

Feb. 11, 1947.

W. E. STILWELL, JR

2,415,448

SNAP SWITCH

Filed June 5, 1942

2 Sheets-Sheet 1

Fig. 1.

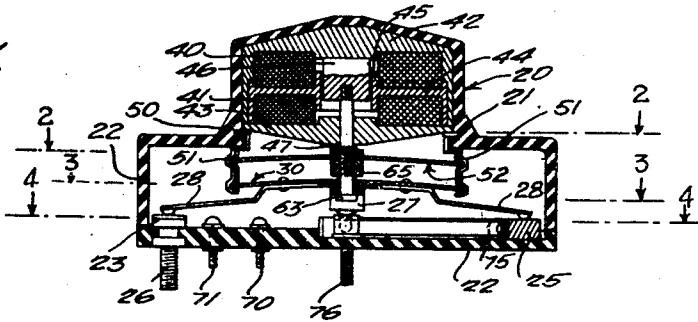


Fig. 2.

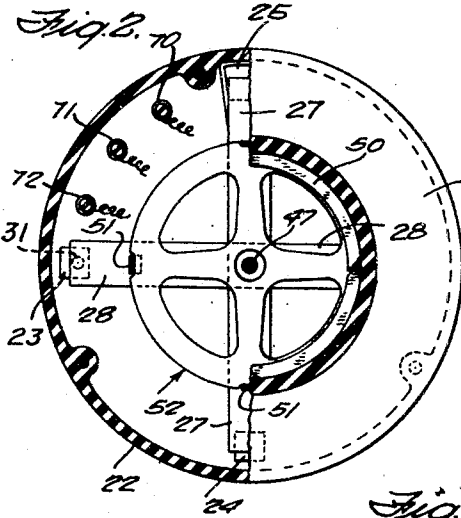


Fig. 3.

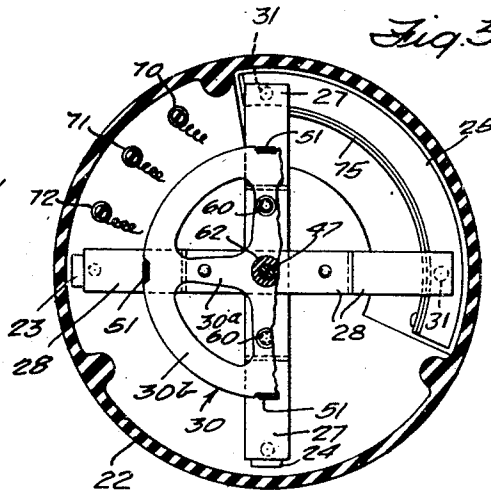


Fig. 6.

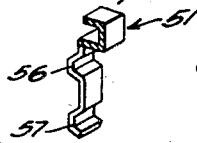


Fig. 9.

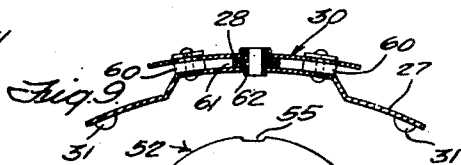


Fig. 4.

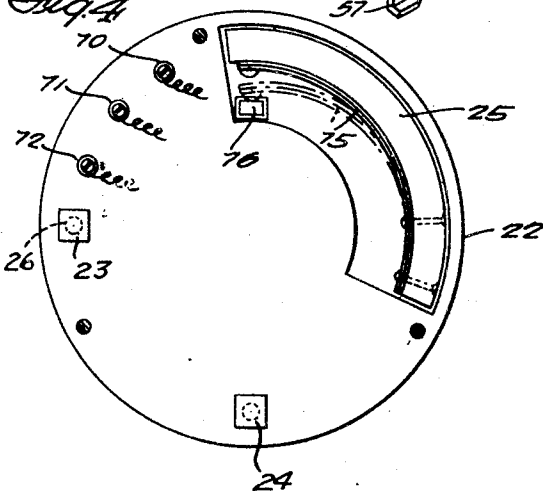
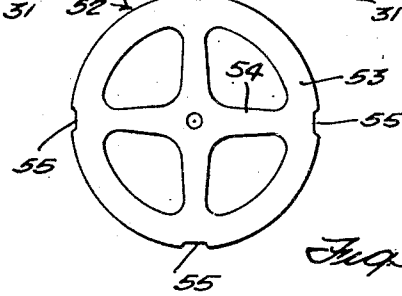


Fig. 5.



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2 Sheets-Sheet 2

Fig. 7.

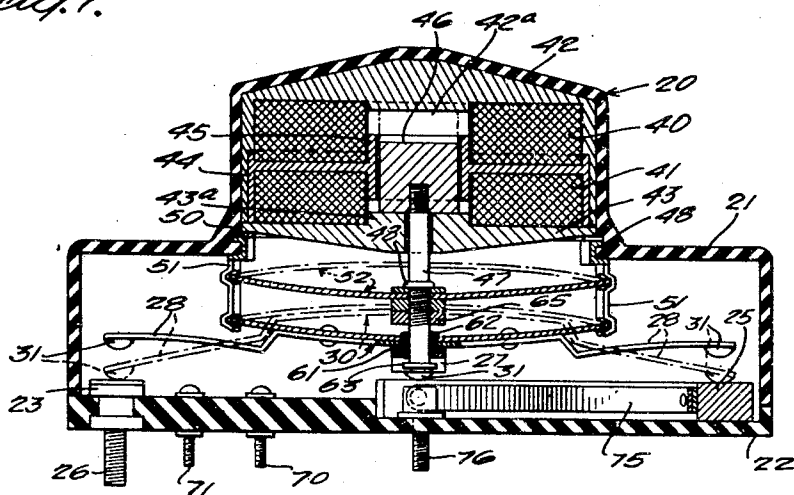


Fig. 8.

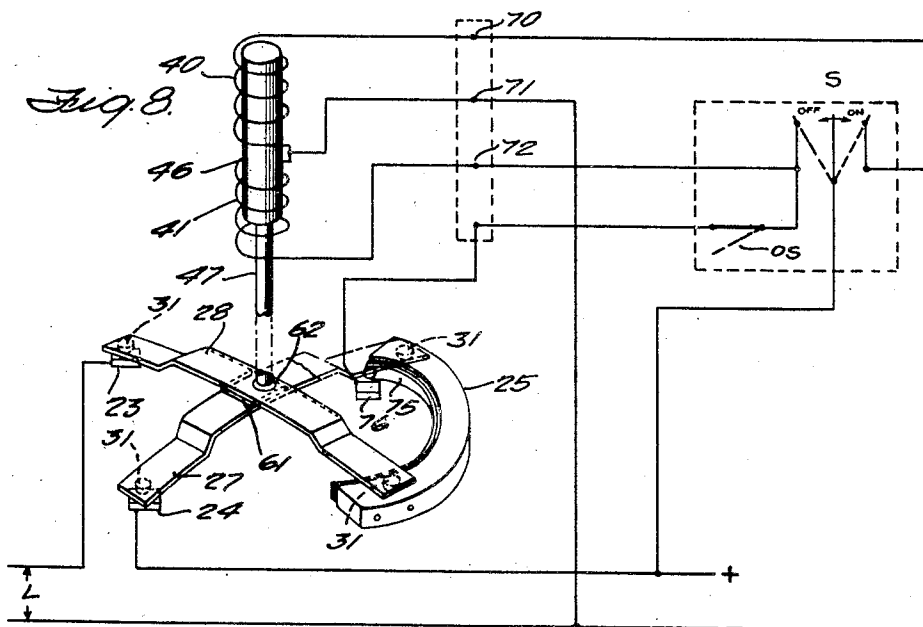
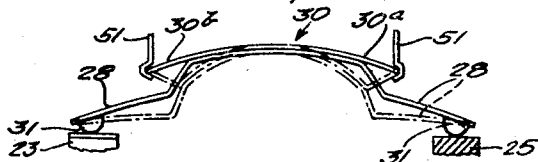


Fig. 10.



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SNAP SWITCH

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Application June 5, 1942, Serial No. 445,851

6 Claims. (Cl. 200—67)

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This invention relates to electric circuit breakers, and particularly, to electric circuit breakers adaptable for remote control.

It is an object of the invention to provide an electric circuit breaker of small size and light weight, embodying improved means for breaking a high-amperage electric circuit.

It is an object of the invention to provide an electric circuit breaker having improved contact means for making or breaking an electric circuit.

It is an object of the invention to provide an electric circuit breaker having improved movable contact means which will engage with, or break with, stationary contacts, with a wiping action.

It is an object of the invention to provide an electric circuit breaker having improved means for holding the movable contacts in resilient engagement with the fixed contacts thereof.

It is an object of the invention to provide an electric circuit breaker wherein the circuit is made or broken at high speed.

It is an object of the invention to provide an electric circuit breaker wherein a plurality of contacts of the load circuit are connected in series with the movable contacts, thus reducing the arcing resulting from disengagement of the respective movable and fixed contacts.

It is an object of the invention to provide an electric circuit breaker embodying a plurality of fixed contacts and movable contacts associated therewith, wherein certain of the movable contacts break circuit in advance of other of the movable contacts, whereby the contact points of said last-breaking movable contacts may be of material particularly resistant to the effects of arcing.

It is an object of the invention to provide a circuit breaker which may be optionally trip-free in operation.

It is an object of the invention to provide a magnetically actuated circuit breaker having improved means for supporting the armature of the magnetic system.

It is an object of the invention to provide an electric circuit breaker embodying a plurality of operatively associated toggle springs wherein an actuating armature common to the plurality of springs is given an initial, high-velocity impulse prior to its operation upon a second toggle spring to throw the same, thereby increasing the velocity of operation of said second toggle spring.

In its essentials, the improved circuit breaker comprises a plurality of toggle springs, preferably two, each of which has two points of stable

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equilibrium. One of said toggle springs receives the initial impulse of a magnetically movable armature system and increases the velocity and stroke of such armature system. The second of said toggle springs is actuated by the engagement of the armature system therewith, and by suitable lost motion connection, said armature system gains acceleration and momentum prior to its engagement with said second toggle spring to throw the same.

The second toggle spring carries a plurality of movable contacts, certain of which are electrically insulated from each other and from the toggle spring. Said movable contacts may be spring members of silver or other material having springable qualities and high electrical conductivity.

By mounting said contact members on the under side of the toggle spring in such manner that they assume the general configuration of the spring in its positions of equilibrium, the throw of the toggle spring can be increased to the extent that the contact members project beyond the toggle spring, thereby achieving a greater travel and speed of the ends of the contact members in relation to the "throw" of the toggle spring.

Means are provided whereby an overload condition in the load circuit may automatically operate to break such load circuit. Desirably, the overload means includes a thermal member responsive to the increased temperature of one of the load line contacts under overload condition, said thermal member expanding to close an auxiliary circuit which will energize the "off" coil of the magnetic system. It will be apparent, however, that there may be conditions wherein the load circuit must be maintained closed even at the risk of burning out or damaging the apparatus controlled thereby, and accordingly, a switch is provided in the overload control circuit to disconnect said circuit from the magnetic actuating circuit.

Other features and advantages will hereinafter appear.

Referring to the drawings—

Fig. 1 is a vertical sectional elevation of a circuit breaker embodying the present invention;

Fig. 2 is a plan section taken through lines 2—2 of Fig. 1;

Fig. 3 is a plan section taken through 3—3 of Fig. 1;

Fig. 4 is a plan section taken through 4—4 of Fig. 1;

Fig. 5 is a plan view of one of the toggle springs employed in the present invention;

Fig. 6 is a perspective of one of the toggle spring holding members;

Fig. 7 is an enlarged vertical section, similar to Fig. 1, but showing the circuit breaker in open circuit position;

Fig. 8 is a schematic representation of the control and load circuits of the circuit breaker, with the toggle springs removed to show better the relationship of the movable and fixed contacts;

Fig. 9 is a partial vertical section taken through the toggle spring and therewith associated movable contacts showing one manner of insulated mounting a contact member thereon; and

Fig. 10 is a diagrammatic representation of the action of the contact carrying toggle spring and a contact mounted thereon at the instant prior to the throw of said toggle spring to open circuit position.

Referring to the drawings for a more detailed description of the invention, my improved circuit breaker 20 may include a cover 21 of suitable insulation material, preferably moldable insulation, and a base member 22, also of insulation material; the base may be removably attached to the cover by machine screws or equivalent passing into suitable bosses therein.

Fixedly mounted on the base 22 are load-line contacts 23, 24, and 25, the latter being an arcuate bus having a length suitably greater than 90 angular degrees. Contacts 23, 24 may be mounted on the ends of studs 26, see Fig. 1, wherein one of said connection members is shown. Contact 25 is secured to the base in any manner precluding movement or shifting thereof, as by suitable rivets or the like (not shown).

Operatively associated with said load-line contacts are a plurality of shorting bars 27, 28, which may be relatively long strips of spring silver arranged in cruciform pattern, see Figs. 3 and 8, and suitably carried by a toggle spring 30, as later described. Said shorting bars 27, 28 may be provided at their terminal ends with suitable contact buttons 31.

By employing the cruciform-arranged movable shorting bars 27, 28 and the plurality of fixed contacts 23, 24, 25, the relationship which said shorting bars bear with respect to the fixed contacts is in series, electrically. As is shown in Fig. 8, the load current passes from fixed contact 24, through shorting bar 27 to contact 25, then through said contact to shorting bar 28, whence it passes through fixed contact 23 to the negative pole of the circuit. In such a series-break arrangement, the arcing resulting from disengagement of the respective fixed and movable contacts is greatly reduced, adding materially to the life of the contacts.

As will hereinafter appear, the toggle spring 30 resiliently holds shorting bars 27, 28 against their associated fixed contacts, to exert a continuing pressure thereagainst. With one shorting bar, i. e., 28, mounted above bar 27, said bar 28 may be made to break with its associated fixed contacts prior to the breaking of the bar 27 therewith, and accordingly the contact buttons 31 of said shorting bar 27 may be of known materials especially resistant to arcing.

The electric circuit is made or broken by the relative movement of the shorting bars 26, 28, with respect to the fixed contacts. Such movement is advantageously attained by electromagnetic means associated with a suitable armature system; and to eliminate the necessity for con-

tinuous magnetic action to hold the movable contacts either in closed circuit or open circuit status with respect to the fixed contacts, I provide toggle spring means whereby a momentary energization of the appropriate magnetic coil initiates a throw of the toggle spring from one position of stable equilibrium to a second position of stable equilibrium. Therefore, the control circuit for the electromagnets may include a conventional momentary contact switch, preferably of a single pole, double throw type.

Referring to Fig. 7, wherein the apparatus is shown in open circuit position, the electromagnetic system includes an "on" coil 40 and an "off" coil 41, preferably arranged one above the other, as shown.

Magnetic poles are provided by a shell 42, and end stop 43, both of magnetic material, the pole pieces thereof being the raised bosses 42a, 43a. As seen in Fig. 7, the shell 42 encompasses both of the electromagnets and rests upon end stop 43 about its full periphery. An intermediate sleeve 44, preferably of non-magnetic material, acts as a spacer for the coils; a cylindrical portion 45 establishes the preferred air gap between the magnets 40, 41, and the magnetic plunger 46. Said plunger is desirably of Norway iron or other material highly responsive to magnetic flux.

The armature system is completed by a drive rod 47, of bronze or other non-magnetic material, screw-threadedly secured to the plunger 46.

After the electromagnets 40, 41 are positioned within the casing 42 and sleeve 44, drive rod 47 may be passed through the central aperture in end stop 43 and attached to the plunger 46, whereupon the complete assembly may be positioned within the cover 21.

As shown in Fig. 7, said cover 21 has an annular slot 48, within which is placed a split spring washer 50 and a plurality, preferably four, of toggle spring support members 51. The end stop 43 rests upon, and is supported in position by, the split washer 50.

The throw toggle spring 52 is desirably circular, and most preferably, is of the type employing a concatenation of spring systems of different spring characteristics, described in my presently co-pending application Serial No. 441,382, entitled "Toggle springs," filed May 1, 1942. Said spring systems comprise, see Fig. 5, a rim 53 and a central, "legged," spring system 54. As appears in my aforementioned application, the spring rim 53 is given a permanent set in a dish or approximately frusto-conical shape, whereas the spring system 54 does not have a permanent set, but is maintained in bowed elastic tension by the slope of spring rim 53.

Spring 52 snaps into the offset 56 of supports 51, said supports being yieldable to permit the insertion. Notches 55 in the spring 52 are slightly wider than the supports 51, whereby the sides of said notches engage the supports 51, to prevent rotation of the spring.

Spring 52 may be secured to drive rod 47 by suitable lock nuts; to insure a proper positioning of the spring on the drive rod, the latter may be formed with a shoulder or bead 48.

Spring 52 has two positions of stable equilibrium and will hold the armature system in either of its two extremes of travel independently of magnetic action.

A toggle spring 52 made according to the teachings of my aforesaid application will throw from one position of stable equilibrium to the other after an initial impulse movement of ap-

proximately twenty-five per cent (25%) of its total throw, pursuant to certain kinetic energy forces developed within the spring during said initial twenty-five per cent (25%) impulse movement. In such a toggle spring 52, therefore, only a momentary energization of one or the other magnetic coils is required to effect a full throw of the toggle spring. Additionally and importantly, the throw of the toggle spring accelerates very rapidly, attaining a high terminal velocity, prior to attaining its other stable equilibrium point. Such high velocity movement permits the employment of a plunger 46 of relatively light weight, without substantial reduction of momentum of the armature system.

The contact toggle spring 30 may be similar to spring 52, and likewise non-rotatably supported by the members 51, said spring engaging with the step 57 thereof, see Fig. 6.

Fig. 9 indicates one method of securing the respective shorting bars 27, 28 with respect to spring 30. Bar 28 is placed immediately beneath, and in engagement with, the spring 30, and may be riveted thereto as indicated in Fig. 3. Said shorting bar 28 follows the curvature of the legged central spring system of the toggle spring 30 in each of its positions of stable equilibrium.

Shorting bar 27 is secured to the spring 30 in a manner which insulates it from said spring and from the bar 28, to insure the series-break cooperation with fixed contacts 23, 24, 25.

Such insulated securement may be attained by any suitable means, such as the insulating bushings 60, a plate of insulation material 61 separating the respective shorting bars 27, 28, and an insulating sleeve 62 through which passes the drive rod 47. A screw 63, see Fig. 7, having a flat head of greater diameter than sleeve 62, is tapped into the end of drive rod 47, to retain the spring 30 and its associated contact members on the drive rod.

Drive rod 47 is in slidable engagement with the bushing 62, but with minimum of clearance, whereby upon centering the drive rod and the springs 30, 52, said springs form a two-point mounting for the drive rod; and since said springs operate in parallelism during the stages of throw, said drive rod 47 moves without deviation from a fixed path of travel. The inside diameter of sleeve 45 may be only minutely greater than the diameter of plunger 46 for movement of said plunger without frictional contact with said sleeve; the small air gap between the plunger and the sleeve affords improved magnetic action.

It is a feature of the relationship of the armature system to the toggle springs that the contact spring 30 does not begin movement simultaneously with the spring 52, there being a lost motion therebetween. As appears in Figs. 1 and 7, the lower lock nut 65 is spaced slightly above the spring 30, and when it is recalled that drive rod 47 passes slidably through bushing 62, the initial impulse of the spring 52 in a downward direction under magnetic action permits the drive rod to attain an initial momentum prior to engagement of said lock nut 65 with the spring 30, whereby the spring 30 is given a sudden impulse which supplements its normal snap-action characteristic. The normal speed of action of spring 30 is increased, and contact buttons 31 disengage from the respective fixed contacts at high velocity. On the return or circuit closing stroke of the armature system, a slight clearance between the

headed screw 63 and the shorting bar 27 provides a similar "running start."

As shown in Fig. 7 with specific reference to shorting bar 28, the free ends of each shorting bar have a curved spring formation when in repose. When the toggle spring 30 assumes its closed circuit position indicated by the broken line in Fig. 7, the shorting bars are deflected downward, and the contacts 31 thereof are held in resilient engagement with the respective fixed contacts 23, 24 and 25.

The extension of the free ends of shorting bars 27, 28 beyond the periphery of spring 30 magnifies the extent of throw of said spring when it reverses its position from convex closed circuit status to concave open circuit status, thereby increasing the breaking distance between the contacts 31 with respect to fixed contacts 23, 24, 25. Under actual test, the spring 30 throws from one to its other position of stable equilibrium in .0004 second; with an attainable contact break of one quarter ($\frac{1}{4}$) inch, whereby the total effective speed of break approximates 2500 inches per second.

In Fig. 10 is shown a characteristic of the toggle spring 30 more fully explained in my said co-pending application Serial No. 441,382, namely, that the center legged spring system 30a of toggle spring 30 maintains a convex shape while reversing the angle of the rim 30b, shown in dot and dash outline in Fig. 7 immediately following which, the center spring system 30a is snapped through to concave shape, to assume the Fig. 7, open circuit position, shown in full outline.

It will be noted that the break or offset of the shorting bars 28 and 27 occurs where the legged center spring system 30a is connected to the rim 30b; therefore, the initial downward drive of the center spring system 30a urges the shorting bars 27, 28 into firmer contact with the respective fixed contacts, thus substantially increasing the contact pressure until the precise instant of break. During the initial downward movement of spring system 30a, a lateral movement, or "wipe" occurs between the contacts 31 and the fixed contacts, maintaining the same in clean condition.

Arcing may be additionally quenched by maintaining a hydrogen atmosphere within the housing. A hydrogen pressure equal to one atmosphere has been found satisfactory.

The magnet windings are suitably brought to binding posts 70, 71, 72, post 71 being common to the two magnets.

The schematic wiring diagram, Fig. 8, shows the magnet control and load circuit. The "on" coil 40 and the "off" coil 41 are individually energized by suitable movement of the momentary contact switch S.

Means are provided to break the electric circuit automatically in the circumstance of an overload condition in load line L, or to eliminate overload control at the option of the operator to meet possible emergency requirements where adverse results would follow an automatic breaking of the circuit. Such overload control may include a thermally controlled circuit which may be cut into or out of the "off" coil circuit under control of a suitable switch OS.

Fig. 4 shows an overload cut-out which has been found satisfactory. A bimetallic conductor 75 is secured, at one end, to fixed contact 25, and under normal load conditions is in heat-transfer engagement with said fixed contact throughout its length. The arrangement of bimetal conductor 75 is such that upon heating of the conductor

strip 75, namely, by the passage of the load circuit therethrough, the free end of conductor 75 will move away from said contact 25 toward a fixed contact 76, electrically connected into the "off" coil circuit, see Fig. 8, through the switch OS.

The temperature of contact 25, through which the load current passes, will rise upon an increase in the load current, and its temperature rise will be transmitted to bimetallic member 75. When the temperature of contact 25, and, therefore, contact 75, is characteristic of an undesirable overload, said member 75 will warp to a position, see Fig. 4, where its contact member engages with the fixed contact 76. Assuming the switch OS to be closed, a circuit will be completed through the "off" coil, which will energize and move the armature system into open circuit position. And this will be the case, even though switch S is moved to "on" position, so long as the overload member 75 remains in contact with fixed contact 76. It is also apparent that due to the two positions of stable equilibrium of the contact spring 30, the load circuit will not automatically reclose. The operator must energize the "on" coil before the circuit may again be closed.

Under emergency conditions, it may be desirable that the circuit be kept closed even under overload conditions. This is accomplished merely by throwing the overload switch OS into open position, thereby disconnecting the overload conductor from the "off" coil circuit.

Whereas I have described my invention by reference to specific forms thereof, it will be understood that many changes and modifications may be made provided they do not depart from the scope of the claims.

I claim:

1. A circuit breaker for control of an electric circuit, including a toggle spring having an outer spring portion and a central spring portion, said portions collectively defining a curved surface and individually and collectively invertible from convex to concave shape and vice versa; said central spring portion maintaining its initial curvature until the outer spring portion has been inverted; means for mounting said toggle spring at the periphery of its outer spring portion; contact means mounted on said central spring portion to substantially assume the curvature thereof; a fixed contact with which said contact means may engage or disengage in making or breaking an electric circuit; and means for causing said toggle spring to invert from one to the other of its curvatures.

2. A circuit breaker according to claim 1, wherein said spring contact means include a plurality of spring fingers arranged in cruciform fashion and mutually electrically insulated.

3. A circuit breaker according to claim 1, in

which the contact means mounted on said central spring portion includes two long, relatively thin, contact members disposed one above the other in cruciform pattern and mutually electrically insulated.

4. A circuit breaker according to claim 1, wherein the means for actuating the toggle spring includes a shaft operatively associated therewith, and means for moving said shaft relative to said toggle spring; said shaft being so disposed with respect to said toggle spring that an initial movement of said shaft does not actuate said toggle spring.

5. A circuit breaker according to claim 1, wherein the means for actuating said toggle spring includes a second toggle spring having outer and central spring portions similar to said toggle spring; means for mounting said second toggle spring at the periphery of its outer spring portion; shaft means secured to said second toggle spring at the geometric center thereof and passing slidably through the geometric center of said first toggle spring, said toggle springs collectively forming a parallel motion linkage whereby the said shaft means is guided in a straight path of travel.

6. A circuit breaker including a movable contact and a fixed contact associated therewith, and connected into a common electric circuit, and means for bringing the movable contact into or out of engagement with the fixed contact to close or open said circuit; said means including a toggle spring movable into one or another position of stable equilibrium, said toggle spring having a portion remote from its center operable to move initially toward said fixed contact and then sharply away therefrom during the stage of movement from one of its positions of stable equilibrium to the other position; said movable contact being secured to said toggle spring at the said portion thereof, whereby the movable contact is moved initially toward the fixed contact and subsequently away therefrom during the throw of said toggle spring.

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