioned for tripping upon overload. The contacts 27 and 29 are closed by virtue of the downward force exerted by the lower end of the toggle link 67 upon the movable contact member 31 and arising from the partially compressed spring 69 bearing on the pivot "c." These forces are represented by the arrows F_6 and F_4, respectively.

At this point it is to be noted that those forces with arrows directed toward the toggle links are the "equal and opposite" forces exerted by parts external of the linkage to maintain the arrangement in the position shown.

Because of the slight knee adjacent pivot "c," components of forces F_4 and F_6 act to the right and bear upon the trip lever 55, urging counterclockwise rotation which is prohibited by the lanced lip 52. This restraining force, provided by the trip lever, is F_5. The other end of the partially compressed spring bears upon the pivot "b" (F_3) and because of the disposition of pivot "b" to the left of pivot "a" imparts a clockwise moment to the link 57 which is equalized by the force F_1 on the pivot "a" and the molding limitation on the handle travel (F_2). The internal handle bias has been omitted from this figure and may be considered slightly less than the moment produced by force F_3; the force F_2 contributing the difference and preventing angular displacement.

FIG. 4 illustrates the initial reaction of the toggles to a tripping of the breaker due to overload (i.e. a lifting of the trip lever restraining lip 52 by the resultant closing of the air gap). Again the internal biasing of the handle is omitted from consideration; this time to more clearly illustrate the initial reaction. With the trip lever 55 free to move counterclockwise, the force F_5 (in FIG. 3(a)) is removed, and the knee of toggle "two" moves to the right rotating the trip lever until the knee clears its end, at which time the knee enters the adjacent gap. When this knee moves out the top of link 67 moves to the right and because a portion intermediate the ends of this link is between two molding abutments, which serve as pivots, the bottom of link 67 moves to the left and slides off contact member 31. Contacts 27 and 29 thereupon snap open by virtue of spring force 34'. There are now no forces acting upon the pair of toggles other than the internal bias acting on the handle and urging the link 57 counterclockwise. This force will now be considered.

The handle bias serves the reset function by rotating the handle and hence the whole toggle assembly to the right, the first consequence of which is the withdrawal of the link 67 from the gap between the left molding abutment and the contact member. FIG. 5 shows the final toggle assembly position which arises as a result of this torque (T_1). During the travel the shoulder 61 of the link 59 bears (M_2) upon the abutment 63 swinging the whole of toggle "two" to the left; the lower left end of the link 67 contacting (M_3) the molding at 81 to reverse the knee of toggle "two." At the same time, the arcuate segment 83 of the trip lever 55 is encountered by the knee of toggle "one" (M_1) and returned to its latched condition, with the lip 52 of the movable armature overhanging the free end of the trip lever under the force of spring 54. The letter M with numerical subscripts has been chosen to represent these forces since they play no part in the final quiescent state. The only forces now bearing on the toggle assembly are the internal biasing of the handle (T_1) and the force F_7 produced when the handle strikes the molding limitation on its angular displacement.

The breaker is now in the full OFF position, the handle position giving an indication to this effect. It has also been reset in preparation for the reclosing of contacts. The reclosing occurs manually, the handle being rotated clockwise. FIG. 6 illustrates the maximum energy storing condition of the toggle assembly (just prior to thrust) occurring during handle rotation at a point intermediate the two handle displacement limits. From FIG. 5 it may be seen that as the handle is rotated (T_2 in FIG. 6(a)) the knee of toggle "two," adjacent to pivot "c," cams down the molding surface 85. Turning back to FIG. 6 (but continuing the travel of the knee), the lanced lip 71 of the lower link 67 now engages (F_9) the molding shoulder 73 retaining this link in position (bearing on the movable contact member 31) as the handle rotation continues to compress the effective length of the common toggle link 59; thus storing energy in the spring 69. Meanwhile the bottom end of link 67 has encountered, as mentioned, the movable contact member 31, decreasing the contact gap before the initiation of energy storage and ultimately reducing contact bounce and increasing contact life. Further handle rotation brings link 59 in contact with the fulcruming molding shoulder 87 (F_8) causing the lip 71 to jump off the shoulder 73 and the end of the link 67 to bear suddenly upon the movable contact member 31, effecting a quick make between contacts 27 and 29, and causing the breaker mechanism to assume the position shown in FIG. 3. The arcuate section of contact member 31 adjacent the bearing surface upon which the lower link 67 rests is included to guide the lower link end during the thrust, and prevent its wedging between the juxtaposed molding sections. It also provides a surface which in the full "ON" position is substantially perpendicular to the plane of link 67, thus permitting the link to slip off the arm readily upon actuation of the tripping mechanism.

While FIG. 3 shows the pivot "c" located at the extreme end of the slot, this is not necessarily a prerequisite to operability. The fundamental consideration is that some spring energy remain when the toggle assembly has achieved its final "set" position so that a force is available to bear upon the trip lever 55.

The foregoing description of an embodiment of the invention has, for the sake of brevity, omitted details concerning the specific materials employed for the vari-

ous components. Such details, however, are felt to be well known to those versed in the art who will be guided by pertinent electrical and mechanical design considerations. For example, the knife edge, abutments, shoulders, and camming surfaces may deteriorate in repeated use unless care is undertaken to select constituent materials which will reduce the effects of friction.

Further, while I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. In a circuit breaker of the type having a pivoted manually operable handle, a pair of complementary contact members, one of which is movable relative the other and biased apart therefrom, and a current responsive means for tripping the breaker upon overload, the improvement therein for producing a quick make of contacts and tripping the breaker upon overload comprising:
   (a) a toggle assembly connected to said handle and extending toward said movable contact member, said assembly having a lost motion energy storing link;
   (b) means for causing said link to store energy upon manual handle rotation; and
   (c) means for releasing a portion of said energy substantially instantaneously at a predetermined handle displacement as a rectilinear thrust finally bearing upon said movable contact and closing it, said means including means adjacent an intermediate portion of said toggle assembly for causing said assembly to assume a knee-out position subsequent to the release of said energy portion, and
   (d) a trip lever releasably latched against movement by the current responsive means and contacting said knee for restraining further lateral motion thereof: whereby said trip lever is released by said current responsive means, said knee may move out, removing the force upon said biased contact member thereby causing contact separation.

2. The improvement claimed in claim 1 in which the means for causing the knee-out position and the means for first releasing the portion of energy are the same.

3. In a circuit breaker of the type having a pivoted manually operable handle, a pair of complementary contact members, one of which is movable relative the other and biased apart therefrom, and a current responsive means for tripping the breaker upon overload, the improvement therein for producing a quick make of contacts comprising:
   (a) a pair of toggles serially connected to said handle and freely extending toward said movable contact, said pair having a common lost motion energy storing link;
   (b) means for substantially aligning said pair of toggles during manual rotation of said handle;
   (c) means restraining said free toggle for causing said common link to store energy upon manual handle rotation; and
   (d) means for releasing a portion of said energy substantially instantaneously at a predetermined handle displacement as a rectilinear thrust finally bearing upon said movable contact and closing it.

4. The improvement claimed in claim 3 in which one link in said pair of toggles is formed in said handle.

5. The improvement claimed in claim 3, in which the means for substantially aligning said pair of toggles comprises a camming surface contiguous to one toggle knee during its travel, and means for guiding the toggle link in closest proximity to the movable contact member.

6. The improvement claimed in claim 5 in which the means for guiding the said closest proximity link comprises an arcuate section on the movable contact member.

7. The improvement claimed in claim 5 in which the means for guiding the said closest proximity link comprises a pair of guiding surfaces juxtaposed on either side thereof.

8. The improvement claimed in claim 3, in which the means for causing the said link to store energy comprises means for engaging the toggle link in closest proximity to the movable contact member and preventing the rectilinear motion thereof during manual handle rotation.

9. The improvement claimed in claim 8 in which the means for releasing a portion of said energy comprises a fulcruming shoulder adjacent the lost motion link and in the path of travel thereof for disengaging the said closest proximity link from the said engaging means.

10. The improvement claimed in claim 3 adapted for tripping the circuit breaker upon overload further comprising:
   (a) means adjacent said energy storing link for causing the toggle in closer proximity to said movable contact member to assume a knee-out position subsequent to the release of said energy portion; and
   (b) a trip lever releasably latched against movement by the current responsive means and contacting said knee for restraining further lateral motion thereof; whereby when said trip lever is released by said current responsive means, said knee may move out, removing the force upon said biased contact member thereby causing contact separation.

11. The improvement claimed in claim 10 adapted for automatic reset comprising:
   (a) means angularly biasing said handle for rotating said handle and connected pair of toggles upon the release of said trip lever by said current responsive means;
   (b) means for restoring said trip lever to its latched condition; and
   (c) means for rotating a portion of said pair of toggles into cooperating relationship with said aligning means.

12. The improvement claimed in claim 11 in which the means for rotating a portion of said pair of toggles comprises a shoulder on the lost motion link, and a fixed abutment for engaging said shoulder during rotation of said handle and connected pair of toggles.

13. A circuit breaker comprising:
   (a) a pair of complementary contact members, one of which is movable relative the other and is biased apart therefrom;
   (b) a trip lever pivotally mounted between its ends;
   (c) current responsive means adjacent said trip lever for latching one end thereof and releasing said end upon overload;
   (d) a manually operable pivoted handle;
   (e) a toggle assembly connected to said handle and extending toward said movable contact member, said assembly having a knee adjacent the other end of said trip lever;
   (f) means for aligning said toggle assembly during the manual rotation of said handle, thereby abutting one end of said assembly upon said movable contact member and causing its closure; and
   (g) a means for causing said toggle assembly to assume a final knee-out position, said knee abutting upon and being impeded in its lateral movement by the other end of said trip lever.

14. A circuit breaker comprising:
   (a) a pair of complementary contact members, one of which is movable relative the other and is biased apart therefrom;
   (b) a trip lever pivotally mounted between its ends;
   (c) current responsive means adjacent said trip lever for latching one end thereof and releasing said end upon overload;
   (d) a manually operable pivoted handle;
   (e) a pair of toggles serially connected to said handle

and extending toward said movable contact, said pair having a common lost motion energy storing link;

(f) means for substantially aligning said pair of toggles during manual rotation of said handle;

(g) means for causing said link to store energy upon manual handle rotation;

(h) means for releasing a portion of said energy substantially instantaneously at a predetermined handle displacement as a rectilinear thrust finally bearing upon said movable contact and closing it; and

(i) means adjacent said energy storing link for causing the toggle in closer proximity to said movable contact member to assume a knee-out position subsequent to the release of said energy portion; said knee abutting upon and being impeded in its lateral movement by the other end of said trip lever;

whereby, when said trip lever is released by said current responsive means, said knee may move out, removing the force upon said biased contact member thereby causing contact separation.

15. The circuit breaker claimed in claim **14**, in which said current responsive means comprises a movable armature having a portion thereof engaging said one end of said trip lever.

16. The circuit breaker cleaimed in claim **15** in which said current responsive means consists of an electromagnet having a stationary armature upon which said movable armature is pivoted.

17. The circuit breaker claimed in claim **14** in which said trip lever is pivotally mounted upon a knife edge, and in which the lever moment arms to the associated

knee and latching means, respectively, are in a ratio giving a substantial mechanical advantage to said current responsive means.

18. The circuit breaker claimed in claim **14** further comprising for the automatic resetting of said breaker:

(a) means angularly biasing said handle for rotating said handle and connected pair of toggles upon the release of said trip lever by said circuit responsive means;

(b) means for restoring said trip lever to its latched condition; and

(c) means for rotating a portion of said pair of toggles into cooperating relationship with said aligning means.

19. The circuit breaker claimed in claim **18** in which said current responsive means comprises a movable armature having a portion thereof engaging said one end of said trip lever, and in which the means for restoring said trip lever to its latched condition comprises means for biasing said armature into engaging position; said biased handle and connected pair of toggles upon released rotation bearing upon and restoring said trip lever to the engaging position.

References Cited by the Examiner

UNITED STATES PATENTS

2,806,103 9/1957 Gelzheiser ---------- 200—88

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