Sept. 7, 1943. F. B. ADAM ET AL 2,328,767

CIRCUIT BREAKER

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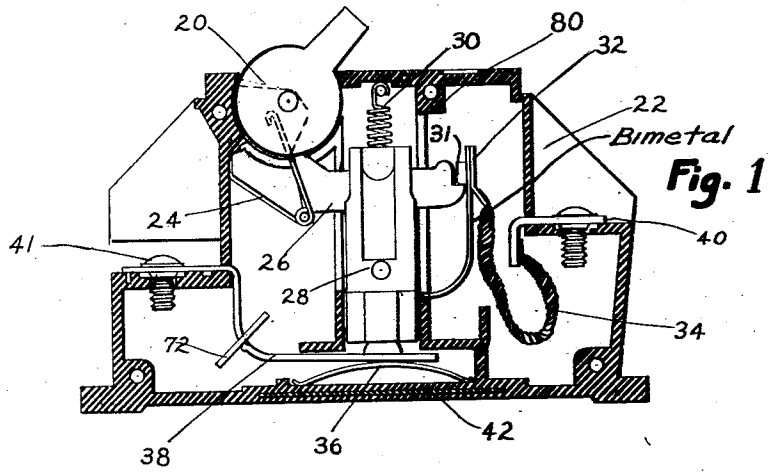


Fig. 1

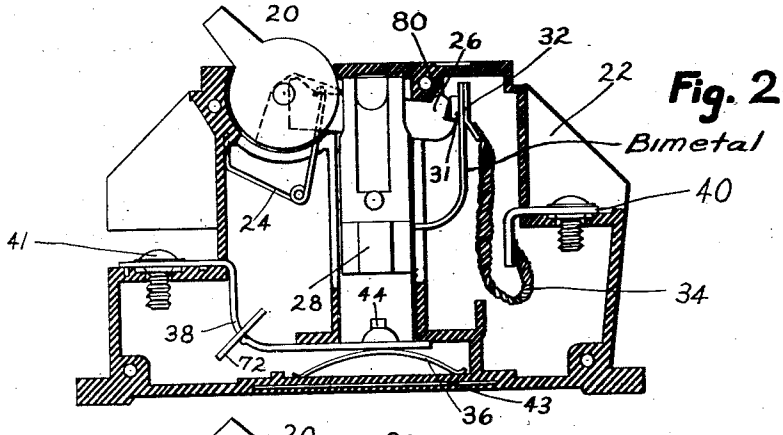


Fig. 2

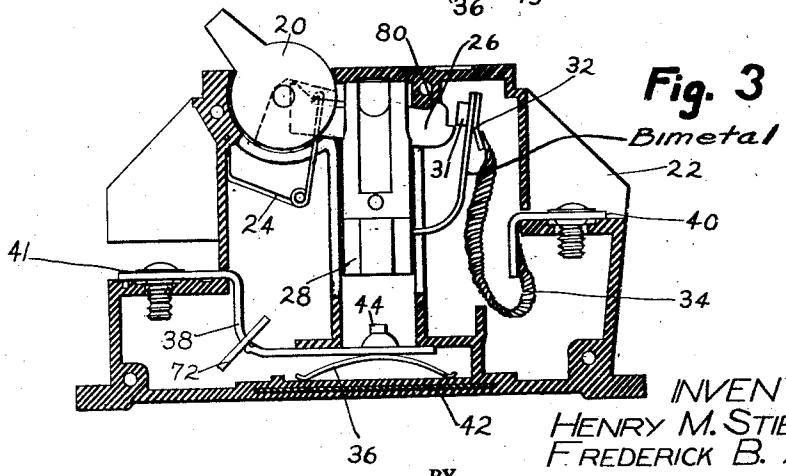


Fig. 3

INVENTORS:
HENRY M. STIEGLITZ
FREDERICK B. ADAM

BY

Roy M. Eilers
ATTORNEY.

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CIRCUIT BREAKER

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Fig. 4.

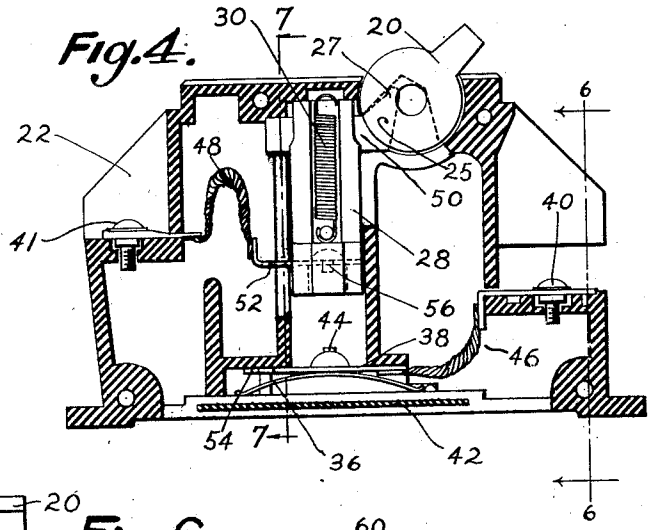


Fig. 7.

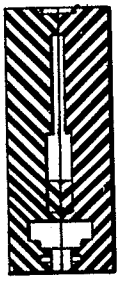


Fig. 6

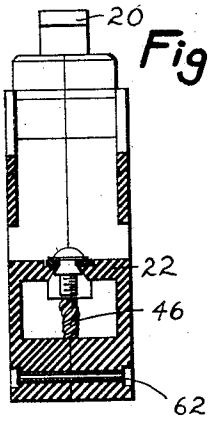


Fig. 5

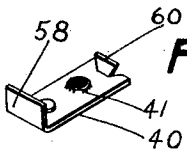


Fig. 8.

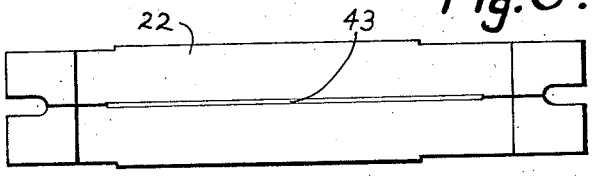


Fig. 10.

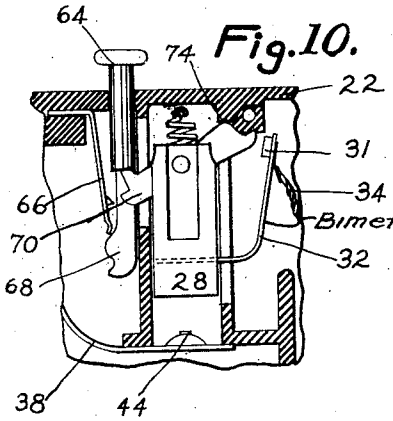
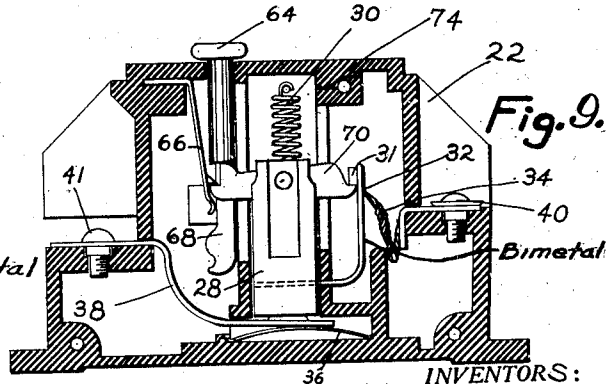


Fig. 9.



INVENTORS:
HENRY M. STIEGLITZ
FREDERICK B. ADAM
BY
Roy M. Eilers
ATTORNEYS.

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CIRCUIT BREAKER

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Fig. 11.

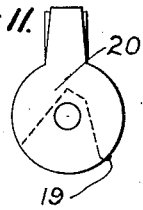
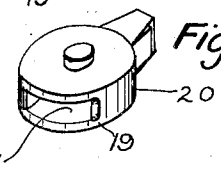


Fig. 12.



Fig. 13.



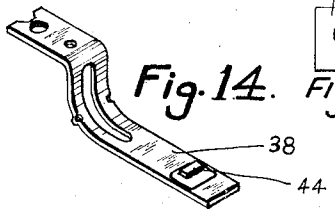


Fig. 14.

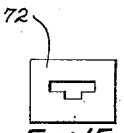


Fig. 15.

Fig. 16.

Fig. 17.

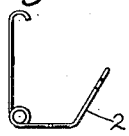


Fig. 18.

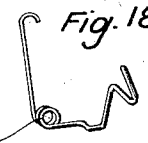


Fig. 19.

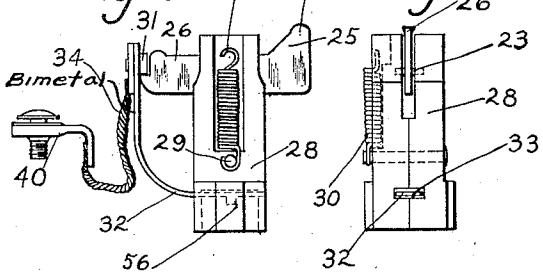


Fig. 20.

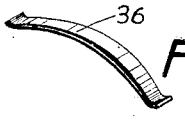


Fig. 22.

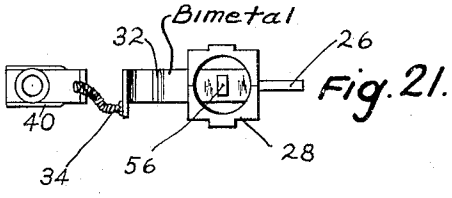


Fig. 21.

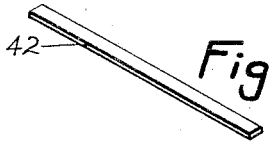


Fig. 23.

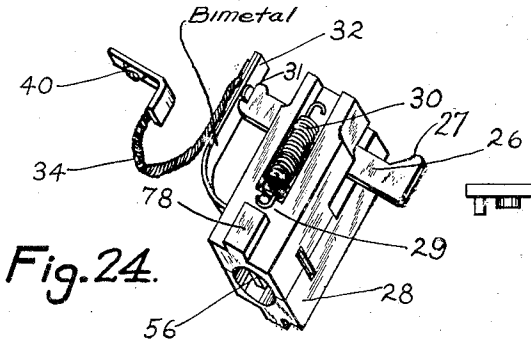


Fig. 24.

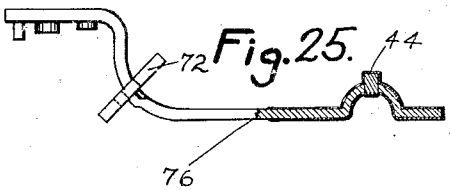


Fig. 25.

INVENTORS:
HENRY M. STIEGLITZ
FREDERICK B. ADAM

BY

Roy M. Silers
ATTORNEY.

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CIRCUIT BREAKER

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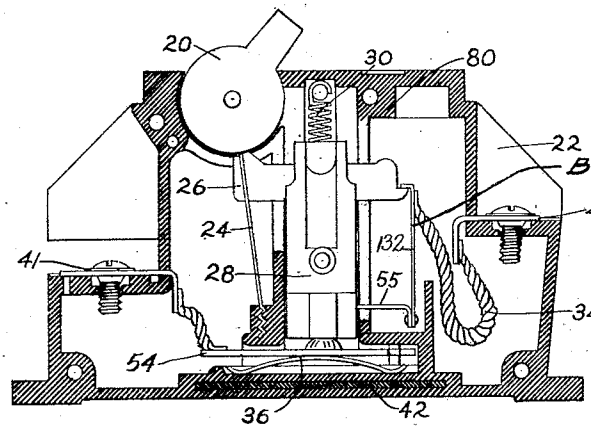


Fig. 26.

Fig. 29.

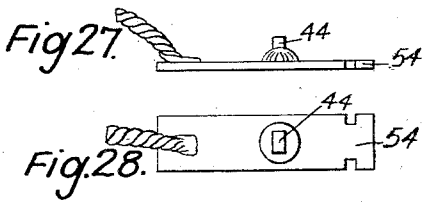


Fig. 27.

Fig. 28.

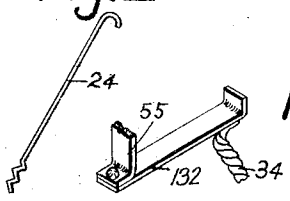


Fig. 30.

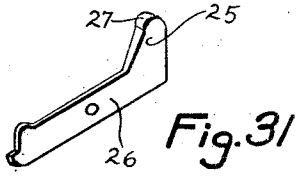


Fig. 31

INVENTORS:
HENRY M. STIEGLITZ
FREDERICK B. ADAM
BY
Roy M. Eilers
ATTORNEYS.

Sept. 7, 1943. F. B. ADAM ET AL 2,328,767

CIRCUIT BREAKER

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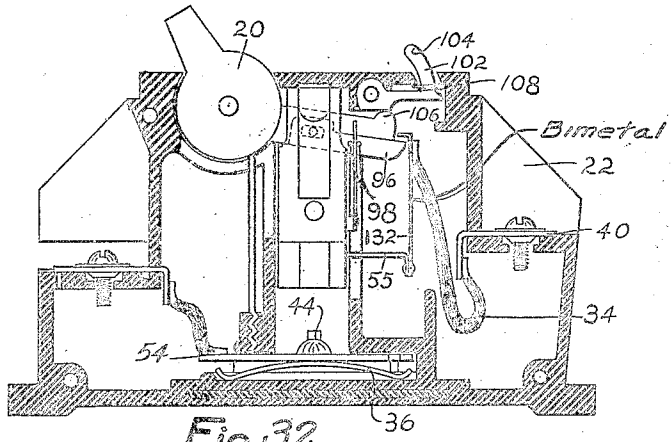


Fig. 32.

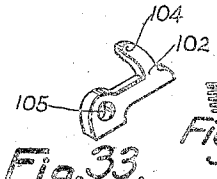


Fig. 33.

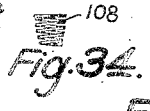


Fig. 34.

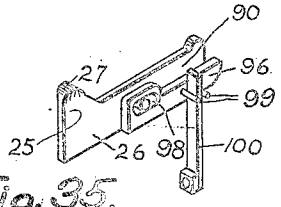


Fig. 35.

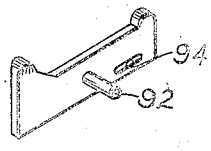


Fig. 36.

INVENTORS:
HENRY M. STIEGLITZ
FREDERICK B. ADAM
BY
Roy M. Eilers
ATTORNEY

Patented Sept. 7, 1943

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UNITED STATES PATENT OFFICE

2,328,767

CIRCUIT BREAKER

Frederick B. Adam, St. Louis County, and Henry M. Stieglitz, St. Louis, Mo.

Application July 31, 1940, Serial No. 348,776

19 Claims. (Cl. 200—116)

This invention relates to improvements in switches and automatic circuit breakers. More particularly, the invention relates to improvements in small enclosed type switches and automatic circuit breakers that are operated by rotatable actuating means.

It is one object of the invention to provide an improved enclosed type switch or circuit breaker.

In many of the switches and circuit breakers now in use, snap action of the movable contact is obtained by the employment of complicated systems of springs and levers. Such switches and circuit breakers are objectionable because the use of complicated systems of springs and levers makes the devices expensive. The present invention avoids the objection outlined above by providing snap action for the movable contact without using a complicated system of springs and levers. It is, therefore, an object of the invention to provide a simple snap-acting mechanism for switches and circuit breakers of the enclosed type.

Difficulty has been encountered in maintaining adequate contact pressure between the contacts of small enclosed type switches and circuit breakers. In some of these devices, contact pressure is secured by the bending of the contacts. Such construction is not entirely satisfactory because materials of which contacts are ordinarily made do not have much resiliency. The invention avoids this objection by providing means to maintain intimate engagement between the contacts which is independent of the resiliency of the contacts. It is, therefore, an object of the invention to provide a switch or circuit breaker of the enclosed type wherein contact pressure is secured by means that is not dependent on resiliency of the contact.

In some of the small enclosed type circuit breakers now in use, difficulty has been experienced in preparing them for circuit-closing operation after they have been tripped by an excessive current. The invention provides means to automatically return the actuationg means of the switch or circuit breaker to the "off" position on the occurrence of an overload, and it is, therefore, an object of the present invention to provide an automatic circuit breaker of the enclosed type which automatically prepares itself for circuit-closing operation after the breaker has been tripped.

When the circuit is broken by some of the circuit breakers and switches now in use, burning occurs on the copper on which the contact is supported. Such burning shortens the life of the device and is, therefore, quite objectionable. The invention obviates the objection outlined above by providing means to prevent the burning of the copper contact support and restrict any arc that might form to the surface of the arc-resisting contact. It is, therefore, an object of the present invention to provide a contact support and a coating therefor that limits any arc which might form to the surface of the contact.

Where automatic circuit breakers using electrothermally responsive means to open the circuit in response to an overload current are exposed to heat, the circuit may be broken by a current that is less than the current for which the device is rated. Such circuit breakers are not dependable since they permit interruptions of service that are not necessary. The invention obviates any such interruptions by providing means to compensate automatically for the effect of ambient temperature on the circuit breaker. Such an arrangement permits the circuit breaker to operate only when an overload current of greater strength than the rated current occurs. It is, therefore, an object of the present invention to provide an automatic circuit breaker having means to compensate for ambient temperature.

It is often desirable to use several small automatic circuit breakers of the enclosed type in a gang, and it is often desirable to connect two or more circuit breakers by a handle. Where this is the case, the tripping of one of the breakers may occur without a movement of the actuating means to the "off" position because the actuating means will be held by the other breaker. In such a case it is quite difficult to determine whether or not the circuit is open or closed. The invention provides an indicator that operates independently of the actuating means to show whether or not the circuit is closed. It is, therefore, an object of the present invention to provide a small automatic circuit breaker of the enclosed type having means that operates independently of the actuating means to indicate whether or not the circuit is closed.

Other objects and advantages of the invention will be shown and described in the drawings and accompanying description.

Several preferred forms of the invention are shown and described in the drawings and accompanying description, but it is to be understood that the drawings and accompanying description do not limit the invention and that the invention will be defined by the appended claims.

In the accompanying drawings,

Fig. 1 is a cross-sectional view of the invention

as applied to a circuit breaker, and shows the elements of the circuit breaker in the "on" position.

Fig. 2 is a cross-sectional view of the elements of the circuit breaker in the "off" position.

Fig. 3 is a cross-sectional view of the elements of the circuit breaker in the "off" position after the circuit has been broken in response to an overload current condition.

Fig. 4 is a cross-sectional view of the elements of a switch of the simple, non-automatic type to which the invention may be applied. The elements are shown in the "off" position.

Fig. 5 is a perspective view of a terminal used in the circuit breaker and switch.

Fig. 6 is a cross-sectional view of the switch shown in Fig. 4, that is taken along the plane 6—6, and shows an end view of the switch.

Fig. 7 is a cross sectional view of the insulating housing of the switch taken along 7—7 in Fig. 4.

Fig. 8 is a view of the bottom of the casing in which the circuit breaker or switch may be mounted.

Fig. 9 is a cross-sectional view of an optional form of the invention and shows the elements of the device in the "on" position.

Fig. 10 is a partial cross-sectional view of the optional form of the invention of Fig. 9 immediately after the circuit has been broken in response to an overload current condition.

Fig. 11 is a side elevational view of the actuating means used with the invention.

Fig. 12 is an end elevational view of the actuating means shown in Fig. 10.

Fig. 13 is a perspective view of the actuating means shown in Figs. 11 and 12.

Fig. 14 is a perspective view of one preferred form of semi-fixed contact support used in the invention.

Fig. 15 is a plan view of a magnetic choke shown in position in Fig. 25 and Figs. 1, 2 and 3.

Fig. 16 is an end elevational view of the magnetic choke shown in Fig. 15.

Fig. 17 is a side elevational view of one form of spring that biases the actuating means to the "off" position.

Fig. 18 is a perspective view of the spring shown in Fig. 17.

Fig. 19 is a side elevational view of the contact carrier used in the preferred form of circuit breaker.

Fig. 20 is an end elevational view of the contact carrier shown in Fig. 19.

Fig. 21 is a bottom view of the contact carrier shown in Fig. 19.

Fig. 22 is a view of the spring which assures intimate contact between the movable and fixed contact in the circuit breaker and switch.

Fig. 23 is a view of an insulating member that acts as a baffle plate in the bottom of the casing that encloses the circuit breaker.

Fig. 24 is a perspective view of the contact carrier used in the preferred form of circuit breaker.

Fig. 25 is a view of an optional form of semi-fixed contact support.

Fig. 26 is a cross-sectional view of another optional form of the invention showing the elements of the device in the "on" position.

Fig. 27 is a side elevational view of the semi-fixed contact support used in the device shown in Fig. 26.

Fig. 28 is a plan view of semi-fixed contact shown in Fig. 27.

Fig. 29 is a view of an optional form of spring that biases the actuating means to the "off" position.

Fig. 30 is a view of an optional form of electro-responsive means used in the device shown in Fig. 26.

Fig. 31 is a view of the transverse bar used in the invention.

Fig. 32 is a cross-sectional view of an automatic circuit breaker of the enclosed type having means to compensate for the effect of ambient temperature.

Fig. 33 is a perspective view of an indicator that acts independently of the actuating means to indicate whether or not the circuit is closed.

Fig. 34 is a side view of a spring that is used with the indicator shown in Fig. 33.

Fig. 35 is an enlarged perspective view of the means that compensates for ambient temperature, and

Fig. 36 is a perspective view of a modified form of transverse bar used in the invention.

Referring to the drawings in detail, Figs. 1, 2, and 3 show three positions of the elements of a preferred form of the invention. The elements of this form of the invention are positioned in a casing or housing **22**. This casing is preferably made of molded insulating material and has formed portions that guide and support the elements of the device. An actuating means **20** is positioned in a recess in the housing and rotates about the axis of a projection thereon, which engages a socket in the casing. As shown in Figs. 11, 12, and 13 the actuating means **20** has a recess **21** therein and a raised portion **19** on the periphery of the actuating means adjacent the recess. The recess **21** in the actuating means is designed to receive a cam portion **25** on a transverse bar **26**. This bar is rotatably secured to contact carrier **28** and is normally held at one end by electro-responsive means **32** and held at the other end by actuating means **20**. In the preferred form of the invention shown, the electro-responsive means is a bimetallic strip, but any means that operates in response to an overload current condition may be used. The recess **21** in the actuating means **20** also receives one end of spring **24** which is supported by the casing **22**. Attached to the bimetal **32** is a flexible conductor **34** that connects terminal **40** with with the electro-responsive means **32**. The terminal **40** shown in Fig. 5 is designed to be secured to casing **22** without a positive connection therebetween. The electro-responsive means **32** has a contact **56** mounted on one end thereof and a stop **31** mounted on the other end thereof. The stop **31** on one end of the electro-responsive means **32** normally engages and holds one end of the transverse bar **26**. The other end of the bimetal and the contact **56** thereon, engage and are held by the contact carrier **28**. The contact carrier **28** as shown in Figs. 19, 20, 21 and 24 comprises two sections of insulating material that are held together by a suitable means. The contact carrier has recesses in which the electro-responsive means **32** is held, and has projections on the sides thereof that engage formed portions of the casing and guide the movement of the contact carrier. A spring **30** is connected to the contact carrier and the casing. Where desired, two springs **30** may be used, one on each side of the contact carrier **28**. The spring or springs **30** are employed to bias the contact carrier to open circuit position. The contact **56** on the lower portion of the electro-responsive means **32** engages a contact **44** mounted on a semi-fixed

contact support 38. The contact support 38 is designed to engage formed portions of the casing and be supported and restrained thereby. The contact 44 is biased toward closed circuit position by the action of a spring 36 that is positioned in the bottom of the casing. This spring 36 presses contact support 38 upwardly against formed sections of the casing 22 when the circuit is open, and presses the contact 44 against contact 56 when the circuit is closed. An opening 43 is provided in the bottom of the casing 22 to permit any gases generated by electrical arcs to escape from the casing. A baffle plate 42 of insulating material may be positioned in the bottom of the casing adjacent the opening 43 and may be loosely supported by formed portions of said casing.

To operate the device shown in Figs. 1, 2, and 3, so as to close the circuit, the actuating means 20 is rotated in a clockwise direction to the "on" position. The rotation of actuating means 20 is resisted by the combined force of springs 24 and 30. As the actuating means 20 rotates, its end slides along the cam profile 25 formed on transverse bar 26 and exerts a downward acting force on the cam end of the bar. Since the middle of the bar is pinned to the contact carrier 28 and the other end of the bar 26 is held by electro-responsive means 32, the downward force on the cam end of the bar causes the downward movement of the bar and the contact carrier. As the actuating means 20 continues to rotate, the edge of the recess 21 therein engages a raised portion 27 on the cam portion 25 of bar 26 and thus obstructs easy operation of the parts to the full closed position. This obstruction necessitates the application of additional force to continue the rotation of the actuating means 20 to the full closed position. The raised portion 27 is positioned near the upper limit of the cam profile 25 so that the force required to rotate the actuating means past the raised portion 27 will be more than sufficient to rotate the actuating means into the full "on" position. This arrangement insures that the impulse applied to the actuating means immediately ahead of the position where the contacts engage will be sufficiently great to move the contact carrier into full "on" position once the obstruction to easy operation is passed. The movement of the contact carrier into the "on" position results in the engagement of contacts 56 and 44 and the bending of semi-fixed contact support 38. The bending of the contact support 38 is resisted by the spring 36 that is positioned beneath the contact support 38. The pressure exerted by the spring 36 insures intimate contact between contacts 44 and 56.

To open the circuit, the actuating means 20 is rotated in a counter-clockwise direction. As the actuating means is rotated, raised portion 19 on its periphery engages the profile of the cam portion 25 of the transverse bar 26. This engagement between the raised portion 19 on the actuating means and the cam profile 25 of the bar 26 obstructs easy operation of the parts immediately ahead of the position where the contacts 44 and 56 separate to break the circuit and, hence, a greater force is required to move the parts past this position than is required to move the handle 20 through the remainder of its orbit. Consequently, the impulse required to overcome the obstruction to easy operation thus provided is such that when the obstruction is passed the parts move quickly to the extreme positions. This quick action of the actuating means permits the contact carrier to move quickly into the "off" position under the biasing force of the spring 30 and prevents the holding of an arc between contacts 44 and 56.

Whenever an overload current condition occurs when the switch is closed, the bimetal 32 gets warm and bends outwardly. The outward bending of the bimetal causes stop 31 to move out of engagement with the end of bar 26. This movement of stop 31 permits contact carrier 28 to move upward and permits bar 26 to rotate under the biasing force of spring 30. The sudden release of bar 26 by the movement of stop 31 disturbs the engagement between actuating means 20 and the cam portion 25 of bar 26. This disturbance permits actuating means 20 to rotate to the "off" position under the influence of spring 24 and permits contact carrier 28 to move to the full "off" position. As the bar 26 is carried upwards by the contact carrier 28, it contacts a projection 80 that is formed on the casing 22. This projection is so positioned that the end of bar 26 is held below the lower edge of stop 31 on bimetal 32 when the contact carrier 28 is in the "off" position. The maintenance of the end of the bar 26 at a level below the lower edge of stop 31 permits the latching of stop 31 and bar 26 when bimetal 32 cools sufficiently. This latching arrangement cooperates with the return of the actuating means to "off" position automatically to prepare the circuit breaker for circuit-closing operation. The circuit breaker possesses not only this advantage but possesses also the advantage of being "trip free." The elements are so arranged that the circuit breaker cannot be held closed as long as an overload condition exists.

In Fig. 4 a switch without the automatic overload feature is shown. The casing of this switch is also preferably made of two sections of molded insulating material held together by suitable means. These sections also have preformed portions that support the elements of the device without a positive connection therebetween. A semi-fixed contact support 54 of slightly different construction is used in the device shown in Fig. 4. This contact support has slots on opposite sides thereof that engage projections on the sections of the casing. The engagement between the slots on the contact support and the projections on the casing guides the semi-fixed contact support 54 as it moves during the circuit opening and closing operations. The use of a contact support of this type permits a somewhat more intimate engagement between the contacts than does the use of the semi-fixed contact support 38 shown in Figs. 1, 2, and 3. The contact support 54 moves rectilinearly with the contact carrier 28 and permits plane contact between the contacts 56 and 44 at all times. The contact support 54 is connected to terminal 40 by a flexible conductor 46. This form of contact support may, of course, be used in the automatic overload breaker shown in the other views. In the switch shown in Fig. 4, the electro-responsive means is dispensed with and the contact 52 is connected directly to terminal 41 by a flexible conductor 48. A transverse bar 50 is rigidly connected to the contact carrier 28 and is bodily movable therewith. On one end of this bar, a cam section 25 is formed, and this cam section has a raised portion 27 thereon, similar to the raised portion shown in Figs. 1, 2, and 3. This raised portion 27 on the cam 25 cooperates with the actuating

means 20 to "snap" the contact carrier into the "on" position. The actuating means 20 used with the switch is the same actuating means used with the circuit breaker described above and operates similarly. The switch is operated by movement of actuating means 20. The actuating means 20 cooperates with the cam portion 25 on the bar 50 to provide "snap" action for the contact carrier 28 during the circuit making and breaking operation as previously described.

Fig. 5 is a perspective view of terminal 40. This terminal has folded portions that cooperate with formed recesses in the sections of the casing 22 to support and maintain the terminal in position. The projection 60 is formed so that the upstanding portion is wider at the upper end than it is where it joins the terminal. This projection serves to removably secure the terminal 40 to the casing. The projection 58 serves not only to prevent movement of the terminal, but serves also as a surface to which flexible conductor 46 is secured. An opening 41 is formed in terminal 40 and is tapped to receive a screw or bolt which may secure a lead to the terminal.

Fig. 6 is a cross-sectional view of the device shown in Fig. 4 and is taken along the plane 6—6 indicated therein. The view shows in detail the engagement between terminal 40 and the casing 22. The view also shows the dividing plane between the two sections of the casing and shows the manner in which they are secured to each other.

Fig. 8 is a view of the bottom of the casing and shows the opening 43 therein. This opening is designed to permit any gases generated by an arc that might form when the circuit is broken, to escape from the casing. The view also shows the edge of the plane that splits the casing 22 into two sections.

Fig. 9 shows an optional form of the invention as applied to a different type of automatic circuit breaker. A plunger 64 has a tripping member 68 rigidly attached to it. A catch 66 of springy metal is held at one end by a slot in frame 22 and is free to move at its other end. A transverse bar 70 similar to the transverse bar 26 in Figs. 1, 2, and 3 is rotatably attached to contact carrier 28. One end of this bar engages plunger 64, and the other end engages stop 31 on bimetal 32. The rest of the elements are similar to those described in relation to the preferred form of the invention shown in Figs. 1, 2, and 3. The elements of the device in Fig. 9 are shown in the "on" position.

Fig. 10 shows the elements of this optional form of the invention in greater detail and shows the elements in the "off" position after the automatic circuit-interrupting means has operated to break the circuit. Plunger 64 is shown in one intermediate position along its path of travel from the "on" to "off" position. The spring 30 causes further movement of plunger 64 upward and thereby permits the bar 70 to engage the stop 31 on the bimetallic element when the plunger reaches its top position. To close the circuit, the plunger 64 is pressed down. This downward movement of the plunger causes a downward movement of the bar 70 which the plunger engages, and the contact carrier to which the bar 70 is secured. When the contact carrier 28 reaches the closed circuit position, the catch 66 engages one end of the bar 70. The engagement between the catch 66 and the end of the bar 70 holds the contact carrier in the closed circuit position. To open the circuit, plunger 64 is pulled upward. The upward movement of plunger 64 and the upward movement of the tripping element 68 that is attached to plunger 64, forces the catch 66 to move out of engagement with the bar 70. The bar and the contact carrier may then move into the open circuit position under the influence of spring 30. In the event that an overload condition occurs when the circuit is closed, the electro-responsive means will bend and move out of engagement with the end of bar 70. The elements of the device are shown in Fig. 10 as they appear immediately after the bimetal has moved out of engagement with the bar. The spring 30 then forces the contact carrier to move upward and carry the bar with it. A shoulder 74 is molded in the casing 22 and limits the upward movement of the end of the bar 70. This end of the bar is held at a level below the lower edge of stop 31 on bimetal 32. Such an arrangement permits the device automatically to prepare itself for circuit-closing operation after an overload condition.

Figs. 11, 12, and 13 show actuating means 20 and the recess 21 in detail. There is a small raised portion 19 on the periphery of the actuating means 20, and this ridge 19 in combination with the recess 21 causes the contact carrier 28 to "snap" into the "off" position. This snap action is helpful in preventing the holding of an arc between the contacts 44 and 56.

Fig. 14 shows the semi-fixed contact support 38 and the contact 44 which it carries. This contact support may be of any suitable material since intimacy of engagement between the contacts is not dependent on the resilience of the metal in the contact support. The intimate engagement is secured by the use of a spring positioned beneath the contact support. A shield 72 shown in Figs. 15 and 16 is made to slide onto the contact support 38 to act as a magnetic choke. The effect of such a choke is the prevention of sudden surges of current through the switch. This tends to limit the intensity of any electrical arc that might form when the circuit is broken.

Figs. 17 and 18 respectively show a side view and a perspective view of spring 24 which acts to operate actuating means 20.

Figs. 19, 20, and 21 show three views of the reciprocating member 28. A transverse bar 26 is attached pivotally to the member 28 by a pin 23. A spring 30 is attached to member 28 by a pin 29. The bimetal 32 fits in a slot 33 in member 28 and engages one end of transverse bar 26. A flexible conductor 34 is connected to bimetal 32 and to terminal 40. Mounted on one end of the bimetal 32 is a stop 31 and mounted on the other end is a contact 56.

Fig. 22 shows the spring which fits under semi-fixed contact support 38 and keeps contact 44 in intimate engagement with contact 56. The use of a spring of this sort obviates the necessity of using a contact support of springy metal. This is advantageous because most metals that have good resiliency characteristics are not good conductors of electricity.

Fig. 23 shows a baffle plate of insulating material 42 which may be fitted into slots in the sections of casing 22 and serve to seal the bottom of the circuit maker and breaker. The engagement between the baffle plate and the sections of the casing will be loose enough to permit gases to escape, but tight enough that dirt cannot get into the casing.

Fig. 25 shows an optional form of semi-fixed contact support 76 which may be used in the in-

vention. Such a contact support is designed to reduce the likelihood of holding of an arc. It has been found that, when copper gets hot, as in the case of an overload current condition, it has an affinity for electrical arcs. This affinity draws any arc that might occur between the contacts 44 and 56 to the contact support 76, and such an arc would burn the contact support. By coating the copper contact support 76 with solder or other lead bearing metals or an insulating paint, this affinity is curbed and arcing is limited to the surface of the contact 44. Such an arrangement lengthens the effective life of the contact support.

Fig. 24 shows the member 28 in perspective and shows clearly the shape of projecting members 78 which fit into slides in frame 22 and guide the member 28.

Fig. 26 is a view of another preferred form of the invention that may be used. This form is similar to the preferred form shown in Figs. 1, 2, and 3, and uses the semi-fixed contact support 36 shown in Fig. 4. Such a contact support permits the attainment of an intimate engagement between the contacts and obviates any bending of the contact support. In addition this form of the invention shows an electro-responsive device of somewhat different design that might be used. The device is a bimetal 132 that is secured to the contact support 55 on which is mounted contact 56. The bimetal 132 is a straight bar that has a catch on the upper end thereof which engages and holds one end of bar 26.

Figs. 28 and 27 respectively show a plan and elevation view of the contact support 38 used in the devices shown in Figs. 4 and 26. This contact may be coated with solder or similar material or a coat of insulating paint, and such a coating will serve to confine to the surface of contact 44 any arc that might form.

Fig. 29 is a view of another form of spring that may be used to bias the actuating means 20 to the "off" position. This form of spring is somewhat less expensive than the form shown in Figs. 17 and 18.

Fig. 30 shows in detail the construction of the bimetal 132. One end of the bimetal is secured to the contact support 55 which is carried by the contact carrier, and the other end is bent to form a catch which engages one end of the bar 26.

Fig. 31 is a perspective view of the transverse bar 26 that is rotatably secured to contact carrier 28. The view shows clearly the raised portion 27 on the cam portion 25 of the bar. The raised portion 27 cooperates with the actuating means 20 to "snap" the contact carrier into the "on" position. The view also shows how the cam portion 25 is widened to give a broader bearing surface. Such a design lengthens the life of the bearing surfaces of the cam 25 and the actuating means 20.

Fig. 32 shows the application to a small automatic circuit breaker of the enclosed type, of means to compensate for the effect of ambient temperature. Such a means is desirable since in many installations, the ambient temperature is high enough to cause a bending of the bimetal. Where this is true, a small overload that is less than the rated capacity of the circuit breaker may add sufficient heat to that given by the ambient temperature to trip the device. The means shown in the drawings avoids this by providing a catch that moves an amount equal to the movement of the bimetal where such movement is caused by ambient temperature. This means is mounted on and is bodily movable with the contact carrier. The arrangement of the parts of this compensating means is more clearly shown in Figs. 35 and 36. A novel form of transverse bar denoted by the numeral 90 is provided with a pin 92 on the side thereof and a slot 94 in one end thereof. The slot 94 and the pin 92 support a catch 96 which has a slot 98 therein that engages pin 92 on the transverse bar 90 and a pin that engages the slot 94 in the bar 90. The catch 96 also has two pins 99 that engage bimetallic strip 100. The bimetallic strip 100 may be designed to have the same thermal characteristics as bimetal 32 or bimetal 132 with which it may be used. With such an arrangement, a bending of bimetal 32 or 132 in response to ambient temperature will not permit a tripping of the device since the catch 96 will move with the bimetal 32 or 132 under the influence of bimetal 100. When an overload condition occurs, bimetal 32 or 132 will bend more than bimetal 100 since bimetal 32 or 132 has current passing through it. By use of this arrangement, a definite current value may be required to cause a tripping of the circuit breaker, and this value will not be affected by the ambient temperature. Fig. 32 also shows the application of an indicator to a small enclosed type circuit breaker. The indicator denoted by the numeral 102 has a projection 104 thereon that extends through an opening in the casing of the circuit breaker when the circuit is open as shown in Fig. 32. The indicator 102 has an opening 105 therethrough that engages and is supported by a projection on the casing. A flat portion on the lower edge of the indicator is arranged to engage and be moved by a cam portion 106 on the transverse bar 90. The projection 104 is encircled by a spring 108 which tends to rotate the indicator so that the projection 104 does not extend through the opening in the casing of the circuit breaker. The arrangement of the parts is such that whenever the circuit is closed, the indicator cannot be seen from the outside, but whenever the circuit is open, the projection 104 extends through the opening in the casing. The operation of the indicator is so related to the operation of the various parts of the circuit breaker that the indicator will show that the circuit is open regardless of the position of the actuating means. Such an indicator is useful where a group of circuit breakers are mounted in a gang and operated by one handle. In such a case, one might be tripped and have its actuating means held in the "on" position by the other breakers. With an indicator of this type, however, it would be possible to detect readily the existence of a tripped breaker.

Although the drawings show only a few preferred forms of the invention, it is obvious to those skilled in the art that various changes and alterations may be made in the form of the invention without altering or affecting its scope.

It can be seen, therefore, that by use of the present invention, switches and automatic circuit breakers of the enclosed type may be made of simple but efficient construction.

What we claim is:

1. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion

thereon, means biasing the contacts to the open circuit position, and a rotatable actuating means having a surface in sliding engagement with the cam portion of the movable member, said surface having a raised portion thereon, said raised portion on the surface of said actuating means cooperating with the cam portion on said movable member to obstruct easy operation of the actuating means to the "off" position and thus require an added impulse to overcome such obstruction whereby the movable contact is moved quickly from the closed circuit position to the open circuit position.

2. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion thereon, a raised portion on said cam portion, and a rotatable actuating means having a surface in sliding engagement with the cam portion of the movable member, said raised portion on the cam portion of said movable member cooperating with said rotatable actuating means to obstruct easy operation of the rotatable actuating means into the closed circuit position and thereby require an additional impulse to overcome the obstruction whereby the movable contact is moved quickly into contact with the semi-fixed contact.

3. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion thereon, a raised portion on said cam portion, resilient means tending to disengage the contacts, and a rotatable actuating means having a surface in sliding engagement with the cam portion of the movable member, said surface having a raised portion thereon, said raised portion on the cam portion of said movable member cooperating with the rotatable actuating member to obstruct easy operation of the actuating means into the closed circuit position and thereby cause rapid closing of the movable and fixed contacts when an additional impulse is given the actuating means to overcome the obstruction, and said raised portion on the surface of the rotatable actuating means cooperating with the cam portion of said movable member to obstruct easy operation of the rotatable actuating means to the "off" position whereby the additional impulse needed to overcome the obstruction causes a rapid opening of the movable and fixed contacts.

4. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion thereon, said cam portion having a bearing surface area formed thereon that is broader than other portions of the movable member, and a rotatable actuating means having a surface in sliding engagement with the broad bearing surface of the cam portion of the movable member.

5. In an electric switch, a casing having formed portions therein, a rectilinearly movable contact, a semi-fixed contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, and resilient means tending to move the semi-fixed contact toward the movable contact, said semi-fixed contact being supported on a flat strip provided with slots adapted to cooperate with formed portions in said casing to limit movement of the semi-fixed contact to a path parallel to the axis of translation of the movable contact, said formed portions of the casing being arranged to limit the length of travel of the semi-fixed contact.

6. In an electric switch, a casing having a chamber therein, a copper contact support positioned in said chamber, a contact mounted on said contact support, a second contact movable relative to said copper contact support, means to cause the engagement of the contacts and thereby close the circuit, and a hardened fluid coating of insulating material on portions of the copper contact support in the chamber, said insulating coating cooperating with the contact mounted on the contact support to restrict electrical arcing to the surface of the contact on the contact support.

7. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement and disengagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion thereon, said cam portion having a broad bearing edge thereon, said broad bearing edge having a raised portion thereon, and a rotatable actuating means having a surface in sliding engagement with the broad bearing edge of the cam portion of the movable member.

8. A circuit breaker comprising a housing, a contact carrier positioned and guided by the housing for rectilinear movement therein, a transverse member pivotally secured to the contact carrier, a contact carried by the contact carrier, a bimetallic element carried by the contact carrier and electrically connected to the contact at one end thereof, the other end of the bimetallic member engaging one of the ends of the transverse member, a spring biasing the contact carrier to open circuit position, a rotatable actuating means engaging the other end of the pivoted transverse member and arranged to move the transverse member to operate the contact carrier and close the circuit, a spring biasing said actuating means to the open circuit position, said bimetallic element releasing the contact carrier for movement under influence of the biasing spring toward the open circuit position when an excess current flows through the circuit breaker, and means on the housing to depress the end of the transverse member for re-engagement with the bimetallic element when the contact carrier reaches the open circuit position.

9. A circuit breaker comprising a housing, a contact carrier guided for rectilinear movement in the housing, a contact carried by the contact carrier relatively movable with respect to said first named contact, a transverse bar pivotally secured to the contact carrier, a conducting bar secured to the contact and extending substantially at right angles to the contact carrier a distance substantially the same as the transverse bar extends from the contact carrier, a bimetallic element secured to said conducting bar and engaging one end of the pivoted transverse bar, an actuating means actuating the other end of the transverse bar to close the circuit, said contact carrier being biased to open circuit position, said bimetallic element arranged to release the transverse bar and allow the contact carrier to move to open circuit position under influence of the biasing means when an excess current flows through the circuit breaker.

10. In an electric switch, a casing having a

chamber therein, a copper contact support positioned in said chamber, a contact mounted on said contact support, a second contact movable relative to said copper contact support, means to cause the engagement of the contacts and thereby close the circuit; and a coating of hardened fluid metal having lead therein on portions of the copper contact support in the chamber, said coating cooperating with the contact mounted on the contact support to restrict electrical arcing to the surface of the contact on the contact support.

11. In an automatic circuit breaker of the enclosed type, a substantially stationary contact and a movable contact, said movable contact being connected to and bodily movable with a contact carrier, two electrothermally responsive devices, a catch engaging one end of one of the electrothermally responsive devices thereby maintaining the movable contact in engagement with the substantially stationary contact, said catch being movable under the influence of the second of the electrothermally responsive devices, said electrothermally responsive devices and said catch cooperating to compensate automatically for the effect of ambient temperature on the automatic circuit breaker.

12. In an automatic circuit breaker of the enclosed type, a substantially stationary contact and a movable contact, said movable contact being connected to and bodily movable with a contact carrier, two electrothermally responsive devices, a catch movable with the contact carrier that is adapted to move relative to the contact carrier, said catch engaging one end of one of the electrothermally responsive devices thereby maintaining the movable contact in engagement with the substantially stationary contact, said catch being movable relative to the contact carrier under the influence of the second of the electrothermally responsive devices, said electrothermally responsive devices and said catch cooperating to compensate automatically for the effect of ambient temperature on the automatic circuit breaker.

13. In a circuit breaker, a casing, a substantially stationary contact support biased to closed circuit position by resilient means, a contact on said contact support, a coating on said contact support adapted to restrict any electrical arc to the contact, a movable contact secured to and bodily movable with a contact carrier, said contact carrier being guided for rectilinear movement by the casing, a transverse bar rotatably secured to the contact carrier, said transverse bar having a cam portion on one end thereof, said cam portion on the transverse bar having a raised portion on the broadened face thereof, a rotatable actuating means engaging the cam on the transverse bar, said rotatable actuating means having a raised portion thereon, an indicator operating independently of the rotatable actuating means to indicate when the circuit is open, and a pair of electrothermally responsive devices adapted to compensate automatically for the effect of ambient temperature on the circuit breaker.

14. In a circuit breaker, a casing, a substantially stationary contact support biased to closed circuit position by resilient means, a contact secured to a boss on said contact support, a coating on said contact support adapted to restrict any electrical arc to the contact, a movable contact secured to and bodily movable with a contact carrier, said contact carrier being guided for rectilinear movement by the casing, said contact carrier having a recess in the bottom thereof to receive the movable contact, said recess being substantially complementary to the boss on the substantially stationary contact support and cooperating with the boss to form a closed chamber around the contacts, a transverse bar rotatably secured to the contact carrier, said transverse bar having a cam portion on one end thereof, said cam portion on the transverse bar having a raised portion on the broadened face thereof, a rotatable actuating means engaging the cam on the transverse bar, said rotatable actuating means having a raised portion thereon, an indicator operating independently of the rotatable actuating means to indicate when the circuit is open, and a pair of electrothermally responsive devices adapted to compensate automatically for the effect of ambient temperature on the circuit breaker.

15. In an electric switch, a semi-fixed contact support, a contact secured to a boss on said contact support, a contact carrier arranged to carry and support the movable contact, a recess in said contact carrier to receive the movable contact, said recess being substantially the complement of the boss on said semi-fixed contact support, and means to move the contact carrier thereby opening and closing the circuit, said recess and said boss cooperating to form a small closed chamber around the contacts in which gases generated when the circuit is broken may expand and force the contacts apart.

16. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion thereon, means biasing the contacts to the open circuit position, and a rotatable actuating means having a surface in sliding engagement with the cam portion of the movable member, said cam portion and said surface in sliding engagement therewith being cooperatively configurated to obstruct easy operation thereof immediately ahead of the position whereat the contacts engage and disengage.

17. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion thereon, means biasing the contacts to the open circuit position, and a rotatable actuating means having a surface in sliding engagement with the cam portion of the movable member, said cam portion and said surface in sliding engagement therewith being cooperatively configurated to obstruct easy operation thereof immediately ahead of the position whereat the contacts engage to close the circuit.

18. In an electric switch, a semi-fixed contact, a movable contact, a member movable to cause the engagement of the movable contact with the semi-fixed contact and thereby close the circuit, said movable member having a cam portion thereon, means biasing the contacts to the open circuit position, and a rotatable actuating means having a surface in sliding engagement with the cam portion of the movable member, said cam portion and said surface in sliding engagement therewith being cooperatively configurated to obstruct easy operation thereof immediately ahead of the position whereat the contacts separate to break the circuit.

19. A circuit breaker comprising a housing, a contact carrier guided for rectilinear movement in the housing, a contact carried by the contact carrier, a transverse bar pivotally secured to the contact carrier and extending beyond on either side, a J-shaped thermal element secured to said contact on the contact carrier at the lower end of the J and its side spaced from the contact carrier substantially the same distance that one end of the transverse bar extends therefrom, the open end of the J-shaped thermal element engaging the end of the pivoted transverse bar, actuating means arranged to actuate the other end of the transverse bar to close the circuit, means biasing the contact carrier to open circuit position, said thermal element arranged to release the transverse bar and allow the contact carrier to move to open circuit position under influence of the biasing means when an excess current flows through the circuit breaker.

FREDERICK B. ADAM.
HENRY M. STIEGLITZ.