

May 18, 1943

F. J. POKORNY

2,319,262

CIRCUIT BREAKER

Filed April 27, 1940

5 Sheets-Sheet 1

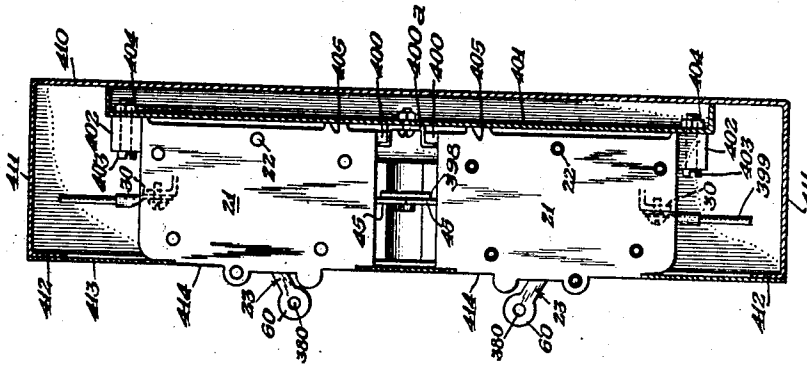


FIG. 3.

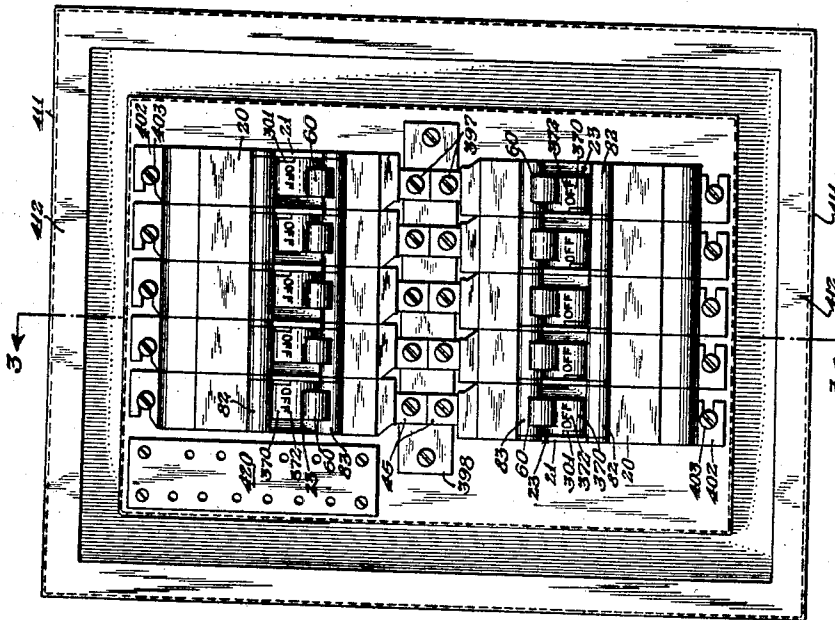
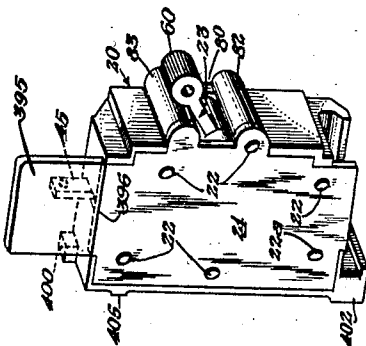


FIG. 2.



May 18, 1943

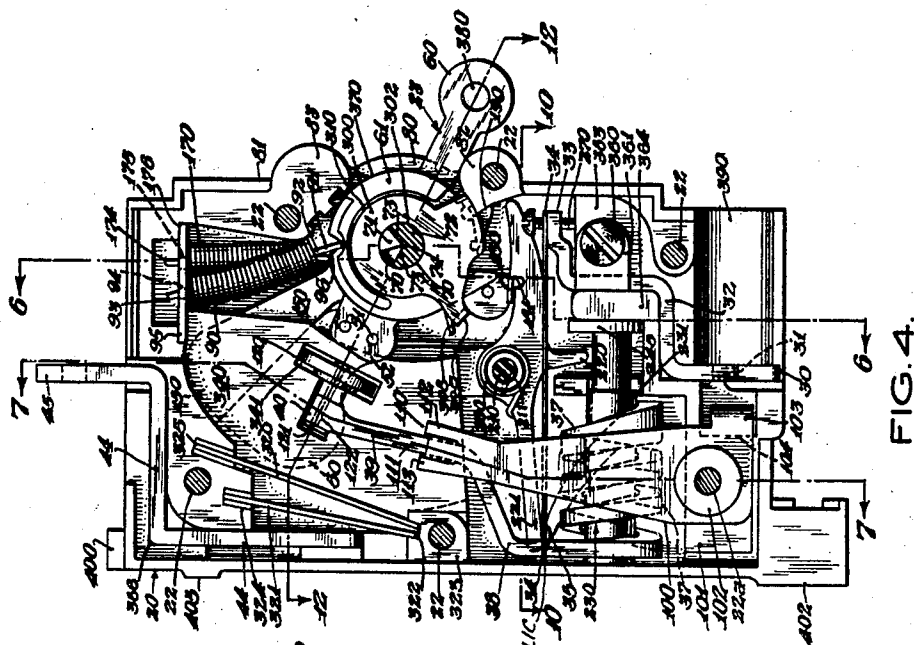
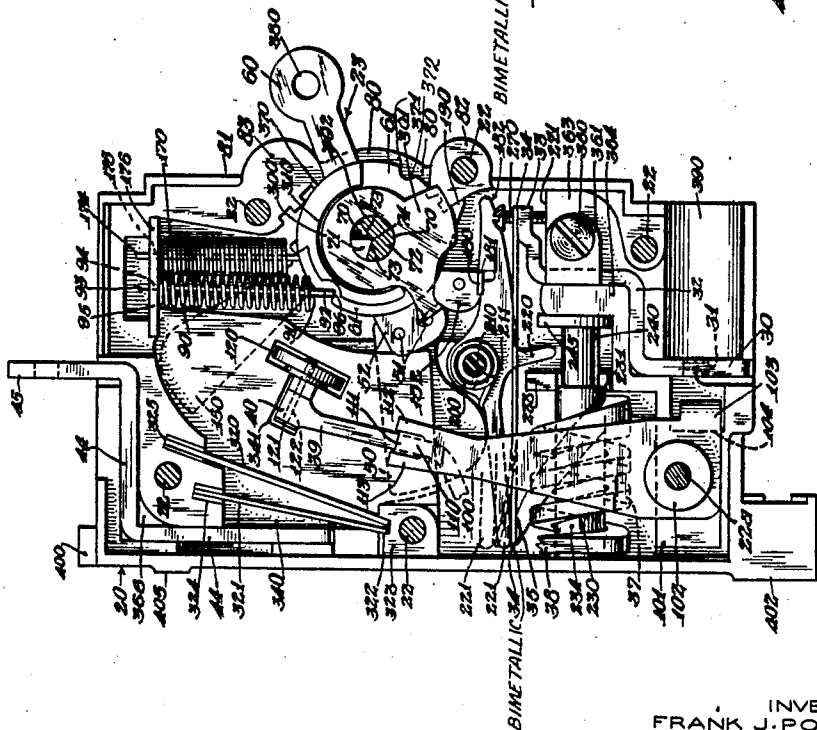
F. J. POKORNY

2,319,262

CIRCUIT BREAKER

Filed April 27, 1940

5 Sheets-Sheet 2



INVENTOR
FRANK J. POKORNY,

Samuel Ostrofsky
ATTORNEY.

May 18, 1943

F. J. POKORNY

2,319,262

CIRCUIT BREAKER

Filed April 27, 1940

5 Sheets-Sheet 3

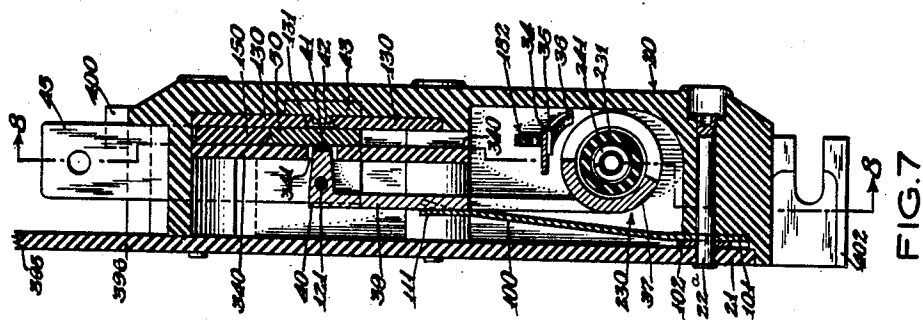


FIG. 7

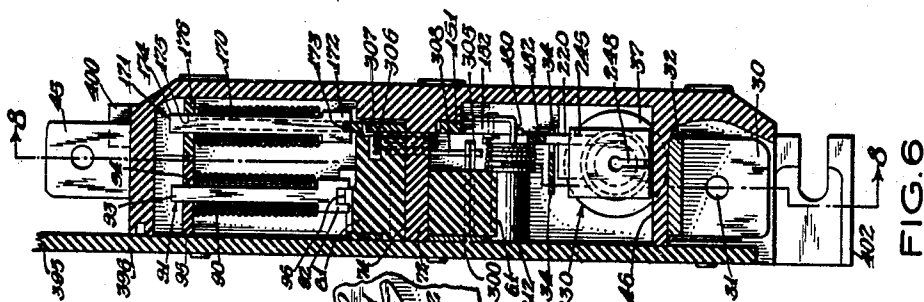
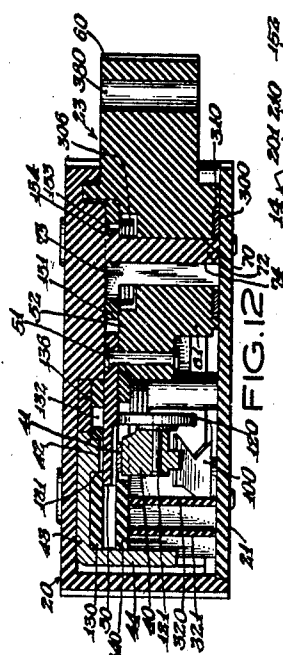


FIG. 6



May 18, 1943

F. J. POKORNY

2,319,262

CIRCUIT BREAKER

Filed April 27, 1940

5 Sheets-Sheet 4

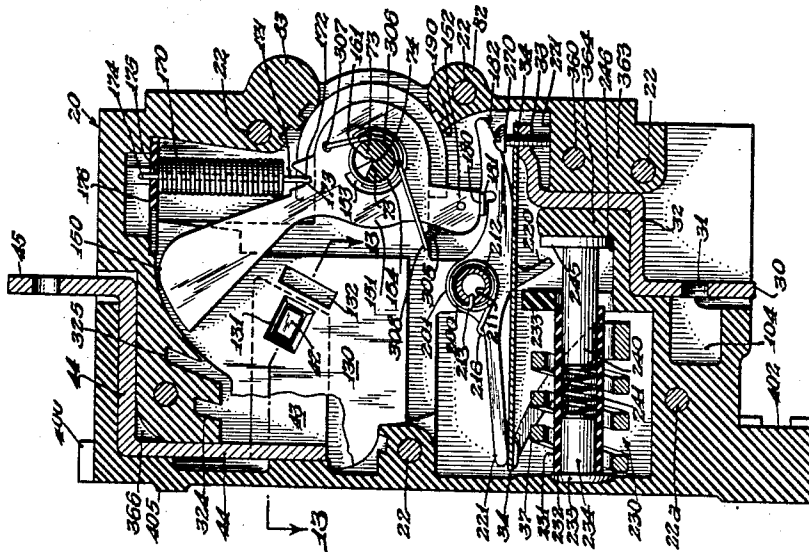


FIG. 8

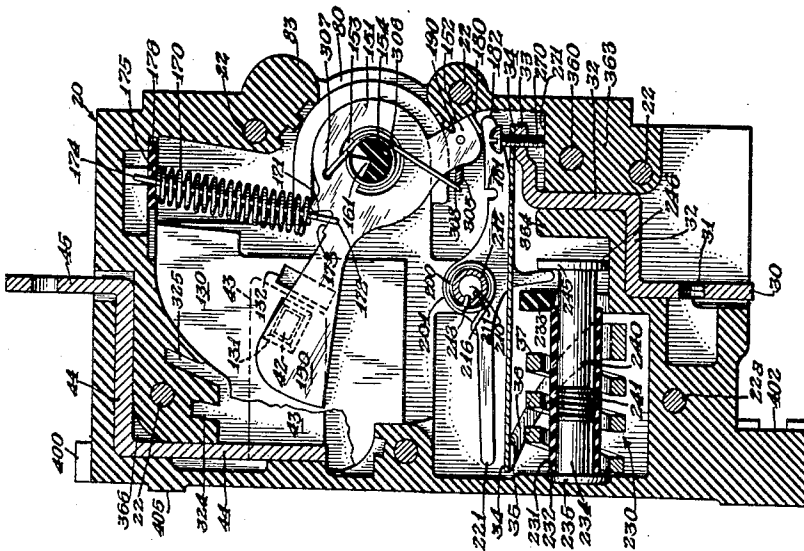


FIG. 9

INVENTOR
FRANK J. POKORNY,

Samuel Chorotinsky
ATTORNEY.

May 18, 1943

F. J. POKORNY

2,319,262

CIRCUIT BREAKER

Filed April 27, 1940

5 Sheets-Sheet 5

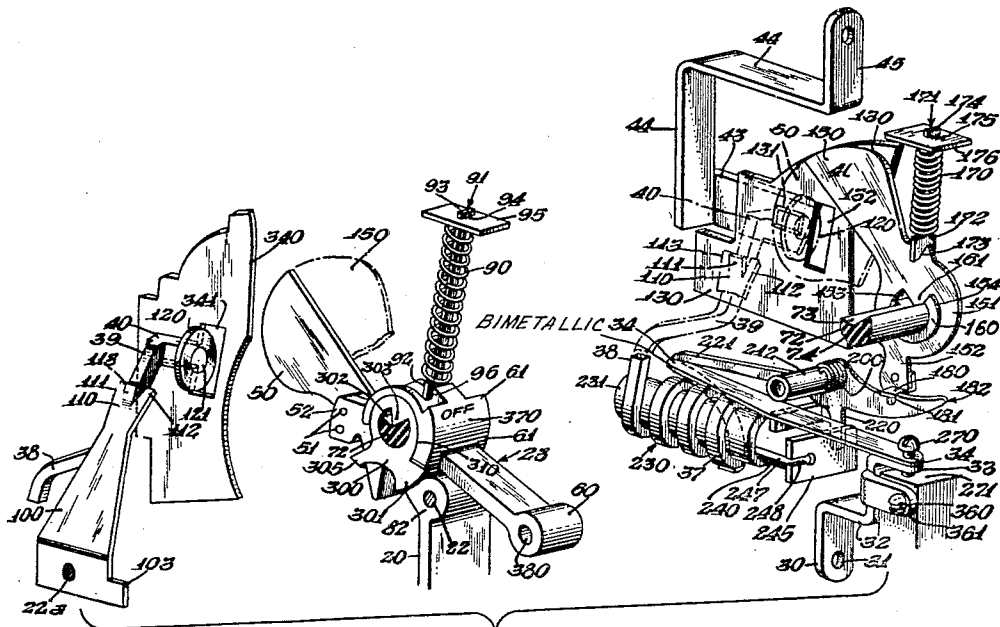


FIG. 15.

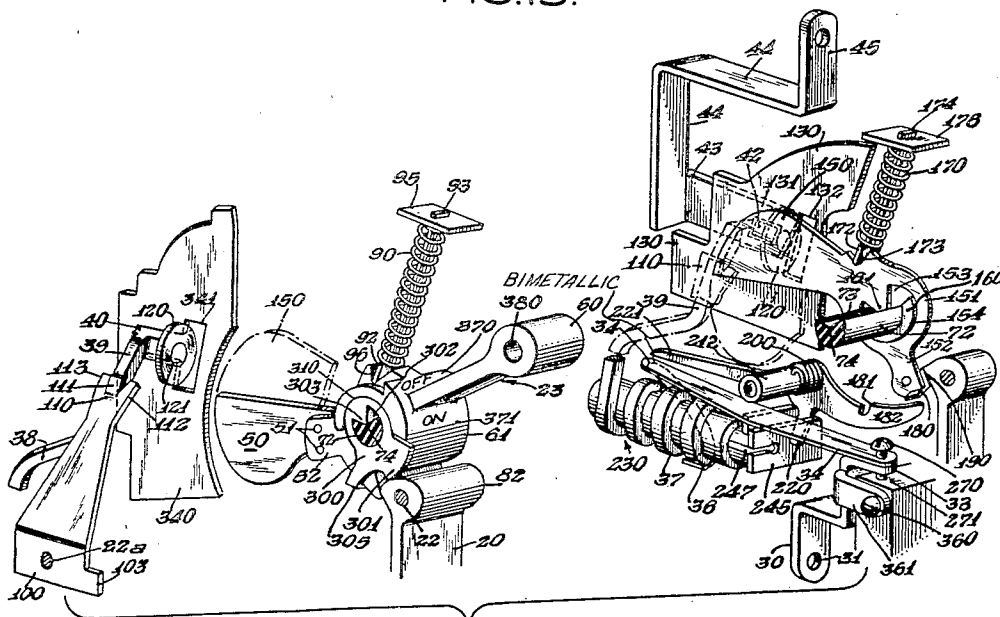


FIG. 16.

INVENTOR
FRANK J. POKORNY,

Samuel C. Crotwell
ATTORNEY.

UNITED STATES PATENT OFFICE

2,319,262

CIRCUIT BREAKER

Frank J. Pokorny, Philadelphia, Pa., assignor to
I.-T.-E. Circuit Breaker Company, Philadel-
phia, Pa., a corporation of Pennsylvania

Application April 27, 1940, Serial No. 331,984

19 Claims. (Cl. 200—116)

This invention relates to switch gear and circuit breakers, and more particularly to a panel type combination switch and circuit breaker adapted for use in branch circuits of various types and arranged to be mounted upon a panel board together with other similar devices for controlling a plurality of circuits.

In the operation of branch circuits, it is frequently important to connect or disconnect individual circuits from the main line without interfering with the operation of other similar circuits, and to arrange for overload protection for individual circuits so that in the event of any fault in any particular branch, that particular circuit may automatically be disconnected without interfering in any way with the operation of other circuits or with the operation of the main circuit itself.

Thus, in the operation of a plurality of small motors for various purposes in a shop, it is important that any fault occurring in the circuit to a particular motor should not affect the operation of other motors or the main line to the end that continuous operation should as far as possible be maintained.

Likewise, in the operation of multiple dwellings or apartment houses where a plurality of individual circuits for different apartments are all connected to a single main line, it is important that any particular circuit to any particular apartment be readily connectible to and disconnectible from the main line and that any fault in any particular circuit should not disturb the operation of any of the other circuits.

Accordingly, the purpose and object of the present invention is to provide a simple combination on-off switch and circuit breaker which may be mounted upon a panel board and connected between the main bus and the individual branch circuits in order to provide suitable manual or automatic control for each of the individual circuits.

In order to provide for panel board mounting of this type and in order further to provide for simplicity in operation and assembly and to facilitate mounting upon the panel board, it is important that the particular combination switch and circuit breaker be compact and nevertheless so arranged as to obviate any internal faults or short circuits.

Therefore, instead of providing for the creation of a simple air-gap between the movable contact member and the stationary contact member of the "on-off" switch circuit breaker combination, one of the important objects of the present in-

vention is to provide for the interposition of an actual physical dielectric barrier between the two contacts when the contacts separate.

Still another extremely important object of the present invention is to so arrange the stationary and movable contacts that they are separated not by any operation initially performed upon the movable contact itself, but by the sweeping or swinging of the physical barrier of dielectric material toward circuit opening position. In such case, the barrier may swing beneath a bearing on the movable contact arm, raising the arm, and separating the contacts, and then the barrier by continuing the movement reaches its final position between the separated contacts.

The movable contact should therefore be so arranged that it is biased into contacting position with the stationary contact in such manner that upon removal of the physical barrier of dielectric material the biasing means will immediately re-establish contact pressure between the movable and stationary contacts.

Still another object of the present invention is to provide for individual and separate physical barriers for each of the two operations of ordinary manual switching and automatic switching. That is, one barrier of dielectric material hereinafter referred to as an interposer may be placed between the contacts by manual operation and another such interposer may be interposed between the movable and stationary contacts by automatic circuit breaking means. Both of these barriers may operate in a single plane and it is still another object of the present invention to utilize the manually operated interposer or barrier to remove the automatically operated interposer or barrier from between the contacts when it is desired to reset the switch and circuit breaker after an automatic tripping thereof.

The circuits and apparatus may be designed to carry (a) a maximum current above and below which small variation may occur (b) a heavy momentary inrush current as in thermal devices such as lamps where operating resistance increases after being switched on (c) starting currents for motors (d) short periods such as may occur in motors.

When these momentary increases occur, the length of time they last should be limited by the circuit breaker preferably in accordance with the square of the current and directly in accordance with the time (I^2T). Whenever the current exceeds the normal maximum value, then however, the circuit should be interrupted as quickly as possible.

It is an important object of the present invention to provide for independent means for automatically operating the circuit breaker in accordance with either of these conditions.

In the case of a short circuit where the resistance drops to zero or substantially zero, this invention provides for an instantaneous trip mechanism for immediately separating the contacts. Where a fault occurs however which is not sufficient to cause operation of the instantaneous trip mechanism, but is nevertheless such that excess heat may be generated in the circuit, then a thermal means responsive to increased heat in the circuit may be utilized for the purpose of automatically separating the contacts in accordance with the aforementioned I²T characteristic.

A further important object of the present invention is to mount the interposer which is automatically brought between the contacts by either of the means abovementioned in such a manner that it is always biased toward contact separating position so that in the event of failure of the mechanism, the automatically operated interposer would be more likely to move to a position separating the contacts than to any other position.

A further object of this invention includes the mounting of the manually operated switch lever in such manner that it is yieldingly but positively held in the open circuit or closed circuit position.

Still another object of this invention is to so arrange the insulating housing of the circuit breaker that it may be readily molded by means of ordinary core dies without any other expensive molding or forming processes.

Still another and extremely important object of the present invention is the arrangement of the housing of the combination switch and circuit breaker, and the various parts thereof in such manner as readily to facilitate assembly. That is, the housing is so formed and each of the parts is so formed that the parts may readily successively be placed in the housing from one side, the assembly operation requiring merely a series of successive steps without any requirement for complicated tools or complicated supporting and holding means for combining and supporting the members during assembly.

A still further object of the present invention is to so arrange the housing and each of the parts that when the cover plate is secured to the housing at one side thereof, each of the parts is securely locked in operative position.

Many other objects and uses of the present invention will in part be apparent and in part pointed out in the following description and drawings, in which:

Figure 1 is an external view of the combination switch and circuit breaker.

Figure 2 is an elevational view showing a plurality of the members of Figure 1 mounted upon a panel board.

Figure 3 is a cross-sectional view taken on line 3—3 of Figure 2.

Figure 4 is a side view of the circuit breaker of Figure 1 with the cover plate removed and with the contacts and various members arranged in open circuit position.

Figure 5 corresponds to the view of Figure 4 showing the contacts and various members in ordinary closed circuit position.

Figure 6 is a cross-sectional view taken on line 6—6 of Figure 4, looking in the direction of the arrows.

Figure 7 is a cross-sectional view taken on line

7—7 of Figure 4, looking in the direction of the arrows.

Figure 8 is a cross-sectional view taken on line 8—8 of Figures 6 and 7, showing the automatically operated interposer in latched position.

Figure 9 is a view corresponding to Figure 8, showing the automatically operated interposer in tripped position.

Figure 10 is a cross-sectional view taken on line 10—10 of Figure 4.

Figure 11 is a cross-sectional view taken on line 11—11 of Figure 10.

Figure 12 is a cross-sectional view taken on line 12—12 of Figure 4.

Figure 13 is a cross-sectional view taken on line 13—13 of Figure 8.

Figure 14 is a cross-sectional view taken on line 14—14 of Figure 11.

Figure 15 is an exploded view of the combination switch and circuit breaker showing the manually operated interposer in circuit breaking position.

Figure 16 is an exploded view of the combination switch and circuit breaker showing the automatically operated interposer in circuit breaking position.

Referring now to Figure 1, I have here shown my combination switch and circuit breaker which comprises a principal housing 20 and a cover plate 21 secured thereto in any suitable manner, as for instance, by means of rivets 22.

The combination switch and circuit breaker comprises a manual operating handle 23 and circuit connecting means, separable contacts and automatic tripping means hereinafter more particularly described.

The combination switch and circuit breaker of Figure 1 is of a form and construction peculiarly adapting it for panel board operation for controlling a series of branch or subsidiary circuits fed from a main line or bus. The arrangement of the members of Figure 1 upon the panel board as well as the arrangement of the various external portions of the switch and circuit breaker combination adapting it for use in panel boards will be more readily understood from a description of the interior construction and relationship of the parts of the circuit breaker itself.

The member of Figure 1 is shown in ordinary closed circuit position which, when the cover plate is removed, corresponds to the arrangement shown in Figure 5; while the arrangement shown in Figure 4 shows the position assumed by the parts when the manual operating handle 23 has been moved to open circuit position.

As will readily be seen from Figures 4 and 5, the combination switch and circuit breaker comprises a terminal or circuit connecting member 30 having any suitable means such as the threaded perforation 31 therein for connecting the circuit breaker to one terminal of the circuit. The current is led to the connecting lug 30 (which is preferably connected to the load) from the integrally associated conductive bar 32 which is connected, through the projecting lug 33 of the bar 32, to the bi-metallic element 34.

The bi-metallic thermal element is at the bottom thereof connected to the flexible wire connection, preferably a copper braid 35 which is in turn conductively connected to the solenoid coil 37. The solenoid coil 37 is connected by means of the integral connecting bar 38 to the movable contact-carrying bar 39, the said contact-carrying bar being preferably an integral extension of the bar 38.

The contact-carrying bar 39, as will be seen preferably in connection with Figure 13, carries the main movable contact block 40. The current enters the movable contact block 40 at the movable contact surface 41 from the stationary contact surface 42 when the switch is closed. The stationary contact surface 42 is carried by the stationary contact supporting bar 43 (see Figures 13 and 16) which is in turn connected by the angular lead-in bar 44 (Figures 4 and 16) to the opposite terminal or lead 45, into which the current is led from the bus bar.

It will thus be seen that when the circuit breaker is so arranged that one terminal 30 thereof is connected through the load to one pole of the circuit and the opposite terminal 45 (connected to the stationary contact) is connected to the opposite pole of the circuit, then the current path is through the two contact surfaces 41 and 42, and that any breaking of these contacts, that is, any separation thereof, will result in an opening of the circuit. Such separation of the contacts may be accomplished either manually, whenever it may be desired, or automatically in response to faults or over current conditions occurring in the circuit which the present circuit breaker is designed to protect.

For the purpose of separating contact surfaces 41 and 42 it may be sufficient merely to move the movable contact a sufficient distance away from a stationary contact so that the air or gases between them furnishes sufficient dielectric interposition to prevent effectively the passage of current therebetween.

Where, owing to the fact that for panel board mounting of these circuit breakers, the various dimensions thereof must be compressed as far as possible and the amount of travel permissible in the movable contacts is relatively limited, then in order to effectively break the contacts apart so that no current may flow therebetween, the present invention relies not on a sufficient movement of the movable contact to accomplish this purpose, but principally on the interposition of a physical barrier of dielectric material which arc may be maintained for the particular current and voltage rating of the circuit breaker or effectively serves to lengthen any possible arcing path beyond the limits within which an effectively serves to prevent any arcing path whatever.

Accordingly, for manually separating the contact when it is desired at selected intervals to disconnect the particular branch circuit controlled by the switch and circuit breaker combination, I prefer to utilize the manually operated interposer 50 (see particularly Figures 4, 5 and 15). The manually operated interposer 50 is so arranged as seen in Figures 5 and 4, that it may be readily moved from the position shown in Figure 5 to the position shown in Figure 4, where it is interposed between the contacts as is even more particularly seen in Figure 12.

The manually operated interposer 50 is connected by rivets 51, 51 or in any other suitable manner to the foot 52 of the manual operating lever 23. The manual operating lever as is more particularly seen in Figures 4, 5 and 15, comprises a finger grasping portion 60, knurled to insure a firm grip, a foot 52 for supporting the barrier 50, and a central pivoting portion 61. Preferably the manual grasping portions 60 and the central pivoting portion 61 as well as the foot 52 are integrally molded from insulating material as a single unit.

The interposer 50 securely attached to the foot 52 preferably is formed and pressed from a suitable insulating dielectric material to a thickness facilitating interposition between a movable and stationary contact. The central portion 61 of the manual operating arm 23 comprises, as is more particularly seen in Figure 4, a central opening or perforation 70 into which projects a knife edge 71, preferably integrally molded with the entire manual handle portion 23.

Owing to the fact that the handle 23 preferably is made of insulating material which may under appropriate circumstances possibly be brittle, the knife edge 71 is given a sufficiently wide base so that in ordinary operation it will be adequately supported for the purposes hereinafter described. The perforation 70 in the manual handle member 23 and the knife edge 71 thereof cooperate to form a relatively frictionless playless bearing for the handle 23 when the perforation 70 thereof is mounted over the supporting post or spindle 72.

The supporting post or spindle 72 preferably is of insulating material integrally molded as a projection of a side of the main housing, although it may be formed of any other suitable material and attached in any appropriate manner to the main housing and comprises a cut-out portion 73 having adjacent surfaces forming an angle 74 between them (see Figures 5 and 16).

When the manual operating handle 23 is mounted upon the spindle 72 so that the knife edge 71 thereof registers with the angle 74 of the spindle and so that the perforation 70 of the central portion 61 of the manual operating member cooperates with the remainder of the spindle 72, then the manual operating handle 23 may readily be rotated about the spindle within definite limits or stops. That is, the manual operating handle may be rotated from the position shown in Figure 5 to the position shown in Figure 4, in each case the side of the knife edge approaching one of the surfaces of the cut-out 73 of the spindle.

During the actual rotation, the principal bearing surface between the manual operating handle and the spindle is the knife edge 71 of the manual operating handle pressing into the angle 74 of the spindle. Thus even though the perforation 70 of the manual operating handle is slightly larger in diameter than the greatest diameter of the spindle, nevertheless the pressure of the knife edge 71 of the handle into the angle 74 of the spindle furnishes an efficient, playless bearing.

The bearing herein is described as a playless one simply because it is not a point-to-point contact between a point and an angle but a knife edge contact over an appreciable length with a corresponding angular member; and such a knife edge contact over such appreciable length prevents any wobble or torque of such nature as to twist the handle out of a plane perpendicular to the axis of the spindle.

The finger grasping portion 60 of the manual operating handle 23 projects through the slot 80 in the upper surface 81 of the housing. The movement of the manual operating handle 23 from the closed circuit position shown in Figure 5 to the open circuit position shown in Figure 4 is effectively limited by the shoulders 82 and 83 which lie at either end of the slot 80 and serve effectively to prevent further movement of the manual operating handle 23.

The manual operating handle 23 is so arranged that it is yieldingly biased either in open circuit position when it is left in that position or into closed circuit position when it is left in closed circuit position. That is, a spring 90 is so arranged relative to the center of rotation of the manual operating lever that when the manual operating lever is moved either toward closed or open circuit position, the spring passes beyond center and serves yieldingly to lock the manual operating lever in place.

The compression spring 90 (Figures 4, 5 and 15) which accomplishes this function is mounted upon a slidable steel bar 91 which terminates at one end thereof in a yoke or bearing surface 92. The opposite end of the bar at 93 projects through a perforation 94 in a suitable bearing plate 95, preferably of insulating material. The slidable steel bar is so arranged that the end 93 thereof may slide freely in the perforation 94 of the bearing plate 95. The yoke or bearing surface 92 of the steel bar 91 engages a notch 96 in the peripheral surface of the central portion 61 of the manual operating arm 23.

The spring 90 is maintained under compression between the bearing plate 95 and the flanges of the yoke or bearing end of the steel bar 92. As may readily be seen in Figure 5, when the manual operating arm 23 is rotated into position where the interposer is not between the contacts and hence when the circuit breaker is in closed circuit position, then the effective pressure exerted by the compression spring 90 between the bearing plate 95 and the notch 96 is so directed beyond the center of the rotation of the manual operating lever 23 (the knife edge 71 and angle 74 engagement) as to exert a torque upon the manual operating lever 23 tending to drive it even further in such direction as to swing the interposer 50 away from the contacts and to swing the finger grasping portion 60 thereof up against the stop 83.

When the manual operating lever 23 is rotated from the position shown in Figure 5 to the open circuit position shown in Figure 4 and the interposer 50 is interposed between the contacts to produce the open circuit position, then as will be noted by a comparison of Figures 4 and 5, the notch 96 of the central portion 61 of the manual operating lever 23 has been rotated to such position that the effective force generated by the compression spring 90 is directed beyond the center of rotation of the manual operating lever in an opposite direction from that in which it was directed in the closed circuit position of Figure 5, thus tending to drive the finger grasping portion 60 of the manual operating arm 23 against the stop 82 and tending further to drive interposer 50 into open circuit position.

Obviously the reason that the compressive force of the spring 90 is either in the open or in the closed position exerted in such direction as to maintain the particular position of the switch (whether open or closed) is that the axis of the spring is in each case shifted beyond the center of rotation so that the effective direction of the force exerted by the spring changes from the counterclockwise direction with respect to Figure 5 to a clockwise rotation with respect to Figure 4 about the center of rotation.

As will be noted from a comparison of Figures 4 and 5, the spring 90 is in a position under greater compression and much less beyond center when the switch is in the open circuit posi-

tion of Figure 4 than when the switch is in the closed circuit position of Figure 5.

Accordingly, a positive closing action is provided for the closing of the switch, that is, it requires only a slight movement of the finger grasping portion 60 of the manual operating lever 23 (when the circuit breaker is in the position shown in Figure 4) to move the manual operating lever 23 so that the force exerted by the spring 90 passes through center and is exerted in an opposite sense to snap the manual operating arm 23 into closed circuit position.

Thus, when the switch is in open circuit position, it requires merely flicking of the finger grasping portion 60 of the manual operating lever 23 to cause the interposer 50 to be snapped out of its position between the movable and stationary contact. Also for this reason, the possibility that the contacts might remain in bare proximity to each other without actual complete removal of the interposer 50 is greatly minimized since in the circuit opening position it is necessary for the circuit opening movement to be substantially completed manually or else the manual operating lever 23 and the finger grasping portion 60 thereof will immediately snap back to circuit closing position.

The position of the finger grasping portion 60 of the manual operating lever 23 generally will indicate the "on" or "off" condition of the switch unless the switch or circuit breaker has been automatically tripped open in which case other indicating means hereinafter described may be utilized.

In order that, upon the removal of the barrier 50, from the position shown in Figure 4, where it is between the movable and stationary contact to the position shown in Figure 5 where it is no longer between these contacts, the movable contact should come into closed current conducting contact with the stationary contact, I provide a leaf spring 100 (Figures 4, 5 and 16) which tends to drive the movable contact surface 41 (see also Figure 13) down upon the stationary contact surface 42. The leaf spring 100 preferably is mounted upon a surface 101 of the housing and secured thereto by a washer 102 and one of the rivets 22a which serves to secure the cover plate 21 to the housing. In order to insure that the leaf spring will be accurately positioned to exert proper contact pressure upon the movable contact, I provide a lug 103 extending from the leaf spring and registerable with a recess 104 of the housing which registry will serve adequately to prevent undue rotation of the leaf spring around the rivet 22a.

The leaf spring 100 preferably is formed of any suitable elastic metal preferably of spring steel and is so arranged and bent as seen particularly in the perspective exploded view of Figure 16 as to exert pressure upon the contact-carrying arm 39 in such direction as to bias the contact block 40 and the movable contact surface 41 thereof into engagement with the stationary contact surface 42.

In order further to ensure that the movable contact-carrying arm 39 cannot escape the pressure, I prefer to shear the end 110 of the leaf spring 100 in such manner as to provide a pressure transmitting surface 111 thereon which presses down upon the contact bar and to provide guide flanges 112 and 113, the edges of which engage the sides of the contact-carrying bar 39, and prevent the escape of the contact-carrying bar 39 from the leaf spring and vice versa.

Obviously a great deal of friction would be generated by the movement of the barrier 50 between the surfaces 41 and 42 of the contacts unless some friction reducing means were provided. Such friction reducing means, however, must be of such a nature as not in any way to interfere with the effective pressure between the two contacts when the circuit is to be closed, while it must be readily usable to reduce the friction caused by the passage of the interposer 50 during the movement of the interposer 50 between the contacts.

Accordingly, a wheel 120 made of suitable insulating material is loosely mounted as is more particularly seen in Figures 5 and 13 upon a rivet 121 which is in turn mounted in the perforation 122 of the movable contact block 40.

The stationary contact surface 42 projects somewhat as will be seen in Figure 13, above the main portion of the stationary contact-carrying bar 43. In order to protect the "Bakelite" housing 20 from the effects of any momentary arcing that may occur during the instant of breaking of the contacts, an insulating plate of any suitable material 130 (see particularly Figures 8 and 13) is placed upon the inner side of the housing and over the stationary contact supporting members.

The insulating plate 130 has a perforation 131 therein which registers with the stationary contact surface 42. The insulating plate also has a perforation 132 therein which provides a recess into which the wheel 120 may descend so that adequate pressure may be maintained between the contact surfaces 41 and 42. In order further to protect the housing 20 at 135 from any arcing that might occur during the instant of opening of the circuit, an additional small plate 136 of insulating material is placed beneath the perforation 132 effectively to protect the housing from any stray arcs that might momentarily exist.

When the contacts are in closed circuit position, it will thus be noted by reference to Figure 13, that the contact surfaces 41 and 42 may come into close positive abutment in relation to each other owing to the fact that the recess 132 in the base insulating plate 130 permits the wheel 120 to descend beneath the surface of the contact without creating any back pressure tending to separate the contacts or tending to raise the movable contact away from the stationary contact. Further, since after a period of use, the contacts may wear, the contact supporting members must be capable of movement closer together. The depth of the recess is such as to provide allowance for this additional movement during the life of the breaker. The prime purpose of the wheel is to prevent friction between the interposer and the contact surface.

When the interposer 50 slides between the contacts it, however, as will clearly be seen by a comparison of Figures 4 and 5 with Figure 12, first comes into contact with the freely rotatable wheel 120. Since the wheel is freely rotatable the barrier may readily slide thereunder and owing to the fact that the barrier is arranged so as to be unyieldingly mounted in its own plane, then the continued sliding of the interposer 50 owing to manual or other pressure, will cause a raising of the wheel 120 and a consequent raising of the movable contact block 40 and of the movable contact surface 41, thus permitting the interposer 50 to slide between the contacts.

In order to facilitate this, the interposer 50 may be bevelled at the leading edge thereof

which first comes into contact with the wheel 120 in order to facilitate the raising of the wheel. However, ordinarily the interposer 50, although it is of sufficient thickness to provide for a sufficient dielectric barrier between the contacts when it is in open circuit position and although it is of sufficient strength to permit it to separate the contacts by the means herein described, it is nevertheless sufficiently thin so as to not make any such bevelling essential for the purpose of lifting the movable contact wheel.

By this means, therefore, the contacts may be manually opened or closed from the outside of the housing by merely applying finger pressure in the proper direction to the finger portion 60 of the manual operating lever 23.

In the event of sudden overloads of great intensity or in the event of a sudden large drop in resistance, it becomes important immediately and automatically to open the circuit, that is, to separate the movable and stationary contacts. Likewise, also, in the event of an overload of less intensity or a drop in resistance below normal and sufficient to permit the passage of current to such an extent as to cause over-heating, means are provided in the present device for also separating the movable and stationary contacts and thereby opening the circuit at that point.

Both of such means, that is, the means responsive to sudden increased overloads and the means responsive to milder overloads which eventually may be deleterious, are so arranged as to actuate the automatically interposable barrier or interposer 150 (see particularly Figures 8 and 9 as well as Figures 15, 4 and 5). The automatically interposable interposer 150 comprises, in addition to the interposing portion thereof which is preferably made of substantially the same dielectric material as the interposer 50, a central portion 151 and a latch engaging arm 152.

The central or mounting portion 151 of the automatically interposable interposer 150 is as is most clearly seen in Figures 8 and 15, perforated at 153 to permit the mounting of the interposer 150 upon the spindle 72.

The spindle 72 has an increased diameter at 154 which is the base portion thereof, most closely adjacent to the wall of the housing. The cut-out portion 73 of the spindle 72 nevertheless extends into this larger portion of the spindle and the angle 74 formed between the surfaces of the cut-out portion also extends into the enlarged portion of the spindle. The enlargement of the spindle 72 at 154 permits not only for a more secure connection between the spindle and the wall on which it is mounted but also serves to register and align the various members upon the spindle. That is, the perforation 153 of the automatically interposable member 150 is of a size permitting accurate registry of the perforation 153 with the large portion of the spindle 154, while the perforation 70 of the manual operating lever 23 is of a size registering with the narrower portion of the spindle 72.

Thus after the automatically interposable member 150 has been placed upon the wider portion of the spindle 154, the manual operating lever may be placed thereon and by reason of the fact that the side thereof abuts against the surface portion 160 of the wider portion 154 of the spindle, the manual operating lever cannot in any way interfere with the operation of the automatically interposable interposer 150. This is more particularly so since the mounting por-

tion 151 of the automatically interposable member 150 is slightly narrower than the length of the wider portion 154 of the spindle 72 so that the mounting 151 may be free of contact with the central mounting portion 61 of the manual operating lever 23.

The interposable barrier 150 is so arranged that it may be readily rotated about the portion 154 of the spindle. For this purpose, an angular projection 161 is integrally extended from the body of the mounting section 151 of the interposable member 150 into the perforation 153. The angular projection 161 registers with the angle 74 in the spindle and provides a suitable bearing for the rotation of the automatically interposable barrier 150.

Rotation of the automatically interposable member 150 about the spindle is also limited by the spacing of the walls of the spindle which surrounds the angular portion 74 thereof. That is, as seen in Figures 8 and 9, a positive stop is provided in each direction of movement of the interposer 150 by the abutment of the sides of the angular portion 161 against the walls of the spindle which join to form the angle 74 thereof.

A compression spring 170 (Figure 8) is mounted on a steel slide bar 171. The steel slide bar has a yoke or bearing surface 172 which at one end thereof bears against a notch 173 of the automatically interposable interposer 150. At the opposite end of the slide bar, the bar is at 174 inserted in a perforation 175 of an insulating bearing plate 176. The end 174 may slide freely in the perforation 175.

Compression spring 170 is under compression between the bearing plate 176 and the flanges of the end bearing 172 of the steel slide bar 171. As may be noted especially in connection with Figure 8, even when the automatically interposable barrier 150 is not between the contacts, the axis of the compression spring 170 is so arranged that the force exerted thereon is to the left of the center of rotation at 161 and hence is so directed as to cause the interposer 150 to rotate in a counterclockwise direction with respect to Figure 8.

The interposer 150 is restrained from counterclockwise movement in response to the action of compression spring 170 by the latch engaging arm 152 thereof. The latch engaging arm 152 carries secured thereto by rivets or any other suitable fastening means, a steel bearing plate 180 which engages the latch 181 of the trigger 182. Upon movement of the trigger 182 in such a direction as to release the engagement between the metal bearing 180 and the latch 181 there is no further restraint upon the rotation of the barrier 150 and since the action of the compression spring 170 is such as to immediately initiate counterclockwise movement thereof with respect to Figure 8, then immediately upon such disengagement, the compression spring 170 will force the interposer 150 into the position shown in Figure 9 where it extends between the movable and stationary contacts.

The open circuit position of the barrier 150 is definitely fixed by the abutment thereof against the edge of the handle shutter 50 which thus halts continued rotation of the interposer 150 in response to the action of the spring 170.

By proper arrangement and spacing of the shutters (that is the closed circuit non-interposing position of the shutter 50 and the open circuit interposing position of shutter 150), it is possible to ensure that in the tripped position of the circuit breaker, the interposer 150 will be po-

sitioned as shown in Figure 9 directly between the movable and stationary contacts.

The abutment of the edges of the shutters in the tripped position forms a complete continuous seal between the contacts cutting off any possible effective arc path. Thus it may be seen by a comparison of Figures 8 and 9 with Figures 4 and 5, that when the manually operated interposer 50 is in the closed circuit position of Figure 5, a free path is provided for the descent of the automatically operated interposer 150 so that it may readily move from the position shown in Figure 8 to the position shown in Figure 9 immediately upon release of the latch 181 of the trigger 182 from its engagement with the metallic bearing surface 180 of the latch engaging portion 152 of the interposer 150.

Therefore when by the operation of the manual operating lever 23, the barrier 50 is moved to closed circuit position, that is, to a position where it no longer extends between the movable contact and the stationary contact, no impediment of any kind exists to the automatic interposition of the interposer 150 between these contacts in response to a release of the latch engaging portion thereof 180 by the trigger 182.

Normally when no fault conditions exist upon a line, the trigger 182 is so arranged that the latch portion 181 thereof engages the bearing 180 of the interposer 150. For the purpose of retaining the interposer in the desired non-interposing position, the trigger 182 is spring biased by means of spring 200 (Figures 10 and 11) into latching position.

The trigger 182 has a central mounting portion 201 which is perforated at 202. An integral projection of the material of the trigger 203 extends into the perforation 202 and terminates in a pointed angular portion 204 which provides a bearing for the trigger upon its shaft, permitting rotation thereof upon the shaft within predetermined limits. The mounting of the trigger, as is seen in Figures 10, 11 and 14 comprises a spindle 210 preferably integrally formed from and secured to the wall of the housing and having a notch 211 therein.

The angular point 204 of the trigger projects into the notch 211 which thus provides an angular bearing surface. The trigger 182 may thus rotate within predetermined limits on the spindle 210 (Figure 14). A sleeve 212 is mounted on the spindle 210 and between the side of the trigger and the side of the cover plate, thus accurately positioning the trigger upon the spindle. A hole in the spindle 210 at 213 (Figure 10) permits one end of the spring 200 to enter therethrough and engage a wall of the groove or notch 211; the spring is wound about the sleeve, the other end at 216 engaging the trigger 182.

The spring is so arranged that it exerts a rotative force upon the trigger about the spindle 210 in a counterclockwise direction with respect to Figure 9 and hence tends to bias the trigger 182 so that the latch portion 181 thereof is positively in engagement with the metallic bearing 180 of the latch engaging portion 152 of the interposer 150.

Any fault condition existing upon the line must be manifested in some mechanical way which may be utilized to cause a rotation of the trigger in such a direction as to release the latch engaging portion 152 of the interposer from the latch 181 of the trigger. Accordingly, arms 220 and 221 are provided on the trigger to cooperate

with elements which respond mechanically to variations in the amount of current.

Trigger release arm 220 is so arranged as to cooperate with the member 245 of the solenoid assembly 230 in the manner shown in Figures 4, 5, 8 and 9. As has been above noted, the solenoid is in the current path through the movable and stationary contacts. Thus, with respect to Figure 4, the current enters at the connecting lug or terminal 45, passes through the contact blocks and the member 39 and 38 into the coils 37 of the solenoid and thence through the wire braid 35, the thermal element 34 and the lug 33 and bar 32 into the opposite terminal 30.

The solenoid coil 37 is composed of several turns of conducting material which, in the preferred embodiment of the present invention, is square copper of substantial cross-section. The large cross-sectional area minimizes the resistance which is injected into the circuit and also increases the actual physical strength of the coil, thus making it possible to use an integral extension 38—39 of the solenoid coil itself as the lead-in and physical support for the movable contact block.

It will be noted that the contact engaging spring 100 forces the contact member 40 toward the molded wall of the housing. The point of engagement of this spring with the bar 39 is between the contact and the coil. The spring thus produces reactions at each end of the bar 38—39; one, producing contact engaging pressure when the interposers are retracted; the other maintaining the solenoid assembly in its sockets.

To obviate the necessity for insulation on the solenoid, the coil preferably is wound with a reasonably large air space between the turns. The solenoid coil 37 as is seen in Figures 4, 5, 8 and 9 is mounted on an insulating sleeve 231 which prevents any current leakage between the successive turns of the coil and at the same time serves to insulate the coil from other members of the mechanism.

The insulating sleeve 231 may be secured within the housing in any suitable manner. Thus one end thereof may at 232 be supported in a depression of the bottom wall of the housing and the opposite end thereof may be supported in a U-shaped member 233 preferably integrally molded from a wall of the housing.

For purposes of securing the support of the sleeve 231 at 232 in the housing, a steel core 234 having a flange 235 engaging the sleeve may be secured at the bottom of the sleeve to provide a suitable bearing for the main armature spring and further to rigidify and strengthen the sleeve against any stresses that may be placed thereon. The movable solenoid armature 240 is slidably mounted in the top of the sleeve 231 and preferably may be maintained in the normal raised position shown in Figure 8 by the compression spring 241 which is placed between the base of the movable armature and the top of the stationary core. Since the slidable armature 240 is preferably made of steel or any other suitable magnetizable material, it may be drawn down so that it extends substantially within the coils 37 of the solenoid when a sufficient current is passed through such coils.

Spring 241 of the solenoid should be so calibrated and arranged that it will permit the drawing of the armature 240 within the coils of the solenoid in response only to an overload sufficiently excessive to possibly cause damage. That is, the spring 241 should not permit descent of

the solenoid armature 240 when ordinary currents customarily to be expected in the circuit are passing through the coil 37. Nor should it even permit descent of the armature when only slightly excessive currents are passing through the coil. But the movement of the armature 240 into the coil should be in response only to excessive loads.

The circular cross-section of the armature 240 and the free fit thereof within the sleeve 231 permits it to slide readily. A rectangular trigger arm engaging member 245 is secured either by welding or by any other suitable means to the top of the armature. Preferably as is seen in Figure 15, the trigger arm engaging member 245 is squared-off and preferably the interior wall 246 (Figure 9) is close to the plate 245 of the armature (see also Figure 6).

As is therefore seen particularly in Figure 6, while the squaring-off of the plate 245 does not interfere with the rise or fall of the armature, it prevents undue rotation of the armature to ensure that the trigger arm engaging portion thereof will always extend in such a direction as to engage the trigger and to ensure that it will not rotate out of engagement with the trigger.

The slots 247 (Figure 15) cut into the armature 240 and magnet 234 and the slot 248 cut into the trigger arm engaging plate 245 serve to prevent eddy currents which might otherwise tend to reduce the total magnetic flux in the circuit or occasion any loss of energy owing to heating.

When an overload occurs for any reason causing an excessive current to pass through the coil 37 of the solenoid, then the armature 240 is attracted into the coil of the solenoid, the plate 245 engages the trigger arm 220, presses the arm downwardly with respect to Figure 9, causes a rotation of the trigger about the spindle 210 in a direction opposite to that in which the trigger was originally biased by the trigger spring 200, causes a movement of the latch portion 181 thereof out of engagement with the bearing 180 of the latch engaging arm 152 of the interposer 150 and thus removes any restraint upon the rotation of the interposer 150, thereby permitting the compression spring 170 to drive the interposer to the position shown in Figure 9, where the interposer 150 as will now be clearly understood, extends between the movable and stationary contacts.

Obviously, any such tripping of the interposer 150 into circuit opening position shown in Figure 9 will not occur owing to the energization of the solenoid 230 unless the movable and stationary contacts are pressed together, that is, unless the entire mechanism has first been placed in the position shown in Figure 5 where the manually operated interposer 50 is no longer between them.

As will be noted in Figure 5, when the manually operated interposer 50 is moved from the open circuit position of Figure 4 to the closed circuit position of Figure 5 then not only does it permit the circuit to be closed between the movable and stationary contacts but also it is moved to a position where it will not interfere with the descent of the automatically operated interposer upon release of its latch engaging arm 152. So that when the automatically operated interposer 150 moves from the position shown in Figures 5 and 8 into the position shown in Figure 9, in response to over current conditions, it is clearly free to do so without interfering with the interposer 50.

Obviously when the interposer 150 moves from the position shown in Figures 5 and 8 to the position shown in Figure 9, it engages and raises the wheel 120 and separates the stationary and movable contacts in exactly the same manner as has been shown heretofore in the manually operated interposer 50. The manually operated interposer 50 is off-set out of the principal plane of the main portion of the manual operating lever 23 so that it will be coplanar with the automatically operated interposer 150.

This condition simplifies the resetting process after the automatically operated interposer 150 is tripped.

Obviously once the automatically operated interposer 150 is tripped to separate the contacts, then the solenoid coil 37 is no longer energized and the spring 241 is free to restore the armature 240 to the original position shown in Figure 8.

There is therefore no restraining force upon the trigger arm 220, and the spring 200 of the trigger 182 is then free to restore the trigger to its original position preparatory to latching engagement with the arm 152 of the interposer 150. Since the interposer 50 and the interposer 150 are coplanar with respect to each other, it will be then clear that the movement of the manual operating lever 23 from the closed circuit position shown in Figure 5 to the open circuit position shown in Figure 4 will result in a corresponding movement of the interposer 50 as shown and will also therefore result in the pushing up of the interposer 150 by the interposer 50.

When the manually operated interposer 50 has been moved into position shown in Figure 4, it will have raised the automatically operated interposer 150 so that the latch engaging arm 152 will be in latching engagement with the latch 181 of the trigger 182. And the circuit breaker will have been restored to its original non-tripped position but the circuit will then remain open since in the very operation of resetting the interposer 150, the interposer 50 has been moved into position between the contacts.

Subsequent to this operation which thus results in the position of the members shown in Figure 4, in order to restore the circuit, the manually operable interposer 50 must be moved back to the position shown in Figure 5. If, during such movement, and at the moment the movable contact touches the stationary contact, over current conditions still exist on the line, then the solenoid coil 37 will be immediately energized to trip the automatically interposable barrier 150 to tripped position.

It is thus absolutely impossible to hold the circuit closed when over current conditions exist on the line and to this extent at least the present invention is a trip-free circuit breaker. In other words, the tripping action which results in the placement of the interposer 150 between the movable and stationary contacts occurs independently of the manual operated lever 23.

The spring 200 which biases the trigger 182 in the proper position should preferably be only of sufficient strength for this purpose. Otherwise it will be necessary not merely to calibrate the spring 241 of the solenoid in accordance with the particular overload current conditions which are to be expected but also to calibrate the spring 200 in accordance therewith.

It will also be possible, should it be desirable, merely to depend on the spring 200 of the trigger and to arrange this spring so that it will permit a release of the latch only when a sufficient force

is exerted upon the armature to rotate the trigger despite the force of the spring. In such latter case, spring 241 will not be necessary.

I have here shown, however, the preferred embodiment wherein compression spring 241 which may readily be calibrated is utilized to resist the force exerted upon the armature by the passage of current through the solenoid. By this means, the automatically operated interposer 150 may be tripped in response to a specific excessive overload of substantial extent. It may be necessary or desirable to effect a similar tripping operation of the interposer 150 when an overload which is not greatly excessive but is nevertheless continuous occurs.

In order to accomplish this purpose, I provide a thermal bi-metallic element 34 (Figures 4, 5, 8 and 9) which is responsive to heating effects which may occur in this circuit. The thermal bi-metallic element 34 is so arranged that the lower end thereof will be rotated clockwise with respect to Figure 8 under the influence of heat. The current path from the connecting lug 45 through the contacts and to the connecting lug 30 is through the thermal element 34. Thus the current is led from connecting lug 45 through the bar 44 to the contact surfaces 42 and 41, the contact supporting arms 39 and 38, the solenoid coil 37, the wire braid 36 to the thermal element; from the thermal element, the current flows into the thermal element supporting arm 33, thence through the bar 32 to the opposite connecting terminal 30.

Any overload conditions on the line which may result in the passage of sufficient current to generate heat in the circuit but which may not be of sufficient intensity to energize the solenoid 239 may nevertheless be sufficient to cause a bending of the thermal element 34. The thermal element 34 preferably is so calibrated that it will bend into engagement with the arm 221 of the trigger under predetermined excessive load conditions which are not greatly in excess of the desired current condition but which nevertheless result in the generation of excessive heat.

Upon bending of the thermal element 34 in response to such heating conditions in the circuit, the end thereof will be swung over in the manner shown in the dotted lines of Figure 5 into mechanical contact with the trigger arm 221 and will cause a rotation of the trigger 182 about the spindle 210, such rotation releasing the latch portion 181 thereof from the metallic bearing 180 of the latch engaging arm 152 of the automatically interposable interposer 150.

This permits a tripping operation to occur and permits the compression spring 170 to force the automatically operated interposer 150 into the position shown in Figure 9.

The automatically operated interposer may then be reset in the manner above described by the operation of the manual operating lever 23, but the trigger 182 will not be rotated to latching position by its spring 200 until the heating conditions which resulted in a curling of the thermal element 34 have been removed.

Thus, should the interposer 150 be reset in the manner above described immediately after tripping in response to heating conditions, it will immediately trip once more owing to the fact that the thermal element will not have had an opportunity to cool off sufficiently to permit it to disengage the trigger arm 221. For this reason, therefore, the interposer 150 cannot be reset until whatever heat has already been generated in the

circuit has had an opportunity to radiate away. If, after such radiation has occurred, the interposable barrier 150 should be reset and an excessive overload occur, the solenoid operating mechanism 230 will cause another tripping; and should there be in the case of such resetting a slight overload resulting in the generation of heat once more, then after heat has been generated for a sufficient amount of time to permit the curling over of the thermal element 34, the interposer 150 will again be tripped and the circuit broken.

In every case it must be understood that the operation of the interposer 150 is completely free of the manual operating arm 23 and that it is absolutely impossible to maintain the circuit in closed circuit position when fault conditions exist upon the line.

The circuit breaker may be adjusted for different types of excessive overloads by proper calibration, and interchanging of the spring 241, and it may be adjusted for different responses to slight or heating overloads by either a change in the bi-metallic element or a shifting of the bi-metallic element 34 with respect to the trigger arm 221 so as to require a difference in the amount of bending of the thermal element before it is in mechanical contact with the trigger arm 221.

In order to provide for such shifting of position I provide that a screw 270 be threaded through the arm 33 which supports the thermal element 34 and that the end of this screw bear against the ledge 271 in the interior of the housing. The arm 33 is made of resilient conductive material and is sufficiently elastic so that upon rotation of the screw 270 the arm 33 will be moved closer to or further away from the ledge 271 thus changing the position of the mounting of the thermal element 34 and shifting it closer to or further away from the trigger arm 221.

The mounting portion 61 of the manual operating lever 23 is so arranged that whatever the position of the manual operating lever, whether on or off, the slot 80 is completely covered over so that virtually no dust may enter from the outside into the mechanism.

This results, however, in making it either difficult or impossible to examine the interior of the mechanism while the circuit breaker is mounted upon the panel board to determine whether the circuit breaker has been tripped. As a matter of fact, even though the finger grasping portion 60 of the manually operated lever 23 is in the closed circuit position shown in Figure 5, the circuit breaker may be tripped open by the dropping of the interposer 150 to the position shown in Figure 9 without changing the position of the finger grasping portion 60. Thus unless some outward visual indication is provided as to the position of the interposer 150, it will be difficult if not impossible to determine whether a circuit breaker has been tripped.

Accordingly, I have provided a visual indicator which will readily show the position of the automatically operated interposer 150. The visual indicator is preferably a flat metallic member 300 (Figures 5 and 16) carrying a flag 301 and having a perforation 302 registerable with the mounting shaft 72 and an angular projection 303 registerable with the angle 74 of the mounting shaft. The indicator 300 is mounted upon the shaft 72 above the interposer 150 and the mounting portion 61 of the manually operated lever 23. The indicator disk 300 also has a finger 305 preferably at right angles to the main por-

tion of the disk 300 and extending as is shown in Figure 9 immediately below the latch engaging arm 152 of the interposer 150.

A spring 306 (Figure 9) is at one end thereof engaged in an opening 307 of the automatically operated interposer 150 and at the other end at 308 is caught beneath the finger 305. The central coil portion thereof is wound about the shaft 72 and is placed between the automatic interposer 150 and the manual operating arm mounting 61.

The spring 306 and especially the end 308 thereof is therefore biased to raise the finger 305 and thus is biased in such a direction as to cause a rotation of the disk 300 so as to raise the flag 301. Normally, however, when the automatically operated interposer 150 is in the latched position shown in Figure 8, the latch engaging arm 152 thereof presses down the finger 305 against the bias of the end 308 of the spring and hence also presses down the flag 301 so that it is not visible. When the automatically operated interposer 150 is tripped into the position shown in Figure 9 and the latch engaging portion 152 thereof is raised, then the end 308 of the spring pushes up the finger 305 of the indicator and pushes the flag 301 up into the slot 80 where it may be visible from the outside alongside the mounting portion 61 of the manual operating lever 23.

Accordingly, even though the finger grasping portion 60 of the manual operating lever 23 is in the apparent closed circuit position, the appearance of the flag 301 in the slot 80 alongside the mounting portion 61 of the manual operating lever will immediately give an indication that the circuit breaker has been tripped to open circuit position.

In order to provide a recess in the mounting portion 61 to permit the flag 301 to appear in the slot 80, the mounting portion 61 is cut-out at 310 to a depth sufficient to permit the entry of the flap 301 therein (310, Figure 5).

In order to prevent any possibility during the opening of the contacts of any arcing over between the movable contact block 40 and the bar 44, I prefer to provide insulating barriers 320 and 321 (Figure 5) which may be mounted in notch 322 of the ledge or boss 323 in the bottom wall of the housing and in notches 324 and 325 of an end wall of the housing.

In order further to protect the members against arcing, I provide an upper shield 340 (see Figures 5 and 16) having a T-shaped opening 341 therein to permit the engagement of the contacts and the passage of the wheel there-through. This protective shield may be formed or stamped to shape, the shape being, of course, determined by the contour of the housing and obviously this shield 340 is spaced from the bottom shield 130 by a distance sufficient to permit the free passage of the insulating interposers between them.

From the foregoing description it will be seen that each of the members of the circuit breaker is supported within the housing in such a manner that they may readily be assembled in connection therewith. The housing itself is so formed and constructed as to provide supporting elements of various types, most of which having hereinbefore been described. Thus, for instance, the bar 32 which is an extension of the connecting lug 30 is securely mounted within the housing assembly by the screw 360 (Figures 4 and 5) which passes through a lug 361 of the bar 32 and into an integrally molded rectangular support 363 of the housing. The bar 32 is also securely

positioned within the housing by being mounted between the rectangular abutment 363 and the angular portion 364 of the housing.

Each of the interposers and the manual operating lever rotates about a single spindle which is integrally molded from or secured to one wall of the housing.

The member 44 which carries the lug 45 is also securely mounted within the housing, as is seen in Figure 9, by being mounted in a recess or channel 366 thereof. The various portions of the housing cooperate with other elements to provide stops for certain of the movements and to provide mountings and securement in the manner hereinbefore described. When the cover plate 21 is secured in place by the rivets 22, then each of the members is securely fixed in its operative position, particularly as is seen by the cross-sectional view of Figure 6. Thus, the final securement of all of the members is obtained after most of the members have merely been slipped into place by the attachment of the cover member 21 and the passing of the rivets 22 through the elements and the housing.

Obviously, suitable on-off indication may be printed or written on the outside of the housing in cooperation with the manual operating lever 23 and particularly the finger grasping portion 60. If so desired the mounted portion 61 of the manual operating lever may be lettered with the legend "off" at 370 (Figures 4, 15 and 16) and with the legend "on" at 371 (Figures 5 and 16). Furthermore the indentation 372 of the mounted portion 61 of the manual operating lever 23 may be provided and may be suitably colored to indicate the "on" position, since it will be visible only when the finger grasping portion of the manual operating lever 23 has been moved to the "on" position.

From the foregoing description of the various elements and the manner in which they operate, it will be clear that the same type of apparatus may be adapted, where desired, to multi-pole operation and where desired, it may be possible to place two or more of the combination switch and circuit breakers side by side for multi-pole operation connecting the manual operating levers 23 by passing any suitable member through the perforation 380 (Figure 4) of adjoining manual operating levers so that multi-pole switching may be effected.

As has been above emphasized, while this circuit breaker is useful for individual operation, the greatest utility lies in its arrangement and adaptability for panel board mounting in the manner shown in Figure 2.

The lead connecting lug 30 as will be noted particularly with reference to Figure 4 is protected by the curved extension 390 of the housing and is enclosed between the cover plate and this extension. The lead 45 may, if desired, extend from the opposite side or it may where necessary be protected in a similar manner by the extension 395 of the cover plate (Figure 1) and/or by a corresponding extension of the housing. For ordinary panel board mounting where the lead 45 is to be used as part of the support for the circuit breaker upon the bus it may be desirable to use a cover plate which terminates at the side of the housing. For this purpose a weakening line 396 comprising indentations or grooves or any other suitable weakening elements may be provided in the cover 21 to facilitate the breaking off of the extension 395 so that the circuit breaker may readily be

mounted in the panel board shown in Figure 2.

In Figures 2 and 3 a plurality of circuit breakers of the present invention are shown mounted upon a panel board with the leads 45 connected by suitable conductive securing means, as for instance the screws 397, to a common bus 398, and the opposite leads connected to load wires 399 in any suitable manner. The leads 45 obviously may be sufficient to provide adequate support for one end of the circuit breaker upon the common bus 398, although if desired any other securing means may be provided for this purpose, as for instance, the foot or lug 400 which may serve to engage a suitable clamp member upon the supporting base 401 of the panel or which may be extended and formed in such a manner as to provide a screw engaging means. As seen in Figure 3, flanged plate 400a may be screwed to the panel and may be formed to encase foot or lug 400 to secure the same to the panel.

The foot 402 may be provided at the opposite end of the circuit breaker in order to provide the proper support for a screw 403 which may be passed therethrough into the panel board supporting member 401 and secured in any suitable manner as for instance by the nut 404.

In order to insure that the circuit breaker will be perfectly level upon the panel board support 401, the foot 402 may be flush with the under-surface of the circuit breaker or, if this is not feasible, then an additional support 405 may be provided for the purpose. The common bus may, if desired, be protected by any suitable circuit breaker. The circuit to any individual mechanism connected to any one of the circuit breakers will thus be through the common bus 398 to the connecting lead 45 through the circuit breaker and the opposite lead 30 (Figure 4) and therefrom to the load wire 399 (Figure 3) to the mechanism, and then any suitable return, as for instance to the terminal block 420 to which is connected the return wires from the individual loads; the terminal block 420 being connected to the side of the line opposite that to which the common bus is connected.

Each of the individual circuits operated from each of the individual circuit breakers is thus fully protected by its own individual circuit breakers while the entire panel board and all of the elements operated therefrom may, if desired, be protected by a single circuit breaker capable of handling the full load. The panel board itself, as is seen in Figures 2 and 3, comprises a main base or mounting portion 410 upon which the panel board supporting member 401 is secured in any suitable manner. The main base and mounting portion 410 may have side members 411 and covering flanges 412. The covering flanges 412 may be formed in order to support a slotted frame covering member 413 which will conceal all of the circuit breakers except for the top surfaces thereof at 414, 414 from which the finger grasping portion 60 of the manual operating lever 23 projects.

In this manner no part of the circuit breakers or of the panel board or of the connecting wires are accessible except for the manual operating lever above mentioned and except for the indicating means previously described. If desired, also a suitable cover may be mounted upon the flanges 412 to cover over the entire panel board against unauthorized operation thereof. Where the circuit breakers are thus to be mounted closely adjacent to each other, the ends of rivet

22 may be countersunk in the molding (and bosses placed thereabout) to provide an air space between said rivet ends so that they will not be in contact with similar rivet ends on adjacent breakers. The rivet ends on adjacent breakers may then extend slightly into the counterbore. Such adjacent rivet ends are the ones extending from the cover plate. The cover plate is a die cut blank and the head of the rivet engages the cover plate at the rivet openings, while the opposite ends of the rivets in the counterbores or recesses of the molding are spun down.

Where only a thermal trip is desired without changing the structure of the device, then the core of the solenoid coil may be removed or member 245 of the core may be removed, thus leaving a dummy solenoid bushing and coil; in such case, only the thermal trip will operate. In this case also, the coil arrangement may be dispensed with, and the braid 36 from the thermal element may be connected to a metallic tube or other pivotable element which may carry the movable contact arm. Such tube or pivotable element may rotate about an insulating tube similar to the insulating tube 231 of the solenoid.

The present circuit breaker comprises a magnetic trip and a thermal time delay element may be incorporated in the usual form of power and light panel to handle branch circuits. The members as has been noted are readily mounted in any suitable support upon the panel and require no more space than a fused switch, and, taking into consideration the expense of replacement of fuses and the expense of operation of the fused switch, they are better than an adequate substitute therefor.

They are designed to be mounted in a panel with a number of units side by side with the line terminal of each circuit breaker screwed directly to the common bus, this screw also serving to hold one end of the unit mechanically, the opposite end of the circuit breaker being mechanically supported in any suitable manner. In this manner therefore any individual units may be removed and replaced without disturbing adjoining units.

As has been above noted the circuit breaker of the present invention is trip free in that it will open even though the handle is held in closed position and the switch cannot be held against overload or short circuit. The only way in which the circuit breaker may be reset after the interposer has been tripped is by moving the manually interposable interposer between contacts and thus maintaining the contacts in open circuit position. Should the circuit protected by the circuit breaker still be under overload conditions, then permitting the manually interposable interposer to be moved away from between the contacts will again cause the actuation of the thermal and/or solenoid elements to cause the automatically interposable interposer to move between the contacts and thus maintain the separation therebetween.

The circuit breaker, as has been noted, trips immediately upon an excessive overload owing to the operation of solenoid means above described. The thermal tripping means which acts in response to an overload which is not greatly excessive, but nevertheless is excessive, is slowly heated as this minor overload continues until it effects the tripping operation above described. As the overload increases the thermal element acts more and more rapidly. However, should excessive overloads occur, then it may be dangerous

to allow any delay until the thermal element is sufficiently heated to accomplish the tripping operation and accordingly the solenoid tripping mechanism acts instantaneously upon greatly excessive overloads.

Furthermore, the ability of the present circuit breaker to trip at high speeds upon greatly excessive overloads would serve to prevent the main protecting circuit breaker from tripping upon the occurrence of an excessive overload in a single branch circuit, and thus will serve to prevent the other branch circuits operating from the same bus from being disconnected from the main circuit.

In the foregoing description, cooperating elements have been set forth and the interrelation therebetween has been described.

Various modifications and changes in the different parts will now be obvious to those skilled in the art. Accordingly, it is desired to be bound not by the specific disclosures herein but only by the appended claims.

This application is filed simultaneously with the application of Herbert C. Graves, Jr., Serial No. 331,982, for Circuit breaker; the application of William M. Scott, Jr., Serial No. 332,037, for Circuit breaker; and the application of Otto Jensen, Serial No. 331,967, for Circuit breaker. In this application I have claimed those inventions and portions of the structure devised by me.

I claim:

1. A circuit interrupter and a molded housing therefor having a side wall, an opposed open side and a cover plate therefor, a fixed contact and a movable contact biased toward engagement with said fixed contact, pivotally mounted interposer means movable to position between the contacts and a pivot for said pivotally mounted interposer means, said pivot being integrated with said side wall, said interposer being in operative position in relation to the contacts when mounted on the pivot, the parts of the circuit interrupter being operative about said pivot before said cover plate is mounted thereon.

2. A circuit interrupter and a molded housing therefor, having a side wall, an opposed open side and a cover plate therefor, a fixed contact and a movable contact biased toward engagement with said fixed contact, a pivotally mounted manual interposer and a pivotally mounted automatically interposable interposer, said interposers being movable to position between the contacts, and a pivot for said pivotally mounted interposers, said pivot being integrated with said side wall, said interposer being in operative position in relation to the contacts when mounted on the pivot, the parts of the circuit interrupter being operative about said pivot before said cover plate is mounted thereon.

3. A circuit interrupter and a molded housing of insulating material therefor, said housing having a side wall; a fixed contact; and a movable contact biased toward engagement with said fixed contact, means for separating said contacts, said means being controlled by a pivotally mounted latch, and a pivot for said pivotally mounted latch, said pivot being integrated with said side wall and being supported solely by said side wall.

4. A circuit interrupter and a molded housing of insulating material therefor, said housing having a side wall; a fixed contact; and a movable contact biased toward engagement with said fixed contact, means for separating said contacts, said means being controlled by a pivotally mounted latch, and a pivot for said pivotally

mounted latch, said pivot being integral with said side wall and being supported solely by said side wall, and a bushing on said pivot for retaining said latch in predetermined position; a cover for the opposite side of the housing; said cover when in place retaining said bushing in latch positioning relation.

5. In a circuit interrupter, a fixed contact and a movable contact biased toward engagement with said fixed contact, a pivotally mounted interposer movable to two limiting positions from non-interposing position to position between the contacts; an over center compression spring operable upon said interposer for positioning said interposer in selected limiting position; and a guide link within said compression spring for directing the force of the spring in a beyond center direction in each limiting position.

6. In a circuit interrupter, a fixed contact and a movable contact biased toward engagement with said fixed contact, a pivotally mounted interposer movable to two limiting positions from non-interposing position to position between the contacts; said interposer having a central pivoting portion, means on said pivoting portion for engaging the end of a link, a link, one end of said link bearing against said engaging means, the opposite end of said link being slidably supported, said link being aligned beyond the center of said central pivoting portion in each limiting position, and a compression spring bearing against a fixed stop at one end and against a portion of the link at the other end for driving the first end of said link against said engaging means.

7. In a circuit interrupter, a fixed contact and a movable contact biased toward engagement with said fixed contact, a pivotally mounted interposer biased toward interposing position and releasably held in non-interposing position, said interposer having a pivoting portion, means on said pivoting portion for engaging the end of a link, a link, one end of said link bearing against said engaging means, the opposite end of said link being slidably supported, said link being aligned beneath the center of said pivoting portion and a compression spring bearing against a fixed stop at one end and against a portion of the link at the other end for driving the first end of said link against said engaging means and constituting the biasing means for said interposer.

8. In a circuit interrupter, a fixed contact and a movable contact biased toward engagement with said fixed contact, a pivotally mounted manual interposer and a pivotally mounted automatically interposable interposer, said interposers being movable to position between the contacts, a spring for biasing said automatically interposable interposer toward interposing position and a separate spring for positioning said manually operated interposer in selected position.

9. In a circuit interrupter, a fixed contact and a movable contact biased toward engagement with said fixed contact, a pivotally mounted manual interposer and a pivotally mounted automatically interposable interposer, said interposers being movable to position between the contacts, a spring for biasing said automatically interposable interposer toward interposing position and a separate over center compression spring operable upon said manually operated interposer for positioning said interposer in selected position.

10. In a circuit breaker, a fixed contact and

a movable contact biased towards engagement with said fixed contact, a pivotally mounted interposer biased towards interposing position between said contacts and independent means for moving the interposer from position between the contacts, said last mentioned means being movable to a self-maintained position between the contacts to maintain them separated when the interposer is moved from position therebetween, and means for releasably maintaining said interposer in non-interposing position, said means comprising an arm on said interposer, a latch plate on said arm and means engageable with said latch plate, and means for releasing said engagement.

11. In a circuit interrupter, a fixed contact, a movable contact, means biasing said movable contact toward engagement with said fixed contact, an interposer movable to cause separation of said contacts and insert itself between them, said interposer comprising means of insulating material having an edge effective to cut off an electrical arc between said contacts and means other than said edge for causing separation of said contacts, a thermal element for initiating the operation of said interposer, said thermal element being mounted in spaced relation to a means for initiating the operation of said interposer, said thermal element comprising a bi-metallic strip; a lug on said support, a resilient metallic member supported at said lug; said metallic member carrying said thermal element, and an adjustment for changing the spacing between the thermal element and said means for initiating the operation of said contact separating means.

12. In a circuit interrupter, a fixed contact and a movable contact, a switch member having an angular movement about a fixed support and biased toward interposing position between said contacts to separate said contacts, means for maintaining said switch member in non-interposing position, means for releasing said member to permit movement thereof to interposing contact opening position and a visual indicator operated by said switch member and brought to indicating position by the movement of the switch member to interposing position.

13. In a circuit interrupter, a fixed contact and a movable contact, a switch member having an angular movement about a fixed support and biased toward interposing position between said contacts to separate said contacts, means for maintaining said switch member in non-interposing position, means for releasing said member to permit movement thereof to interposing contact opening visual position and a visual indicator comprising a member having angular movement about the same fixed support, means biasing said indicator member toward indicating position, and means on said indicator member engageable with a portion of said switch member and restraining said indicator member from movement to indicating position when said switch member is in non-interposing position.

14. In a circuit interrupter, a fixed contact, and a movable contact, a switch member having an angular movement about a fixed support and biased toward interposing position between said contacts, means for maintaining said switch member in non-interposing position, means for releasing said member to permit movement thereof to interposing position and a visual indicator comprising a flat member carrying an indicating flag and having angular movement about the same fixed support, means biasing said indicator

toward movement of said flag to indicating position and a finger on said flat member engageable with a portion of said switch member and restraining said indicator member from movement to indicating position when said switch member is in non-interposing position.

15. In a fully enclosed circuit interrupter having a slot in a wall of the enclosure, a fixed contact and a movable contact, a switch member having an angular movement about a fixed support and biased towards interposing position between said contacts, means for maintaining said switch member in non-interposing position, means for releasing said member to permit movement thereof to interposing position and a visual indicator comprising a flat member carrying an indicating flag and having angular movement about the same fixed support, means biasing said indicator toward movement of said flag into said slot and a finger on said flat member engageable with a portion of said switch member and restraining said indicator member from movement to indicating position when said switch member is in non-interposing position.

16. In a circuit interrupter, a casing of insulating material comprising a side wall and an end wall, a fixed contact on said side wall, a connecting bar between said fixed contact and a terminal, a portion of said bar extending along said side wall and a portion of said bar extending along said end wall; a movable contact for engaging said fixed contact, and means for preventing an arc between said movable contact and the connecting bar, said means comprising an insulating strip inserted in the casing in the arcing path between said movable contact and said connecting bar.

17. In a circuit interrupter, a casing of insulating material comprising a side wall and an end wall, a fixed contact on said side wall, a connecting bar between said fixed contact and a terminal, a portion of said bar extending along said side wall and an exposed portion of said bar extend-

ing along said end wall; a movable contact for engaging said fixed contact, and means for preventing an arc between said movable contact and the exposed portion of said connecting bar, said means comprising an insulating strip inserted in the casing in the arcing path between said movable contact and said exposed portion of said connecting bar.

18. In a circuit interrupter, a casing of insulating material comprising a side wall and an end wall, a fixed contact on said side wall, a connecting bar between said fixed contact and a terminal, a portion of said bar extending along said side wall and an exposed portion of said bar extending along said end wall; a movable contact for engaging said fixed contact, and means for preventing an arc between said movable contact and the exposed portion of said connecting bar, said means comprising an insulating strip inserted in the casing in the arcing path between said movable contact and said exposed portion of said connecting bar, said strip being supported in slots in opposed insulating supports within said casing, said insulating supports being integral with said casing.

19. In a circuit interrupter, a casing of insulating material comprising a side wall and an end wall, a fixed contact on said side wall, a connecting bar between said fixed contact and a terminal, a portion of said bar extending along said side wall and an exposed portion of said bar extending along said end wall; a movable contact for engaging said fixed contact, and means for preventing an arc between said movable contact and the exposed portion of said connecting bar, said means comprising a plurality of insulating strips inserted in the casing in the arcing path between said movable contact and said exposed portion of said connecting bar, said strips being supported in slots in opposed insulating supports within said casing, said insulating supports being integral with said casing.

FRANK J. POKORNY.