Jan. 17, 1928.

1,656,837

H. F. SMITH

CIRCUIT BREAKER

Filed April 21, 1924

2 Sheets-Sheet 1

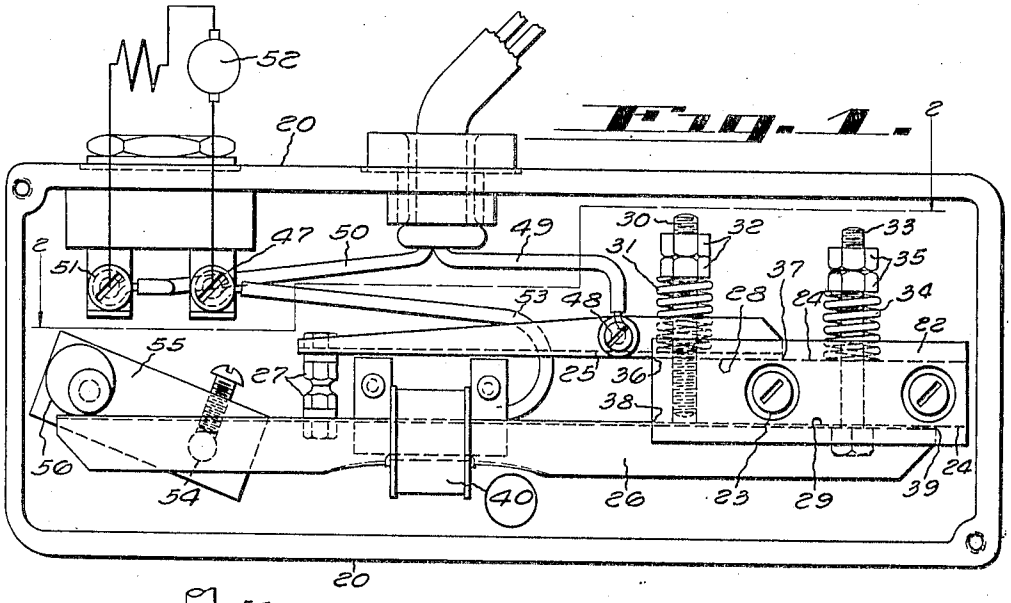


Fig. 1.

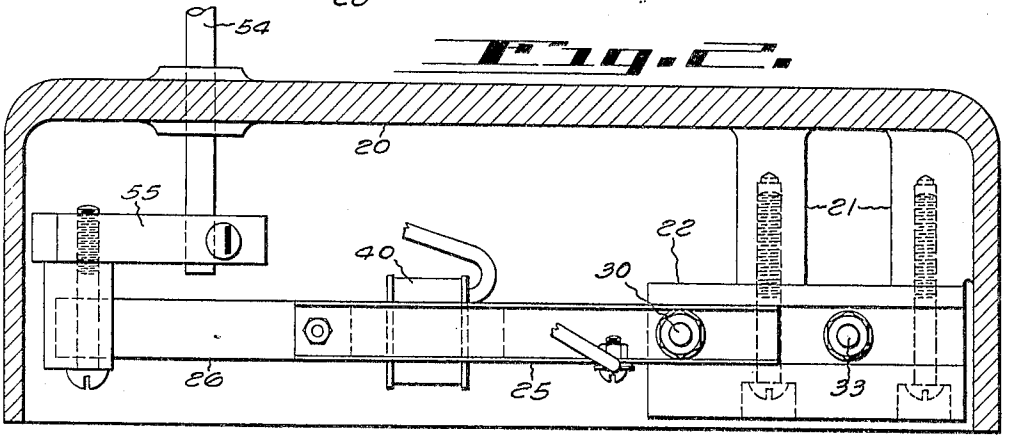


Fig. 2.

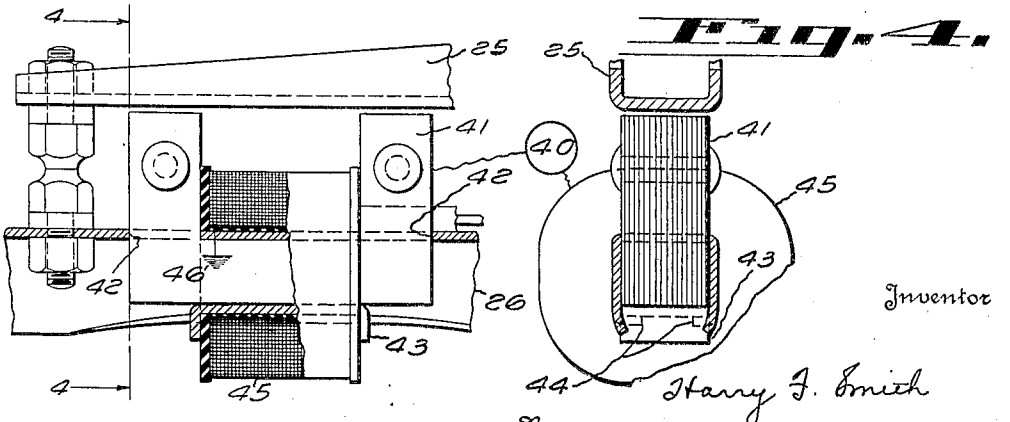


Fig. 4.

Fig. 3.

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2 Sheets-Sheet 2

Fig. 5.

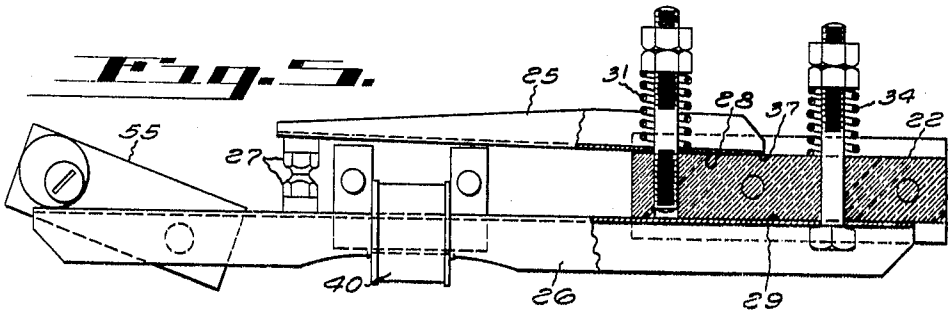


Fig. 6.

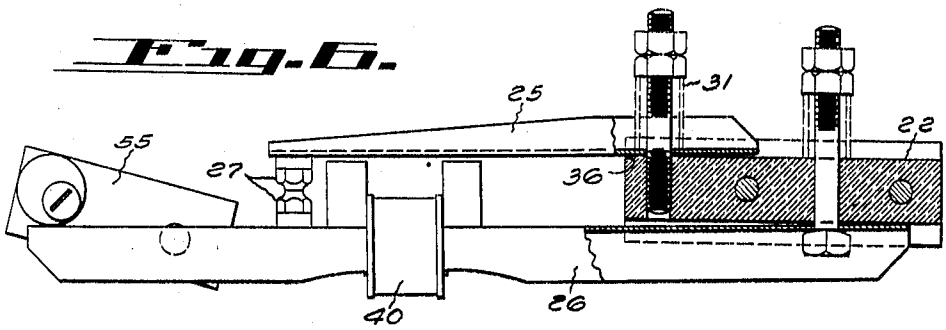
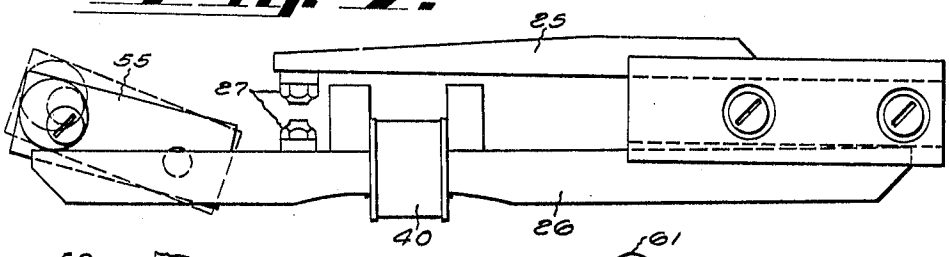


Fig. 7.



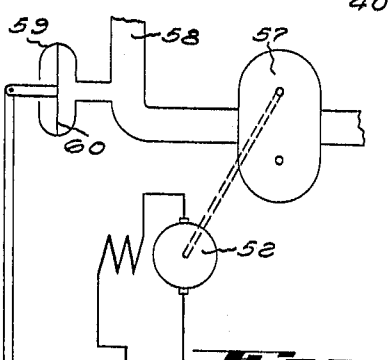
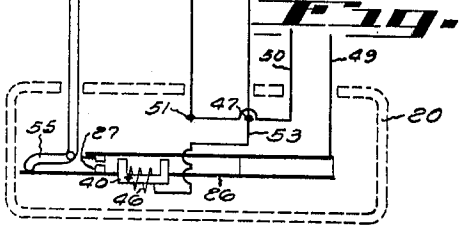


Fig. 8.



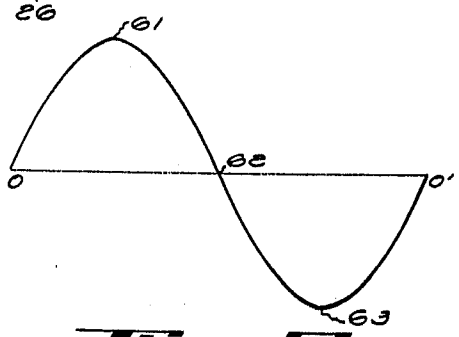


Fig. 9.

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UNITED STATES PATENT OFFICE.

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CIRCUIT BREAKER.

Application filed April 21, 1924. Serial No. 707,913,

The present invention relates to an electric circuit breaker and particularly a circuit breaker of the type adapted to be employed in a circuit carrying alternating or other type of fluctuating current, in which the current flow periodically reaches a low or zero value.

One of the principal objects of the present invention is to provide a circuit breaker or switch for an alternating or pulsating current circuit so constructed and arranged as to break the circuit without producing objectionable arcing at the contacts.

Other objects of the invention will appear from the following description and the accompanying drawings, in which:

Fig. 1 is a side elevation of the switch mounted in a housing;

Fig. 2 is a sectional view taken on the broken line 2—2 of Fig. 1;

Fig. 3 is an enlarged view of a detail of the present invention, partly in elevation and partly in section;

Fig. 4 is a section on the line 4—4 of Fig. 3;

Figs. 5, 6 and 7 show various operating positions of the switch;

Fig. 8 is a diagrammatic view showing an application of the present invention; and

Fig. 9 is a diagram of an alternating current vibration.

It is well known that the opening of a switch or circuit breaker in an electrical circuit is accompanied by arcing at the contacts, which corrodes or destroys the contacts shortening the effective life of such contacts. Such arcing, in general, increases in destructive action and intensity with increase in the current or electrical energy flowing through the contacts at the time of the separation thereof.

According to the present invention arcing across the contacts of a circuit breaker is effectively prevented by so constructing the switch that it opens only when the current or energy flow through the contacts is of such low value that arcing will not result when the contacts are separated.

In the drawing the numeral 20 designates a housing which is provided on its interior with posts or projections 21 for carrying a supporting block 22 of insulating material which is secured to the posts 21 by means of suitable fastening devices 23. The upper and the lower surfaces of the supporting block 22 have channels or grooves 24 formed therein to receive respectively contact arms or supports 25 and 26 which carry at their outer ends the contacts 27.

The contact arms 25 and 26 are of rigid channel construction and have flat bearing surfaces which are adapted to lie against the flat surfaces 28 and 29 respectively forming the bottom of the channels 24. The bearing surface of the upper contact arm is adapted to be held against the bearing surface 28 by means of a bolt 30 secured in the supporting block 22 and passing through the contact arm, the bolt being surrounded by a spring 31 adjustably held in contact with the supporting arm 25 by means of the adjusting device 32. The bearing surface of the lower contact arm 26 is adapted to be held in engagement with the cooperating bearing surface 29 by means of a bolt 33 the head of which bears against the contact arm and the stem of which passes loosely through an opening in the supporting block 22 there being a compression spring 34 about the bolt and suitable adjusting means 35 for adjusting the compression of the spring.

While the spring 31 tends to normally hold the upper contact arm flat against the contact surface 28 as shown in Fig. 1 it will be observed that the arm 25 may nevertheless be rocked from its normal position, any rocking downwardly taking place around the forward edge 36 of the supporting block 22 and any rocking upwardly taking place about the rearward edge 37 of the arm 25. In like manner the lower contact arm 26 may rock about its rearward edge 39.

The lower contact arm is provided with an electro-magnet 40 which is adapted to be connected in series with the contacts 27 and to influence or control the separation thereof. The general purpose of the electro-magnet 40, in cooperation with the other elements of

the circuit breaker, is to hold the contacts 27 closed and to permit their separation only when the current or energy flowing through the contacts 27 is at its minimum or zero value, or of such a low value that destructive arcing across the contacts will not occur. As shown in Figs. 3 and 4 the electromagnet comprises a laminated U-shaped core 41. The laminations are assembled in place on the arm and extend upwardly through the openings 42 formed in the contact arm. After the plate 43 is placed over the laminated core the side portions of the contact arm 26 are crimped over the plate 43 as shown at 44. Coil 45 is then wound about the contact arm 26 between the arms of core 41 as shown, one end of the winding being grounded to the contact arm by soldering at 46 and the other end 53 being connected to the binding post 47.

The upper contact arm 25 is connected at 48 with one of the leads 49 leading to a suitable source of electric current. The other lead 50 is connected to the binding post 51. The motor 52 or other device which it is desired to control by means of the circuit breaker is connected between the binding posts 47 and 51. From the above it will be seen that the electro-magnet 40 is connected in series with the contacts 27, a circuit being traceable from the lead 50 to the binding post 51, device 52, binding post 47, wire 53 to the electro-magnet 40 which is grounded on the lower contact arm 26, and thence through contacts 27 and the upper contact arm 25 to the other side of the line through the lead 49.

As shown in Fig. 1 the contact surfaces 28 and 29 are substantially parallel and are so spaced that the springs 31 and 34 normally hold the contacts 27 in circuit closing position. To separate the switch contacts there is provided a cam device which consists generally of a rotatable shaft 54 carrying at its end an arm 55 having an adjustable pin 56 adapted to engage the contact arm 26 to separate the contacts 27.

One application of the present invention is shown diagrammatically in Fig. 8 wherein 57 is a pump or blower adapted to pump gas into the main 58 and maintain a substantially uniform pressure therein. The pump 57 is operated by the motor 52 the circuit of which is controlled by the circuit breaker which in turn is controlled by the pressure regulator 59 connected to the main 58. The pressure regulator 59 is herein shown diagrammatically as consisting of a diaphragm 60 adapted to respond to the pressure in the main 58 to actuate arm 55 to open or close the contacts 27 of the switch. So long as the pressure in the main 58 does not exceed a given normal pressure the arm 55 is held in such position that the contacts 27 are closed, thereby furnishing current to the motor 52, which thereupon operates the pump 57. If the pressure rises in the main 58 above this predetermined normal the pressure regulator 59 operates through the arm 55 to open the circuit to the motor and stop the pump 57. It is found in practice, in such a system, particularly when the pump 57 is employed in connection with a small gas producing plant suitable for supplying gas for domestic use, that gas pressures in the main fluctuate rapidly so that the contacts 27 of the switch open and close many times a minute, and over long periods of operation. And such frequent and continuous breaking of the circuit, each separation of the contacts, being accompanied by arcing, soon seriously affects or destroys the contacts of the previously known types of switches.

As is well known, in alternating current circuits the current, following the variation in voltage, rises and falls periodically passing from a positive maximum through zero to a negative maximum. This is shown diagrammatically in Fig. 9 wherein the horizontal line 0—0′ represents zero current. From a zero value at 0 the current increases to a positive maximum value at 61, falls to zero value at 62, increases to a negative maximum at 63 and again falls to zero as indicated at 0′. The current value thus passes through zero value twice during each cycle or period so that with an alternating current of 60 cycles per second, it will be seen that the current passes through zero value 120 times per second. And in the present invention advantage is taken of this current variation, and the switch is so constructed that breaking of the circuit will be effected only at a time when the current flow is at substantially zero, or at least of such low value, that destructive arcing is prevented.

The operation of the present invention may be best understood upon reference to Figs. 5, 6 and 7. Although the contact arms 25 and 26 are shown in Fig. 1 as lying flat against the bearing surfaces 28 and 29 when the contacts 27 are closed, it is preferable to bring the bearing surfaces 28 and 29 slightly closer together so that one of the arms will be rocked slightly about its rear pivot so as to place the contacts 27 under a yielding pressure when they are closed. This condition is shown, slightly exaggerated, in Fig. 5, in which the spring 34 has been so adjusted as to maintain the lower contact arm 26 flat against the bearing surface 29 thereby rocking the arm 25 about its rearward edge 37. With the arm 25 thus raised from its bearing surface, spring 31 is placed under additional compression tending to hold the contacts 27 firmly closed. Since the electromagnet 40 is in series with the circuit as already explained, it will be seen that when the contacts 27 are closed as shown in Fig. 5 the electro-magnet is energized and

tends to attract the contact arm 25 thereby exerting still greater pressure upon the contacts 27.

As the arm 55 moves downwardly towards circuit opening position, it lowers the contact arm 26 and contact arm 25 follows owing to the attraction of the electro-magnet 40 and the spring 31, into contact with the supporting block.

If at this instant the current cycle is at substantially zero flow, continued movement of the lower arm 26, under the influence of the arm 55, will separate the two contacts 27 and thus break the motor circuit. And the contacts will remain open until such time as the pressure in the delivery main falls to impart sufficient reverse movement to the arm 55 to permit the lower contact arm 26 to move upwardly again to bring the contacts together. If, however, the current flow at this instant be not at substantially zero the upper arm will rock downwardly about the forward end of the supporting block, being constrained to move with the lower contact arm due to the magnetic pull of the electro-magnet 40. This movement increases the compression tension of the spring 31, as is clearly shown in Fig. 6, and will continue during the given current cycle until the current value falls so that the magnetic pull is overcome by the tension of the spring 31. When this condition is reached the contacts separate, the upper contact arm swinging upwardly until it lies flat along the upper face of the supporting block. And the motor circuit will thus be held open so long as the arm 55 is maintained in lowered position. The contact arm 25 and its supporting means are so constructed and arranged that the arm 25 has a natural frequency of vibration which is higher than the frequency of the alternating current in the circuit in which it is employed, whereby, when the arm 25 is once released by the magnet 40, it immediately swings to separate the contacts before the magnet is reenergized on the succeeding cycle, as shown, in exaggerated detail in Fig. 7.

The initial tension of the spring 31 is made sufficient to separate the contacts 27, when the upper contact arm 25 is thus rocked about the forward edge of the supporting block, against some magnetic pull. The effect of magnetic pull due to possible lag in the magnet is thus taken care of. By properly constructing and arranging and adjusting the mechanical and electrical parts of the present apparatus in accordance with the principles herein disclosed, it is feasible to bring about separation of the contacts 27 at the zero or minimum periodic current value, or at other desired current values prior to or subsequent to the zero value. It will be seen that by the present invention destructive arcing at the contacts is effectively prevented; and also, from the construction of the apparatus described, that when the separation of the contacts once commences, such separation takes place as a continuous motion and is completed within the time-period of a single current cycle if not instantaneously.

While the operation of the invention has been described particularly with reference to an alternating current circuit it should be understood that the invention is equally adapted for use in any circuit in which the current values vary periodically or in which the current values fall to zero value or substantially zero value.

Although the invention has been described and claimed as adapted for opening the circuit when the current value reaches zero, or any desired minimum, it should be understood that this has been done merely for convenience in description and is not intended as a limitation, for obviously the invention is applicable equally for breaking the circuit when the voltage reaches zero value, or when both the voltage and the current or their product reach substantially zero value, or at other current value. Of course, to accommodate this non-arcing switch to such different conditions minor mechanical modifications will be necessary; but since any such modifications are well within the capacity of the skilled electrical mechanic it is thought unnecessary to add examples of such modifications to this disclosure.

Also while the preferred embodiment of the invention shows the means for preventing arcing across the contacts as comprising a magnet applied to the contact arms to prevent their separation as against the tendency of the contact breaker to cause such separation, it is to be understood the same result may be accomplished by means of other equivalent forms of mechanism; as for example by so arranging the apparatus that the contact breaking mechanism will be restrained in its functioning to accomplish this same result of nondestructive arcing.

It is to be also understood that, while this circuit breaker is shown in connection with pressure regulating apparatus, it is of general application and useful wherever a non-arcing switch is desired, as for example in electric signs.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In an electric circuit for carrying periodically fluctuating current, a circuit breaker

adapted for breaking the circuit without setting up destructive arcing, comprising cooperating contacts, yielding means for holding said contacts in circuit closing position, positively operated means for acting upon said contacts to cause separation thereof, and means for resisting such separating motion so long as substantial current is flowing across the contacts.

2. In an electric circuit for carrying periodically fluctuating current, a pair of cooperating contacts, means for imparting opening movement to one of the said contact members and means for causing the other contact member to move with the said one contact member, to delay separation of the contacts until the current passing through the contacts is substantially zero.

3. In an electric circuit for carrying periodically fluctuating current, a pair of cooperating contact members, each contact member being movably mounted, means for normally holding the said contact members in closed position, means for imparting opening movement to one of the said contact members, means for causing the other contact member to follow in unison therewith so long as a substantial current is flowing across the contacts and means for resisting such following movement.

4. In a circuit breaker for an alternating current circuit, in combination, cooperating contacts in the circuit, and means for separating the contacts, said means including a vibratable member having a natural frequency of vibration in excess of the alternating current frequency.

5. In a circuit breaker for an alternating current circuit, in combination, cooperating contacts in the circuit, and means for separating the contacts, said means including a vibratable member having a natural frequency of vibration in excess of the alternating current frequency, and means for placing the vibratable member under stress whereby to cause vibration thereof.

6. In a circuit breaker for an alternating current circuit, in combination, cooperating contacts in the circuit, and means for separating the contacts, said means including a support for one of the contacts having a natural frequency of vibration higher than the frequency of the alternating current in the circuit in which it is connected.

7. In a circuit breaker for an alternating current circuit, in combination, cooperating contacts in the circuit, and means for separating the contacts, said means including a rigid support for one of the contacts having a natural frequency of vibration higher than the frequency of the alternating current in the circuit in which it is connected.

8. In a circuit breaker for an alternating current circuit, in combination, cooperating contacts in the circuit, means tending to separate the contacts, and means for holding the contacts against separation except when the current passing through the contacts is at a minimum, said first mentioned means acting with progressively increasing force until the separation of the contacts takes place.

9. In a circuit breaker for an alternating current circuit, in combination, a pair of movable contact members, cooperating contacts carried thereby and connected in the circuit, means for moving one of said contact members out of circuit closing position, and means for holding the contacts closed during such movement, the last mentioned means being responsive to current conditions in the circuit to permit separation of the contacts when the current is substantially zero.

10. In a circuit breaker for an alternating current circuit, in combination, a pair of movable contact members, cooperating contacts carried thereby and connected in the circuit, means for moving one of said contact members out of circuit closing position, means for holding the second contact member in circuit closing position during such movement whereby it is caused to move with the first contact member, and means for yieldingly resisting the movement of the second contact member, said holding means operating in response to current conditions in the circuit to release the second contact member and open the circuit when the current in the circuit is substantially zero.

11. In a circuit breaker for an alternating current circuit, in combination, a pair of movable contact members, cooperating contacts carried thereby and connected in the circuit, means for moving one of said contact members out of circuit closing position, means for holding the second contact member in circuit closing position during such movement whereby it is caused to move with the first contact member, and means for yieldingly resisting the movement of the second contact member, said holding means including magnetic means carried by the first contact member and responsive to a condition of substantially zero current in the circuit to release the second contact member whereby to open the circuit.

12. In a circuit breaker for an alternating current circuit, in combination, a pair of substantially parallel pivoted contact members having cooperating contacts normally in contact making position, means for moving one of the contact members out of contact making position, and electro-magnet means carried by said contact member and in series with the contacts tending to maintain the contacts closed.

13. A circuit breaker comprising a block having opposed flat surfaces, contact arms having cooperating flat surfaces adapted to lie against the first-mentioned flat surfaces

and extended beyond the edge of the block, cooperating contacts carried by the extended portions of the arms, and means tending to yieldingly hold the arms with their surfaces against the surfaces of the block, said means permitting rocking movements of the arms either about the forward edge of the block or the rearward edges of the arms.

14. A circuit breaker having cooperating contacts adapted to be connected in a circuit carrying periodically fluctuating current, mechanically operated means for moving one of said contacts toward opening position, and means for preventing said mechanically operated separating means from causing separation of the contacts so long as the current value is such that it would cause destructive arcing across said contacts.

In testimony whereof I hereto affix my signature.

HARRY F. SMITH.