Nov. 15, 1938. W. DEANS 2,137,000

ENERGY ABSORBER FOR CIRCUIT BREAKERS

Filed Aug. 28, 1936 2 Sheets-Sheet 1

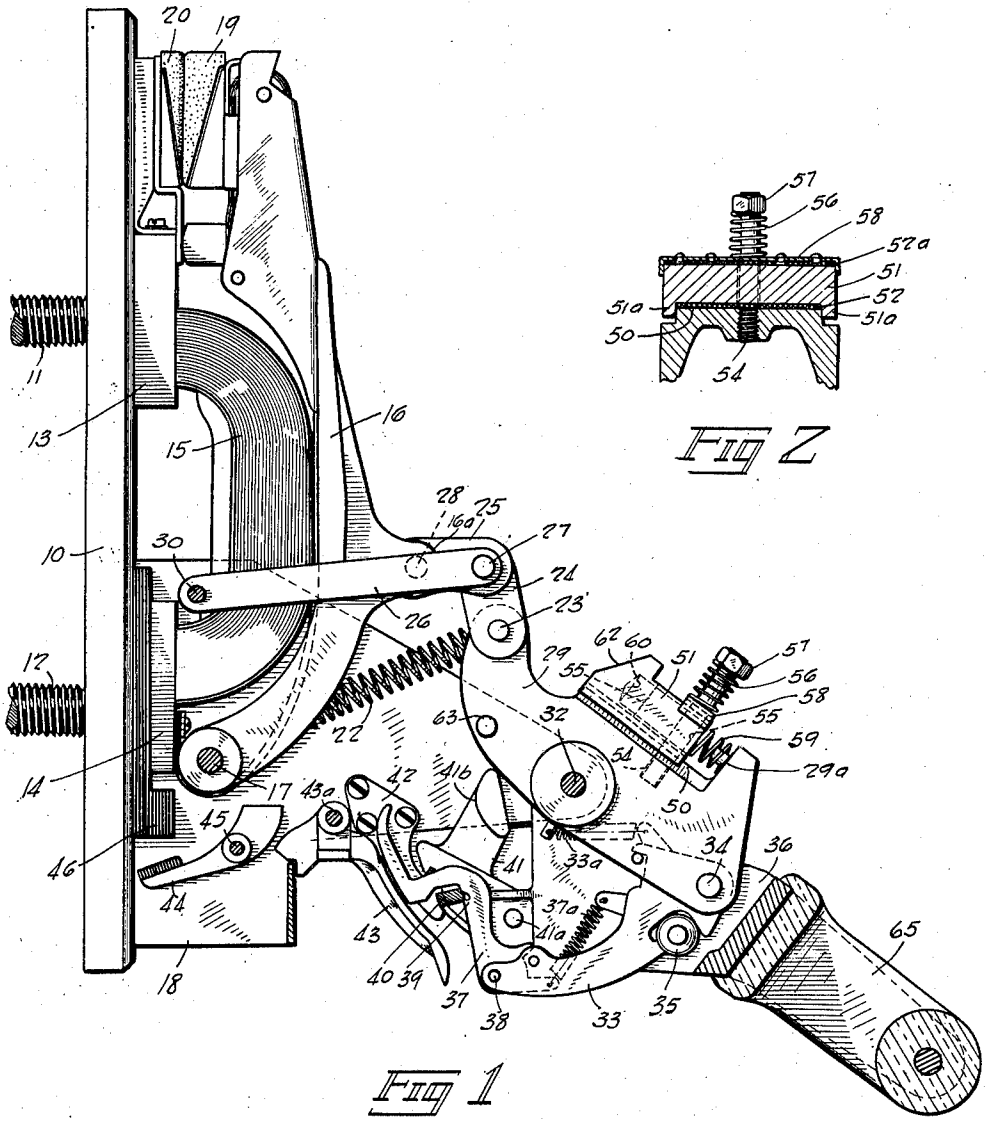


Fig 1

Fig 2

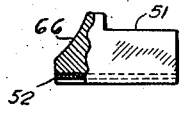


Fig 5

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ENERGY ABSORBER FOR CIRCUIT BREAKERS

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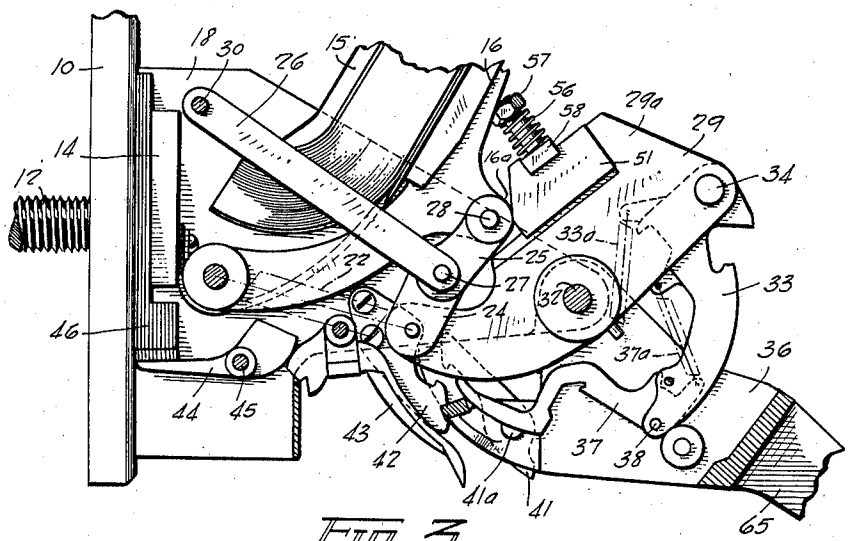


Fig 3

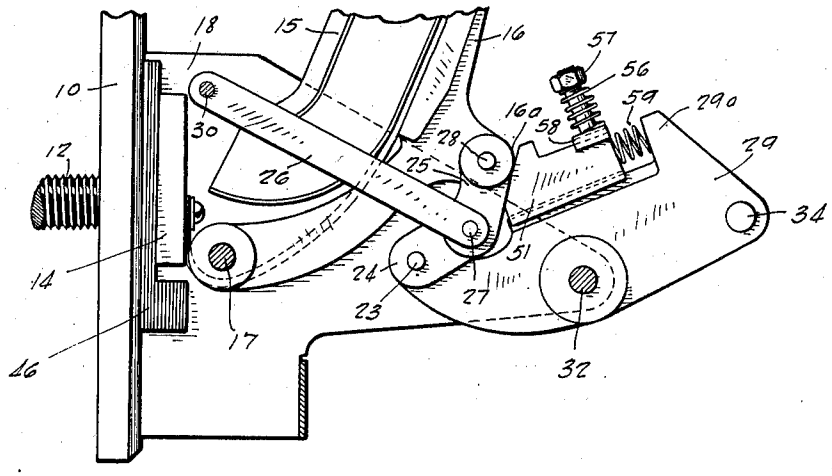


Fig 4

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UNITED STATES PATENT OFFICE

2,137,000

ENERGY ABSORBER FOR CIRCUIT BREAKERS

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Application August 28, 1936, Serial No. 98,276

17 Claims. (Cl. 200—166)

My invention relates to circuit interrupters, particularly to automatic high speed circuit breakers, and has for an object the provision of a simple, reliable and inexpensive means for absorbing the energy of the movable parts of the circuit breaker incident to their movement from one position to another.

In accordance with my invention, the energy stored in the movable parts of the circuit breaker is absorbed by friction developed between members movable relatively to each other. By absorbing their energy, the movable parts are rapidly decelerated and brought to standstill, though the time required to open the circuit is not decreased since the deceleration of the parts occurs only after the movable contact structure has moved substantially to its open circuit position.

My invention is particularly useful in connection with circuit breakers of relatively large current-carrying capacity where the parts, because of the masses of metal necessary to carry the normal, and to withstand the overload, currents, are necessarily heavy and the opening speed is high. Accordingly, with relatively heavy parts moving at high speed the energy dissipated by suddenly arresting movement of the parts, as by striking a fixed stop, which may be a part of the frame or one of the pivot pins of the circuit breaker, produces an impact force whose magnitude is many times that developed by a graduated but rapid deceleration of the members to standstill. As a result of the foregoing phenomena, exemplified by the use of the ordinary hammer, the repeated hammer-blows on the stopping member not only caused its deformation but also transmitted the hammer-blows to the other parts of the circuit breaker, causing rapid deformation and excessive wear of their pivot pins and associated parts.

Further in accordance with my invention, hammer-blows or impact forces are eliminated by securing to one of the switch members suitable friction material and arranging a second member provided with friction material for sliding movement thereover as the circuit breaker is opened. A spring normally biases one member in a position to be engaged by a movable part of the circuit breaker, the engagement taking place along an inclined surface which serves the double function of displacing one friction member with respect to the other and of developing a substantial force which presses them against each other to increase the friction between them. The inclined surface is preferably formed with a varying angle, that is, one which is greater over that portion first engaged by the aforesaid part of the circuit breaker than over that part of the surface over which said part slides as it is brought to standstill.

In accordance with a further aspect of my invention additional cooperating friction surfaces may be provided, the pressure between them being predetermined and not varied by movement of a movable circuit breaker element.

For a more complete understanding of my invention, reference may now be had to the accompanying drawings in which:

Figure 1 is a side elevational view of a circuit breaker embodying my invention with certain parts in section and certain parts omitted;

Fig. 2 is a sectional elevation of the energy absorbing means carried by the circuit breaker of Fig. 1;

Fig. 3 is a fractional side elevational view of the circuit breaker of Fig. 1 with the parts in open circuit position;

Fig. 4 is a fractional side elevational view of the circuit breaker of Fig. 1 with some of the parts omitted and illustrates the position of the energy absorbing means after opening movement of the circuit breaker has been completed.

Fig. 5 is a side elevation, partly in section, of a modified form of the friction member.

Referring to Fig. 1, I have shown my invention in one form as applied to a circuit breaker mounted upon an insulated base or panel 10 through which extend studs or terminal connectors 11 and 12, respectively connected to stationary contacts 13 and 14. To complete a circuit between contacts 13 and 14, a bridging member 15, consisting of a plurality of resilient or spring laminations preferably of copper, is supported on a movable arm 16, itself pivotally mounted on a pivot pin 17 for movement between open and closed circuit positions. The pin 17 is supported by a pair of side plates 18, only one of which is shown. To relieve the bridging member 15 from the duty of interrupting the circuit, the upper end of the arm 16 is provided with an arcing contact 19 formed of arc resistant material arranged to cooperate with an arcing contact 20 electrically connected to the stationary contact 13. The arrangement is such that the contacts 19 and 20 are separated after separation of bridging member 15 from its associated contacts 13 and 14.

The switch or circuit breaker operating mechanism may be of the type described in U. S. Letters Patent No. 2,025,781 granted December 31,

1935, upon application of W. M. Scott, Jr. More specifically, the arm 16 is biased for movement from a closed circuit position to an open circuit position by means of a powerful spring 22 connected at one end to a pivot pin 23 and at its other end to a suitable fixed point, as shown, to the pivot pin 17. A double system of toggles, comprising toggle links 24, 25 and 26 pivotally connected together at corresponding ends by a pivot pin 27, cooperate to hold the switch member 16 in its closed circuit position and also serve to operate it from its open to its closed circuit position. The ends of toggle links 24 and 25, remote from the pin 27, are, respectively, pivotally connected at 23 and 28 to an actuating member 29 and to the arm 16. The ends of the links 26 remote from the pin 27 are supported from fixed pivot pins 30, themselves carried by the side plates 18.

With the parts in their closed circuit positions, as illustrated in Fig. 1, the pivot pins 27, 28 and 30 are in substantial alignment; the spring 22 tends to rotate the links 26 in a clockwise direction but its movement is prevented by the link 24, the actuating member 29 pivoted at 32, and by a latch 33 pivotally connected at 34 to member 29 and engaging a stop 35 carried by a switch operating member 36. The pivot pin 23 occupies a position just short of alignment with pivot pins 27 and 32.

The force directly applied by the spring 22 to the actuating member 29 is resisted by the latch 33 but a component thereof tends to rotate the latch 33 to its unlatched position against the bias of a relatively weak spring 33*a*. An auxiliary latch 37, pivotally mounted at 38 to the main latch 33, has a shoulder 39 engaging a stop 40, carried by operating member 36, to prevent release of the main latch. A second relatively light spring 37*a* tends to retain the auxiliary latch 37 in its latching position.

The operating member 36, biased by spring 22 through member 29 and latch 33 for rotation in a counterclockwise direction, is latched into the position shown in Fig. 1 by a latching member 41 pivoted thereto at 41*a* and engaging the hook-shaped end of a member 42 secured to one of the side plates 18.

To open the circuit breaker, a tripping member 43 may be manually rotated about its pivot 43*a* to release the latch 37 or it may be operated automatically in response to an electrical condition of the circuit. If the circuit breaker is to be opened in response to overload current of predetermined magnitude, an arm 44 pivoted at 45 may be attracted by a U-shaped magnetic structure 46 surrounding the stationary contact 14. Accordingly, when sufficient magnetic flux is produced by the flow of current through the circuit breaker, the arm 44 is rotated in a clockwise direction to move the tripping member 43 against the auxiliary latch 37. Upon exertion of the slight amount of force necessary to release the auxiliary latch, the main latch 33, already biased to a releasing position, frees the movable contact structure for movement to its open circuit position.

Upon release of the latch 33 the powerful spring 22, acting directly upon the knee-pivot pin 23 of the toggle comprising link 24 and member 29 moves the pin 23 toward the panel 10 and a strong component of its force rotates the links 26 in a clockwise direction to move the arm 16 in a clockwise direction and towards its open circuit position. Combined with the opening force of the spring 22, to produce extremely high speed movement of arm 16 and contacts 15 and 19 to open circuit position, are the forces due to the resilience of the movable contacts and/or their supports.

Circuit breakers of the type here under consideration may be designed to carry current of magnitudes upwardly of 8000 amperes at 600 volts and to interrupt a possible short-circuit current of 400,000 amperes. Consequently the parts are relatively heavy to provide sufficient mechanical strength and to carry or withstand large values of current.

Because of the relatively heavy mass of the arm 16 and its associated movable parts, it will be readily understood the kinetic energy of those parts during opening of the switch is proportional to the square of their respective speeds. Moreover, since the maximum speed occurs as the movable contact structure 15, 16, 19 reaches its fully open position, the kinetic energy of the movable structure is greatest as it reaches its limit of movement. Heretofore the impacts, or blows, delivered to stationary stops, in arresting movement of the contact structure, have caused deformation of the stop members as well as deformation or excessive wear of the pivoted portions of the movable parts. The result was a shortened life of the mechanism. There was also a tendency of the parts to rebound, in some cases sufficiently to return the contact structure substantially to its closed circuit position. The result was rapid burning of the contact surfaces and a failure of the circuit breaker to interrupt the overload or short-circuited current in a time short enough to prevent damage to the conductors or to devices connected in the circuit.

In accordance with the present invention, the energy of the moving parts of the circuit breaker as they approach their limit of movement towards circuit opening position is rapidly dissipated as work required to move friction surfaces relative to each other. In this manner the moving parts are rapidly decelerated and brought to standstill without decreasing the opening speed of the circuit breaker. Deformation of parts, excessive wear, and tendency of the parts to rebound are substantially and effectively eliminated. The latter feature, as pointed out above, becomes important when short circuit currents are interrupted because any return movement of the contact members toward closed position decreases the air gap between the contact structures and may delay extinguishment of an arc drawn between the contacts, or may result in re-ignition of an arc.

As shown, the energy absorber and dissipater comprises a ledge 50, preferably formed integrally with member 29, having a flat surface over which is arranged to slide a friction or brake member 51 provided with flanges 51*a* which cooperate with the ledge to guide the brake block or member 51. Secured to member 51 between the flanges 51*a* is a friction element 52 preferably formed of woven fabric impregnated with a phenolic condensation product, though a good grade of automobile, or other type of, brake lining material may be used.

A stud 54 secured to the actuating member 29 extends through a central rectangular slot 55 in the friction member 51 and supports a spring 56, one end of which bears against an adjustable nut 57 and its opposite end against a U-shaped member 58. The spring 56 is normally compressed to bias the friction member 51 against

its cooperating ledge 50. A second or return spring 59, one end of which bears against the inner wall of a recess 60 and its opposite end against an upturned end 29a of the actuating member, biases the friction member 51 to the position shown in Fig. 1. Additional movement of member 51 to the left as viewed in Fig. 1 is prevented by engagement of the right hand portion of the slot 55 with the stud 54. While the spring 56 serves to predetermine the pressure betwen the cooperating friction surfaces, I have found it especially desirable to provide the forward end of the friction member 51 with an inclined surface 62 arranged to be engaged by one of the switch members, such for example as the rounded surface or projection 16a of the arm 16. The surface 62 is inclined at an angle of approximately 52° with respect to the plane friction surfaces although the angle of surface 62 may vary substantially without departing from the present invention, for example it may have a value between 40° and 70° though for special cases it may be selected either above or below these limits.

Again referring to operation of the circuit breaker to the open position, it will be remembered that as the pivot pins 23 and 27 move inwardly toward the panel 10, the actuating member 29 rotates in a counterclockwise direction, and the switch arm 16 moves rapidly in a clockwise direction towards open circuit position. As the rounded surface 16a approaches the friction member 51 the parts are proportioned so that the surface 16a engages the upper end of the face, or surface 62 of the friction member 51. As the surface 16a moves down the inclined face 62, the friction member 51 is displaced laterally and a substantial component of force is by surface 16a applied to the member 51 in a direction to press it against the plane surface of the actuating member 29. The opposition offered to movement of the member 51 is therefore a function both of the pressure of spring 56 and of the magnitude or component of force developed because of the inclined surface 62. Additional and substantial opposition offered by the member 51 is a result of the force required to accelerate it. The braking effort or buffer action of member 51 increases with the increase in the kinetic energy of the parts of the circuit breaker. Thus when their speed is high the surface 16a tends to accelerate at a higher rate the member 51. The higher rate of acceleration requires application of an increased force by surface 16a against surface 62. In consequence, the component of force pressing the friction surfaces together is increased and the total opposition by member 51 to movement by the circuit breaker parts increases with their kinetic energy. It follows that energy absorbing and dissipating devices constructed in accordance with my invention may be readily applied to circuit breakers having widely differing opening speeds since such devices will exert braking efforts, proportioned in accord with the kinetic energy, to bring to a standstill the movable parts of the circuit breaker.

Energy absorbing devices, constructed as aforesaid, have been entirely satisfactory to bring the moving parts of the circuit breaker to a standstill with minimum shock. Impact forces or hammer-blows upon the pivotal connections were substantially entirely eliminated.

Additional friction surfaces may be readily provided by lining the U-shaped member 58 with friction material 52a, this material coating with the upper surface of the friction member 51 to absorb a portion of the energy of the movable parts.

Continuing with the operation of the circuit breaker, as the switch arm 16 reaches its fully open position the friction member 51 is moved into engagement with the upstanding projection 29a of the actuating member 29. About the same time the switch arm 16 may engage a rigid stop. Since the major portion of the kinetic energy has already been absorbed the stops are not subjected to blows of deforming or damaging magnitude.

Instead of the inclined plane surface 62 of the member 51, I have found it particularly advantageous to combine the high energy absorbing characteristics of the smaller angles, i. e., from forty to fifty degrees, with the characteristics of the higher angles of from sixty to seventy degrees. For example, in Fig. 5 the member 51 is provided with a curved surface 66. Lines tangent to the curved surface form angles with the friction surface 52 which vary from the upper part of the curve from seventy degrees down to approximately forty degrees. As referred to the surface 16a of the movable switch arm or part 16, the initial displacement of the member 51, due to the progressive decrease in the aforesaid angles, is small as compared with the travel of the part 16. Moreover, the component of the force pressing the friction member 51 against the member 29 is less. As the surface 16a moves down the curved or inclined surface 66, however, the displacement of the member 51 per unit of travel of the member 16 gradually increases. Similarly the member 51 is pressed against member 29 by a force which, per unit of travel of member 16, continuously and rapidly increases in magnitude. The result is a substantial decrease in the impact of surface 16a against surface 66 and a smoother deceleration of the circuit breaker parts.

Preparatory to reclosure of the circuit breaker, the latch 41 of the operating member 36 is released, during opening of the circuit breaker, by the movement of a projection or roller 63, carried by member 29, over a cam surface 41b.

In order to reclose the circuit breaker an operating handle 65 secured to operating member 36, is rotated in a counterclockwise direction until the stop 35 is again engaged by the main latch 33, this engagement being effected by the bias of the spring 33a. At the same time the auxiliary latch 37 engages the stop 40. The handle 65 and operating member 36 are now effectively secured to the actuating member 29 so that by returning the handle to its original position the circuit breaker is reclosed.

Upon initial movement of the actuating member 29 in a clockwise direction, the return spring 59 is effective to move the friction member 51 towards its original or normal position, the spring 59 being sufficiently strong to overcome the friction produced by the bias of the spring 56. If the spring 59 is sufficiently strong it may, after opening of the breaker, rotate actuating member 29 in a clockwise direction to return the brake block 51 to its original position. In any event the brake block 51, as shown in Fig. 4, is returned to its original position prior to reclosure of the circuit breaker. Thus the energy absorber and dissipater is effective, should the circuit breaker be tripped during the reclosing operation, to prevent shock and injury to the parts.

The circuit closing operation is complete as soon as the latch 41 engages the member 42, although as indicated, the circuit breaker is trip free, that is, it may be automatically opened irrespective of, and without interference from, the

operating member **36** or its associated handle **65**.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto, since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the spirit and scope of my invention.

What I claim is:

1. In a circuit breaker having contact structures, one of which is movable relative to the other from a closed to an open circuit position, the combination of friction means comprising solid bodies having non-resilient surfaces of substantial area in sliding contact with each other during relative movement thereof by said movable contact structure for absorbing energy of said structure after substantial movement thereof toward said open circuit position, and means operable in accordance with the opening speed of said contact structure for controlling the action of said friction means.

2. In a circuit breaker having contact structures, one of which is movable relative to the other between open and closed circuit positions, and means for moving at high speed said movable structure to said open circuit position, the combination of friction means comprising a solid non-resilient body and a second solid non-resilient body supported thereon in frictional engagement therewith and operable immediately before completion of movement of said movable structure to said open position for rapidly decelerating said movable structure to bring it to standstill, and means operable in accordance with the kinetic energy of the movable parts for controlling the decelerating action of said friction means.

3. Means for absorbing the energy of the movable parts of a circuit breaker incident to their movement from a closed to an open circuit position comprising a pair of relatively movable non-resilient members one of which is provided with a friction surface continuously in engagement with an slidable with respect to the surface of the other member, and means operable by one of the parts of said circuit breaker for displacing one of said members with respect to the other and for presssing said surfaces against each other with a pressure which varies in accordance with the energy stored in said movable parts.

4. In a circuit breaker having contact structures, one of which is movable relative to the other from a closed circuit position to an open circuit position, the combination of a member having an inclined surface engaged by said movable structure and movable laterally thereby, and friction means for opposing movement of said member, said movable structure acting on said inclined surface to increase the opposition offered by said friction means.

5. In a circuit breaker having contact structures, one of which is movable relative to the other from a closed circuit position to an open circuit position, the combination of a member having an inclined surface engaged by said movable structure and movable laterally thereby, friction surfaces, one of which is movable relative to the other by said member, said movable structure acting on said inclined surface to press said surfaces against each other to oppose movement of said movable structure, and resilient means for biasing said surfaces against each other.

6. Means for absorbing the energy of the movable parts of a circuit breaker incident to their movement from a closed to an open circuit position comprising a pair of rigid switch members having friction surfaces, one of which is slidable with respect to the other and a common mounting for said members, and means cooperating with at least one of said members for simultaneously pressing said friction surfaces against each other and for displacing one of said members with respect to the other.

7. Means for absorbing the energy of the movable parts of a circuit breaker incident to their movement from one position to another comprising a pair of switch members having friction surfaces continuously in engagement with each other and one of which is slidable upon the other, one of said parts for a portion only of its movement engaging one of said members for simultaneously pressing said friction surfaces against each other and for displacing said one of said members with respect to the other, and means exclusive of said one of said parts for maintaining a predetermined pressure between said friction surfaces throughout the movement of said one of said parts.

8. Means for absorbing the energy of the movable parts of a circuit breaker incident to their movement from a closed to an open circuit position comprising a pair of switch members having friction surfaces continuously in engagement with each other and one of which is slidable upon the other, means cooperating with at least one of said members for simultaneously pressing said members and friction surfaces against each other and for displacing one of said members with respect to the other, and further means including a spring for pressing said friction surfaces against each other before and after they are pressed against each other by said first-named means.

9. Means for absorbing the energy of the movable parts of a circuit breaker incident to their movement from one switching position to another comprising a switch member having a friction surface, a second switch member having a cooperating friction surface, and a friction surface spaced therefrom, a third switch member having a friction surface normally biased in engagement with said third-named surface, said second switch member having an inclined face engageable by one of the parts of said circuit breaker for pressing said first and second-named friction surfaces against each other and for moving one of said surfaces relative to the other.

10. In a circuit breaker having contact structures one of which is movable from a closed circuit position to an open circuit position, the combination of a switch member movable from one position to another during movement of said circuit breaker, a friction surface carried by said member, a second member supported by said first member and having a friction surface cooperatively associated with, and slidable over, said first-named surface, and means operable by said movable structure for displacing said second-named member and for simultaneously pressing said friction surfaces toward each other.

11. Means for relieving the frame of a circuit breaker from the forces incident to movement of its contact structure from one switching position to another comprising a pair of friction members in continuous engagement with each other, carried by one part of said circuit breaker, and movable with said one part towards said movable contact structure, and means carried by said movable contact structure for engaging one of said friction members to displace it upon the other friction member and simultaneously to press them

against each other whereby the energy of the moving parts of said circuit breaker is substantially entirely absorbed by the friction incident to relative displacement of said friction members.

12. In an automatic circuit breaker having contact structure mounted for pivotal movement from a closed to an open circuit position, means for operating at high speed said contact structure from said closed to said open circuit position, the combination of means for absorbing the energy stored in the movable parts of said circuit breaker incident to operation to said open circuit position, comprising relatively movable members having cooperating friction surfaces, one of said members having an inclined surface, means carried by a movable part of said circuit breaker for movement along said inclined surface to slide one friction surface with respect to the other friction surface, said means cooperating with said inclined surface to press said friction surfaces against each other for absorption, by the friction between said friction surfaces, of the major portion of the energy stored in said movable parts of said circuit breaker, and means cooperating with said relatively movable members for returning one of them to its original position.

13. Means for absorbing the energy stored in the movable parts of a high speed circuit breaker incident to their movement from one switching position to another comprising relatively movable members having cooperating friction surfaces, one of said members having an inclined surface, means carried by a movable part of said circuit breaker for engaging said inclined surface to press said friction surfaces together and to displace one of them with respect to the other, a spring associated with said relatively movable members for biasing said friction surfaces against each other, and a spring for returning one of said movable members to its original position after displacement by said means, said last-named spring being sufficiently strong to overcome the friction of said surfaces caused by the bias of said first-named spring.

14. Means for absorbing the energy stored in the movable parts of a high speed circuit breaker incident to their movement from one position to another comprising relatively movable members having cooperating friction surfaces, one of said members provided with flanges on opposite sides of its friction surface and the other of said members having shoulders arranged to receive said flanges, said flanges and shoulders guiding said members for sliding movement of one friction surface with respect to the other, one of said members having an inclined surface, means carried by a movable part of said circuit breaker for movement along said inclined surface simultaneously to displace said members and to press said surfaces against each other, said member with said inclined surface having an additional friction surface, means cooperating therewith for opposing movement of said last-named member, a spring for establishing predetermined pressures between said friction surfaces, and a return spring developing a force greater than the combined opposition of said friction surfaces when said inclined surface is disengaged.

15. A circuit breaker comprising fixed contact structure, a movable system including contact structure movable away from said fixed contact structure to open circuit position, means for braking said movable contact structure comprising a rigid braking member continuously frictionally engaging and movable with respect to a cooperating rigid braking member, and brake-actuating means included in said movable system engaging and actuating said first-named braking member with application thereto of a force having a component acting upon said first-named braking member in direction to increase its pressure upon its said cooperating member.

16. A circuit breaker comprising fixed contact structure, a movable system including contact structure movable away from said fixed contact structure to open circuit position, means for braking said movable contact structure comprising a rigid braking member frictionally engaging and movable with respect to a cooperating rigid braking member, and brake-actuating means engaging and actuating said first-named braking member by application thereto of a force whose magnitude is dependent upon the speed at which said movable system moves to open circuit position and having a component acting in a direction to increase the pressure by said braking member upon its said cooperating member.

17. Means for absorbing the energy of the movable parts of a circuit breaker incident to their movement from a closed to an open circuit position comprising a pair of relatively movable braking members, one of which is provided with an inclined surface, and means operable by one of the parts of said circuit breaker for engaging said inclined surface to displace one braking member with respect to the other braking member and to press one braking member against the other with a force whose magnitude is dependent upon the speed at which said movable parts of the circuit breaker move to open circuit position.

WILLIAM DEANS.

CERTIFICATE OF CORRECTION.

Patent No. 2,137,000. November 15, 1938.

WILLIAM DEANS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 11, for "betwen" read between; page 4, first column, line 44, claim 3, for "an" read and; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of August, A. D. 1939.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)