Oct. 22, 1957 F. S. GREEN 2,810,803

CIRCUIT BREAKERS

Filed Dec. 8, 1952 2 Sheets-Sheet 1

FIG. 1.

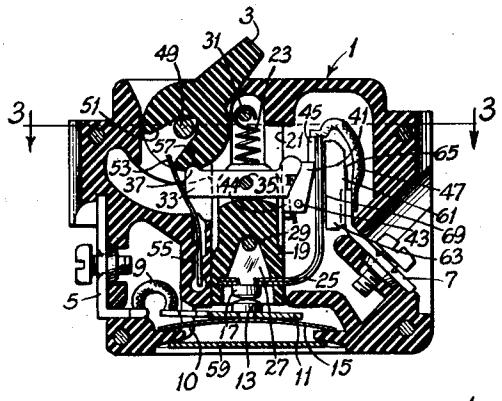


FIG. 2.

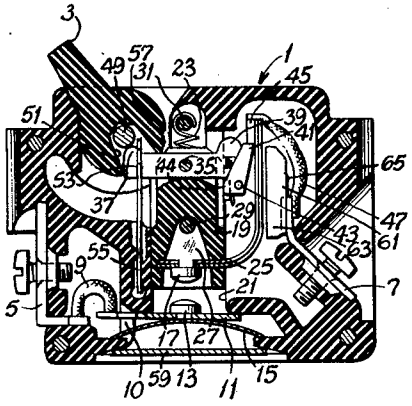


FIG. 3.

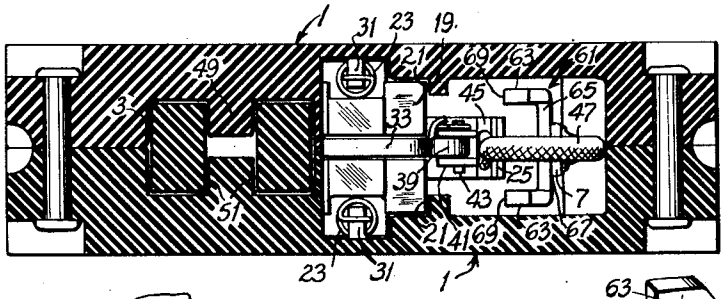


FIG. 4.

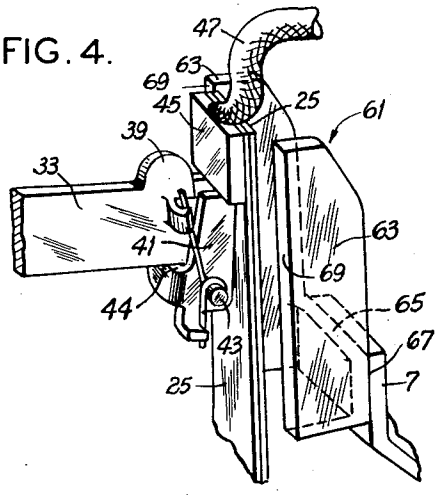
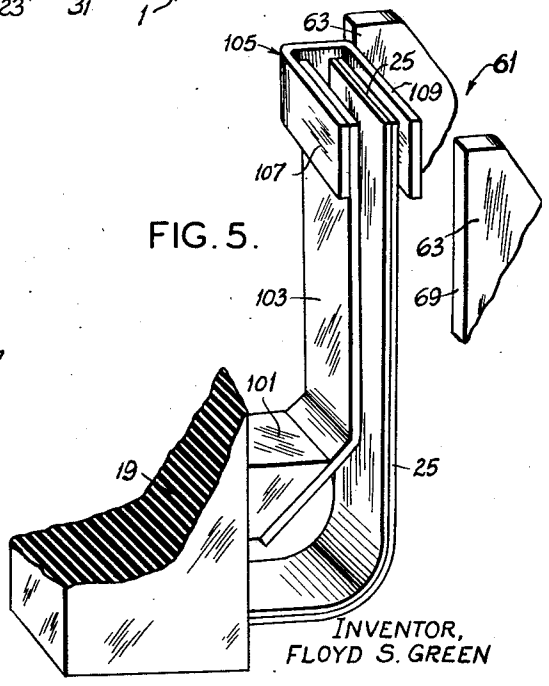


FIG. 5.



INVENTOR,
FLOYD S. GREEN

BY Brunings and Sutherland,
ATTORNEYS.

Oct. 22, 1957 F. S. GREEN 2,810,803

CIRCUIT BREAKERS

Filed Dec. 8, 1952 2 Sheets-Sheet 2

FIG. 6.

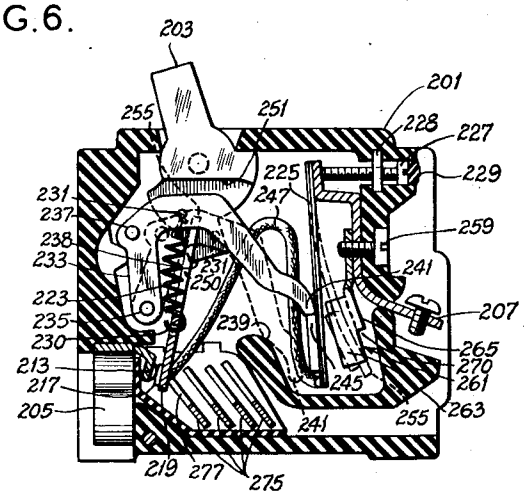
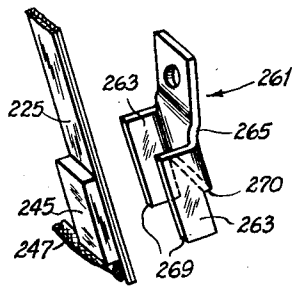


FIG. 7.



INVENTOR,
FLOYD S. GREEN,
BY Bruninga and Sutherland,
ATTORNEYS.

United States Patent Office 2,810,803 Patented Oct. 22, 1957

2,810,803

CIRCUIT BREAKERS

Floyd S. Green, St. Louis, Mo., assignor to Frank Adam Electric Company, St. Louis, Mo., a corporation of Missouri

Application December 8, 1952, Serial No. 324,694

7 Claims. (Cl. 200—88)

This invention relates to circuit breakers and, more particularly, to magnetic tripping mechanism for small circuit breakers.

In apparatus of this general class, there are at least two cooperating contacts, one of which is mounted upon a movable-contact member for actuation by a switch handle between circuit-open and circuit-closed positions, and for actuation by tripping mechanism to open the contacts. This mechanism preferably is arranged so that the contacts do not open on small temporary overloads (motor-starting loads, for example), but open only when the overload condition continues. A bimetallic element is commonly utilized to obtain the time delay characteristic, but because its response is inherently slow, even to large values of overload current, it has also been the practice to include a magnetic trip. The bimetallic element affords a delayed response to the heating effect of the load current, whereas the magnetic trip affords an immediate response to the magnetic induction effect.

Experience has shown that the calibration of the thermal element is quite critical and that this calibration is destroyed if the thermal element is subjected to severe stress. Nevertheless, one of the preferred types of circuit breaker construction contemplates that an armature of the magnetic trip be mounted on or adjacent the thermal element so that the thermal element is subjected to the relatively rapid and forceful action of the magnetic trip. As a consequence, difficulty has been experienced in avoiding damage to the thermal element, and in some types of circuit breakers, the magnetic attractive force and frictional forces have tended to interfere with opening of the contacts subsequent to actual response of the tripping mechanism.

It is accordingly an object of this invention to provide a simple, compact, quick-release magnetic tripping mechanism wherein one of the magnetic parts may be mounted upon the thermal element (to function as a latch, for example) wtihout interference, frictionally or otherwise, with the opening of the contacts or with the calibration of the thermal element. To the attainment of these objectives, I provide a first magnetic part or armature, which may be mounted upon the thermal element, and a second magnetic part is fixed opposite the armature so that there exists an encompassing magnetic inductive relationship with a load-current conductor. One of these parts, preferably the fixed one, is shaped as a horseshoe with the poles thereof elongated in the direction of the conductor and normal to the magnetic movement of the armature, and these poles are spaced apart and disposed to accommodate relative movement therebetween of the other magnetic part and the thermal element. The portions of the poles adjacent the free end of the thermal element are unconnected at the back in order that the end of the thermal element may swing freely, and the movable armature is preferably mounted on the thermal element opposite the unconnected portions of the poles. The armature may comprise a simple block or plate attached to the thermal element and forming a latch catch, or it may be an independently supported member such as a clevis, providing for a lost-motion connection with the thermal element.

It should be understood that although the invention is described in connection with a thermal type of circuit breaker, the invention has application in magnetic circuit breakers per se and in various types of circuit breakers other than those having the particular linkages described hereinafter. Among the several advantages of this invention, it may be noted that the magnetic trip permits relatively unrestrained movement of the thermal element; the magnetic induction is large and the tripping time small in comparison with prior devices; and a convenient compact arrangement of parts is attained.

Other features of the invention will be in part apparent from and in part pointed out in the following detail description taken in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of the circuit breaker with the parts thereof in circuit-closed positions;

Fig. 2 is a view similar to that of Fig. 1 illustrating the positions of parts under circuit-open conditions;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is an oblique detail view of the magnetic elements and adjacent parts shown in Figs. 1–3, a spring bias for the catch being relocated to appear more clearly;

Fig. 5 is an oblique detail view similar to that of Fig. 4 but illustrating a modification of the invention;

Fig. 6 is a view similar to that of Fig. 1 illustrating a different type of circuit breaker, with a tripped condition being indicated by dotted lines; and

Fig. 7 is an oblique view of the magnetic field member used in the Fig. 6 device.

Referring now to Fig. 1 of the drawings, the circuit breaker is shown to comprise a housing **1**, formed by assembly of two matching half-sections of molded plastic or the like. The housing is provided with interior cavities which contain the operating mechanism of the device, and an actuating handle **3** projects from the top thereof. Line connections (not shown) are made to terminal plates **5** and **7** seated at the ends of the housing. The terminal plate **5** is connected by a pigtail **9** to a relatively fixed contact member **11**, which is movably seated within the housing upon a fulcrum **10** so as to supply contact-wiping motion. This contact member **11** and its attached inwardly-facing contact **13** are biased inwardly by a leaf spring **15**.

An outwardly-facing relatively movable contact **17** is carried upon a carrier **19** for cooperation with the contact **13**. This carrier **19** is a block of plastic, which is slidably received in guide walls **21** and spring biased at **23** away from the fixed contact. A bimetallic strip **25** extends across the bottom part of the movable block **19**, and the movable contact **17** is fixed on one side thereof. Welded to the side of the bimetallic strip is an extension **27**, which in turn is secured in the block upon a pin **29**. The pin **29** forms an attachment for one end of the spring **23**. The spring **23** extends between the housing and the block within suitable recesses, and its other end is hooked over a projection **31** formed at the top of the housing.

The top portion of the block **19** is slotted to receive a transverse lever or seesaw bar **33**. The bar is centrally pivoted at **35** for slight swinging movement, and is formed at one end with a surface **37** cooperable with the actuating handle **3**. The other end of the bar is formed with a bumper **39** cooperable with the housing and carries a relatively movable catch **41**. This catch is a generally U-shaped member hinged at **43** upon the seesaw bar and shaped for latching cooperation with a latching element **45**, the latter being secured to the free end of the bimetal-

lic strip 25. It will be seen the bimetallic strip 25 is bent to extend up alongside its supporting block 19 and it is constructed to move outwardly upon increase in temperature. This hinged catch 41 is spring biased or gravity biased in an outward direction, but its outward movement is limited by a shoulder 44 which engages with the under side of the seesaw bar so that there is a release of the latch upon predetermined outward movement of the bimetallic strip.

A pigtail 47 extends from the top free end of the bimetallic strip for connection with the terminal plate 7. With the circuit breaker in the circuit-closed position of Fig. 1, a circuit is established from the terminal 7 through the pigtail 47 and the thermostatic strip 25 to the relatively movable contact 17. The circuit is then completed from the relatively fixed contact 13 through its supporting member 11 and the pigtail 9 to the other terminal 5.

As stated heretofore, the carrier 19 is normally biased away from the fixed contact 13 to open the circuit. The circuit is closed by manipulation of the actuating handle 3 to the position of Fig. 1. The actuating member is pivoted upon a pin 49 formed in the housing and has a slotted segment at 51, which is shaped to receive the end of a spring strip 53. The spring strip 53 is seated at its other end within a slot 55 formed within the housing so as to bias the actuating member to the circuit-open position of Fig. 2. When in the circuit-open position of Fig. 2, the slot 51 also accommodates the end 37 of the seesaw bar 33, but the slot has a limited angular width so that the seesaw bar is driven downward when the actuating member 3 is rotated to its circuit-closed position. Should the other end of the bar be latched at 45, then the carrier 19 is also driven downward to close the contacts.

A small indentation 57 is formed upon the lower portion of the actuating member 3 for a detent cooperation with the surface 37 of the seesaw bar to retain the actuating member in its circuit-closed position until the circuit breaker is tripped. Of course, the switch handle 3 may be moved to a circuit-open position prior to tripping if it is desired to open the circuit. It will be noted the bottom part of the housing 1 is open and a fiber board 59 is loosely seated within this opening to protect the electrical parts thereof yet permit release of gases generated in opening the contacts.

The bimetallic strip series connected in the circuit provides protection against overload, yet prevents tripping by small overloads of brief duration, such as occur when starting a motor. In other words, the thermostatic action provides a time delay because the bimetallic strip 25 does not immediately flex outwardly to release the catch and trip the breaker in response to overload. After a sufficient time interval, however, the flexure is sufficient to move the latching element 45 clear of the hinged catch 41 whereupon the carrier 19 is spring retracted and the actuating handle 3 is released and spring-returned to the circuit-open position of Fig. 2. The contacts are separated and remain open until the device is reset by manipulation of the actuating handle.

Immediately after tripping, the seesaw bar initially pivots counterclockwise as viewed in Fig. 1 to release the actuating handle. As the carrier 19 retracts, however, the bumper 39 engages the top of the housing to effect relatching of the bar after the thermal element has returned to its cool position (Fig. 2). Being hinged, the catch 41 is readily relatched without stressing the strip 25 to a point that would destroy its calibration.

Although such time-delayed thermostatic action is desired to prevent tripping under conditions of small temporary overloads, this time-delay does not provide adequate protection under conditions of abnormal overload, such as occur when the circuit is shorted. In the latter event, the circuit must be opened substantially immediately in response to the overload. It has accordingly been

proposed to include a magnetic trip, and this has generally taken the form of a pair of opposed magnetic plates. One of these plates is fixed and the other is generally supported from the carrier 19 on the free end of the thermal element so that the element is snapped out of position by the magnetic inductive effect of large overload currents.

A fast release is desired, yet heretofore, all attempts to increase the speed of the magnetic trip have merely led to other complications. When the attractive force between magnetic plates was increased, the sudden clapping engagement of the two plates often resulted in the application of such severe stresses to the thermal element that its calibration was changed. Moreover, in the case where one of the magnetic parts was carried by the movable contact carrier, a frictional effect between the plates interfered with retraction of the carrier.

Referring now more particularly to Fig. 4, the latching element 45 is a small block or plate of magnetic material, which is welded against the inner end surface of the bimetallic strip 25. In the circuit-closed position of parts (Fig. 1), the element 45 is located for magnetic cooperation with a fixed magnet 61. This fixed magnet 61, in effect, is a coilless electromagnet formed of soft iron and positioned to have a proportionate magnetic field induced therein by the current through the bimetallic strip. Elongate or wide poles 63 extend upwardly from an outer connecting web 65 with their inner margins 69 located adjacent opposite sides of the thermal element 25. The magnet is fixed in position by an attachment at 67 between the web 65 and the terminal bracket 7. A magnetic circuit is accordingly set up by the poles 63, the web 65 and the block 45 about the thermal element, and because of the substantial coincidence of the poles 63 and the thermal element, a considerable magnetic induction is achieved.

This considerable magnetic induction has the desirable effect of producing a quick opening of the contacts upon short circuits. In contrast to prior constructions, however, the thermal element, which carries the magnetic armature, is not subjected to the severe stresses, which heretofore proved damaging to its calibration. There is a cushioning effect developed as the attached armature swings freely between the spaced poles of the field member. In other words, as the armature tends to swing beyond these poles, a reverse attractive force is supplied to the armature, which force smoothly slows further movement of the thermal element, as distinguished from the abrupt stop heretofore occurring when the armature engaged a plate-type field member.

Fig. 5 discloses a modification of the Fig. 4 construction wherein the performance is further improved. In order to simplify the description thereof, like reference characters are employed to identify identical parts in the two embodiments. The bimetallic strip 25 is located as before, but the contact carrier 19 has a projection at 101 for attachment of a flexible spring strip 103. The strip 103 is generally coextensive with but spaced from the bimetallic element 25, preferably on the side away from that in which the thermally responsive element moves so as not to interfere with its motion. A new latch element and armature 105 is also employed, this element 105 being secured upon the free end of the spring member 103 rather than upon the thermal element 25. The latch element is formed as a clevis having a leg 107 secured on the inner side of the spring strip to function as a latch, and a second leg 109 is spaced upon the opposite side of the bimetallic strip 25 in the path of flexure for actuation thereby or by the magnetic horseshoe 61.

The operation of the device is similar to that described heretofore. In this embodiment, however, the lost motion connection between the magnetic armature 105 and the thermal element 25 functions to minimize the possibility of injury to the latter element, such as might be caused

by violet magnetic action of the former element. In other words, when the magnetic part **105** is attracted to the horseshoe **61**, the bimetallic strip **25** is not immediately actuated thereby.

In Figs. 6 and 7, there is shown an alternative embodiment of the invention involving a different type of contact-actuating linkage. Like the previously described device, this circuit breaker has a molded housing **201** from the top of which extends a pivoted switch-operating handle **203**. A terminal **205** at one end of the housing carries a fixed contact **213**, and a terminal **207** at the other end is connected through a bimetallic strip **225** and a pigtail **247** to a movable-contact member **219** having a movable contact **217**. The terminal **207** is secured to extend upwardly with its upper end engaged by an adjusting screw **227**. This screw is threaded through a nut **228** fixed in the housing and after adjustment, the screw is covered by sealing material **229**. The bimetallic strip **225** is secured to the upper end of the terminal so as to extend downwardly within the housing and the pigtail **247** is secured to its free end.

The movable-contact member **219** is bifurcated with its legs **250** straddling a spring **223** and seated within notches **255** in the lower portion of the switch handle **203**. The tripping mechanism in this instance comprises a latch part **233**, which is pivoted at **235** above the fixed contact **213**. The switch handle is recessed at **251**, and the latch part **233** extends upwardly through the recess and between the legs of the contact member **219**, and thence downwardly toward the free end of the thermal element **225**. The spring **223** is secured at one end **230** to the movable-contact member **219** and at its other end **231** to the latch part **233**. The arrangement provides an over-centering linkage which may be over-centered by movement at either of two points.

In Fig. 6, the switch handle is shown in the circuit-closed position with the notches at **255** located to the right of the spring. As the handle is swung to the circuit-open position, the part of the movable-contact member at **255** is swung to the left of the spring, whereupon the contacts open with snap action. This is true so long as the latch part **233** is in the position shown by solid lines with its free end **241** hooked over a catch **245** on the free end of the thermal element.

It will be noted that the load current is passed through the thermal element so that it is heated thereby and in response to heating flexes outwardly as shown by dotted lines. Upon sufficient flexure, the catch **245** is retracted from beneath the free end **241** of the latch part **233**; whereupon the latch part is snapped downwardly by the spring **223** to rest upon the part **239** of the housing. As the latch part pivots at **235**, the spring **223** is swung to the other side of the movable-contact member and the over-centering action opens the contacts.

To reset the circuit breaker, there is provided a pin **237** extending from the latch part **233** and cooperating legs **238** formed on the switch handle. As the switch handle is moved to its extreme open-circuit position (opposite direction from that shown in Fig. 6), these legs **238** engage the pin **237** and lift the free end **247** of the latch part over the catch **245**. If the thermal element has cooled, the latch part **233** is thereby relatched and the switch may then be moved to the circuit-closed position as shown in the view.

The magnetic trip in this instance comprises a part generally designated **261**, which is fixed alongside of the terminal **207** by a screw **259**. This part **261**, herein referred to as the field member, has an extension or web **265** and spaced poles **263** extending downwardly and so disposed as to accommodate movement of the free end of the thermal element and its attached catch **245** therebetween. The catch **245**, as before, is formed of magnetic material and functions as the armature of the magnetic trip. It will be noticed that the back web **265** terminates at **270** so that the poles **263** are unconnected at their lower portions. Consequently, the free end of the thermal element may swing inwardly a substantial amount as indicated by dotted lines without engaging the field member. The magnetic tripping action otherwise is the same as that described above except that the flexure of the thermal element is caused by the magnetic attractive force developed by the two magnetic parts **245** and **261** rather than by heating of the thermal element.

To minimize arcing, there is a magnetic arc quench comprising a plurality of magnetic horseshoes **275** disposed so that the movable contact **217** sweeps between the poles **277** during its contact-opening motion. These poles operate to extend and extinguish the arc in a manner known in the art.

It will be seen from the above that the magnetic trip of this invention (incorporating spaced poles between which a thermal element and magnetic armature may move) offers pronounced advantages over the prior constructions wherein the armature and field member are formed as plates which clap together. The magnetic armature may be attached direct to the thermal element, but instead of a clapping action which heretofore has caused variations in calibration of the thermal element, there is provided a cushioning effect. With the poles extended or unconnected adjacent the path of the magnetic armature, substantially all clapping tendencies are eliminated, although the attractive force may be quite high to insure quick release, and a cushioning magnetic braking effect is provided to prevent excessive swing of the armature.

From the foregoing description, it is apparent that those skilled in the art will understand the structure, function and mode of operation of the invention herein disclosed, and appreciate the advantages thereof. Although several embodiments have been disclosed in detail, it is to be understood that the invention is not limited thereto, but the drawings and description thereof are to be understood as being merely illustrative. It is realized that many modifications and variations will present themselves to those skilled in the art without departing from the spirit of this invention or the scope thereof as set forth in the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a circuit breaker of the type having a trip element including a bimetal member and relatively movable magnetic elements encompassing said bimetal member; the improvement that comprises one of said magnetic elements having spaced poles extending along opposite sides of said bimetal member, a pole-connecting web portion recessed at one end to accommodate relative movement of said other magnetic element, and said other magnetic element being mounted for movement freely between said poles at the unconnected ends thereof, said poles being spaced apart a distance sufficient to permit said other magnetic element to pass therebetween without contact therewith, and said poles being disposed so that the space between them is in the path of movement of said other magnetic element and said poles are outside said path.

2. In a circuit breaker of the type having a trip element including a bimetal member and relatively movable magnetic elements encompassing said bimetal member; the improvement that comprises an elongate latch-actuating lever which is mounted for swinging movement, one of said magnetic elements being an armature carried on the free end of said lever and said other magnetic element having relatively fixed elongate poles extending lengthwise of said lever on opposite sides thereof, said poles having portions remote from said armature which are joined together by a connecting web and unconnected portions projecting upon opposite sides of said armature, said poles being spaced apart a distance sufficient to per-

mit said armature to pass therebetween without contact therewith, and said poles being disposed so that the space between them is in the path of movement of said armature and said poles are outside said path.

3. A circuit breaker as set forth in claim 2, wherein said poles extend from the free end of said lever toward the other end.

4. A circuit breaker as set forth in claim 3, wherein said latch-actuating lever is a resilient strip.

5. In a thermo-magnetic circuit breaker of the type having a bimetallic member and magnetic elements mounted in a magnetic inductive relationship therewith; the improvement that comprises said bimetallic member being mounted for swinging movement at one end, one of said magnetic elements being a magnetic armature mounted on the bimetallic member adjacent its free end, and a pair of elongate magnetic pole members having pole portions disposed on opposite sides of said armature, said pole portions being spaced to pass the armature and bimetallic member therebetween, said armature and bimetallic member being freely movable between and beyond said pole portions, thereby to provide for gradual magnetic retardation should the armature swing through and beyond the pole portions.

6. In a thermo-magnetic circuit breaker of the type having a bimetallic member and magnetic elements mounted in a magnetic inductive relationship therewith; the improvement that comprises said bimetallic member being mounted for swinging movement at one end, one of said magnetic elements being a magnetic armature mounted on the bimetallic member adjacent its free end, and a pair of elongate magnetic poles having portions remote from said armature joined together by a connecting web and unconnected portions projecting on opposite sides of said armature, said armature and bimetallic member being freely movable between said projecting portions of the pole.

7. In a magnetic circuit breaker of the type having a conductive member and magnetic elements mounted in a magnetic inductive relationship therewith; the improvement that comprises said conductive member being mounted for swinging movement at one end, one of said magnetic elements being a magnetic armature mounted on the free end of said conductive member, and a pair of spaced magnetic pole members having pole portions disposed opposite the sides of said armature, said pole portions being spaced to pass the armature therebetween, and said armature and conductive member being freely movable between and beyond said pole portions, thereby to provide for gradual magnetic retardation should the armature continue swinging movement beyond the pole portions.

References Cited in the file of this patent

UNITED STATES PATENTS

2,184,372	Von Hoorn	Dec. 26, 1939
2,312,169	Jackson	Feb. 23, 1943
2,328,458	Jackson et al.	Aug. 31, 1943
2,353,617	Lamb	July 11, 1944
2,360,684	Jennings	Oct. 17, 1944
2,378,648	Maseng	June 19, 1945
2,424,909	Adam et al.	July 29, 1947
2,439,511	Green	Apr. 13, 1948
2,590,663	Walker	Mar. 25, 1952
2,660,643	Toth	Nov. 24, 1953
2,663,773	Drobney et al.	Dec. 22, 1953
2,689,285	Drobney et al.	Sept. 14, 1954
2,691,708	Drobney et al.	Oct. 12, 1954
2,732,455	Ericson et al.	Jan. 24, 1956
2,738,450	Matthews	Mar. 13, 1956

FOREIGN PATENTS

211,158	Great Britain	Sept. 11, 1924