Dec. 22, 1931. E. T. BURTON 1,837,202

CIRCUIT BREAKER

Filed April 11, 1930

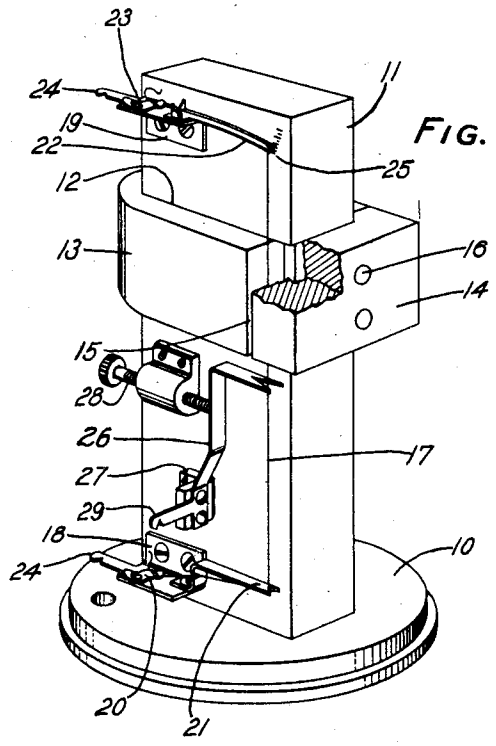


FIG. 1

FIG. 2

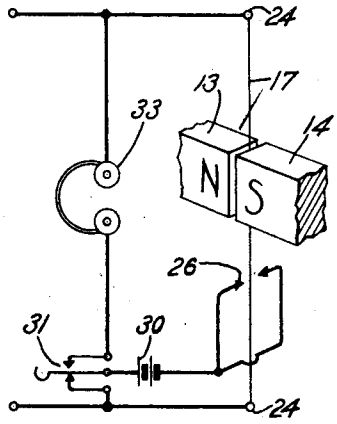
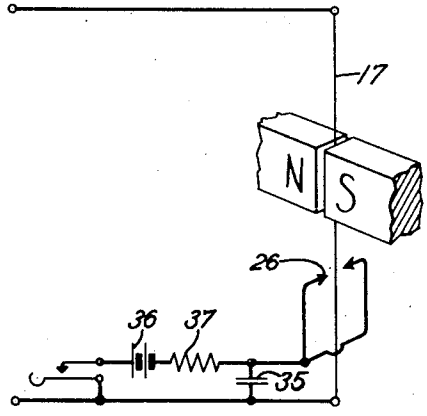


FIG. 3



INVENTOR
E. T. BURTON
BY J. W. Schmied
ATTORNEY

Patented Dec. 22, 1931 1,837,202

UNITED STATES PATENT OFFICE

EVERETT T. BURTON, OF MILLBURN, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

CIRCUIT BREAKER

Application filed April 11, 1930. Serial No. 443,289.

This invention relates to a circuit maker or breaker for use particularly where responsiveness to very small current values is desired.

An object of this invention is to provide a mechanical relay for closing one circuit in response to a current of any selected value in another circuit.

Another object of this invention is to provide an electromagnetic device operative to open a circuit automatically when the current exceeds a predetermined limit of small value, say two milliamperes.

This invention is applicable particularly to telephone and telegraph systems for protecting apparatus which might be damaged by currents exceeding a predetermined small value, such as inductances of which the core material changes in magnetic characteristics when the magnetizing force exceeds a certain limit. Other apparatus requiring current to be limited to a very small value includes thermo-couples, oscillograph vibrators and certain parts of thermionic amplifiers, such as transformers.

A further object of this invention is to provide a fusible circuit breaker whose maximum current can be predetermined accurately and adjusted conveniently to any desired value. The exact value of current necessary to melt the usual type of fuse cannot be ascertained without destroying the latter, for the reason that the resistivity and melting point of the constituents of each fuse differs.

The above stated difficulties are avoided by the use of means in accordance with this invention because the current that melts the fuse is from a shunt circuit rather than the principal circuit, the action taking place immediately upon connecting the fuse to the shunt circuit.

In accordance with the above stated and other objects, the invention comprises a fine wire, string or conducting filament suspended in a magnetic field and adapted to permit the passage therethrough of a current of predetermined value. The wire is so positioned that the operation of the circuit breaker is dependent upon the amplitude of deflection of the wire due to the magnetic field set up by the current. The value of the current necessary to effect the desired deflection may be predetermined without burning out the wire.

A feature of this invention consists of the means for adjusting the tension of the wire or string. The terminals of the string are secured by means of a pair of clips or clamps, while the active or vibrating portion extends from a fret near one end of the string to a leaf spring adjacent to the other.

Other objects and features of this invention will appear more clearly from the following description taken in connection with the accompanying drawings and appended claims.

Referring to the drawings, Fig. 1 shows an electromagnetic device in accordance with this invention.

Fig. 2 is a schematic diagram of a circuit breaker in which the apparatus shown in Fig. 1 is embodied, and

Fig. 3 is a modified form of the circuit shown in Fig. 2.

As shown in Fig. 1, the apparatus comprises a base 10 on which is mounted an upright 11 consisting of hard rubber or other suitable insulating material. The upright 11 is provided with a peripherally extending recess 12. Supported within this recess are a permanent steel magnet 13 of the horseshoe type and a V-shaped iron bar 14 extending between the pole pieces of magnet 13. The central portion and one leg of bar 14 are held by magnetic attraction firmly against the block 11 and one pole of magnet 13, respectively. The other leg is shortened so as to leave a gap 15 between the bar and the other pole of magnet 13. A pair of studs 16 extend through the central portion of the bar and cooperate with recesses (not shown) in the hard rubber block 11 to insure proper alignment of the bar and magnet.

A string 17 which may be a fine aluminum wire such as used for oscillograph work is arranged within the magnetic gap 15 and is supported in a vertical position. The supporting means for the string comprises a pair of angle brackets 18 and 19. The bracket 18 supports a spring clip 20 and a rigid

fret 21 by means of which the lower end of the string 17 is secured. At its upper end the string 17 passes over and extends lengthwise of a spring 22 mounted upon bracket 19. The spring 22 may consist of any suitable resilient material. At its extreme upper end the string 17 is secured by means of a clip 23.

The brackets 18 and 19 are provided with terminals 24 connected to the ends of the string 17, by means of which terminals a current may flow through the string. This current sets up a magnetic field which acts upon the field of the magnet 13 to cause the string 17 to be deflected in a direction perpendicular to the lines of force in the air-gap 15. The extent of deflection is dependent upon the current in the string and also upon the tension of the string. The tension may be adjusted by means of the spring 22 before securing the ends of the string. Suitable indicia 25 may be provided upon the block 11 adjacent to the spring 22 for affording a suitable indication of the tension of string 17.

A contact member 26 is disposed adjacent the string so that upon deflection of the string the latter may engage the contact member. The member 26 consists of a spring member of material suitable for electrical contact and is mounted upon an angle bracket 27 attached to the block 11. The upper end of the member 26 is bent and extends in a horizontal direction to the string 17 and terminates in a V-shaped fork, the tines of which are disposed upon opposite sides of the spring. If the device of Fig. 1 is used as a circuit breaker, the inner edges of the fork should preferably be knife-edged. The member 26 is arranged to be moved in a vertical plane, for the purpose of adjusting the spacing between the tines and the string, this movement being controlled manually by a set screw 28 acting against the resiliency of member 26. The contact member is provided with a terminal lug 29.

In Fig. 2 there is shown in schematic form, a circuit breaker comprising the device of Fig. 1, together with an arrangement for automatically breaking the string when it engages the contact 26. During the operation of the circuit breaker as a fuse, a battery 30 is connected by means of a key 31 between the contact member 26 and the lower terminal 24 of the string. It will be seen that the current flowing through the string 17 will be unaffected by the battery 30 as long as the current is insufficient to cause the string 17 to engage one of the sides of contact member 26. When the contact is engaged, however, the full terminal voltage of battery 30 is impressed across that portion of the string 17 which lies between the points 26 and 24. The current from the battery 30 heats the string 17 at the contact 26, thereby weakening the string at this point. The spring 22 then breaks the string at the contact 26 and withdraws it from the contact.

During the time that the contact 26 is in engagement with the string 17, the current from the battery 30 does not appreciably increase the voltage across the terminals 24. This is attributed to the fact that the voltage drop in the battery circuit is consumed almost entirely at the point of contact 26, the resistance of the string being low compared with the contact resistance at the knife edge.

It is possible to predetermine without first breaking the string 17 the exact amount of current necessary to break the same. To accomplish this, the key 31 may be thrown to its test position, thereby connecting battery 30 through an indicator such as a telephone receiver 33 to the upper terminal 24. When the key 31 is in this position a current may flow through the string 17 without danger of breaking the same. This current may be varied and indicated in the usual manner. When the current reaches the value necessary to cause engagement between the string and contact member 26, the circuit is closed through the telephone receiver 33, which indicates the closing of the circuit by means of an audible click.

The value of current necessary to break the string 17 may be regulated in either one of two ways. By means of the set screw 28 the relative positions of the string 17 and contact 26 may be adjusted. This adjustment varies the allowable free motion of the string and consequently the value of current in the string 17 necessary to cause engagement with the contact. Another means by which the maximum current value can be regulated is the spring 22. The amount of tension of the spring determines the extent of deflection of the string for any given current.

When a string is broken, it is usually desired to replace it with another string which will be broken at substantially the same current value. It is possible to accomplish this result without again using the telephone receiver 33. To replace a string, first the bar 14 is removed. The new string is attached at one end by means of the clip 23, is passed over the spring end 22 and through the contact member 26 without disturbing the position of the latter. At the lower end the string is pulled lengthwise of the fret 21 until the deflection of the spring is the same as indicated when the previous string was in place. The lower end of the string is then secured by means of the clip 20, the bar 14 is replaced, and the aparatus is again ready for operation. It should be noted that the current necessary to break the second string will be almost exactly the same as the current that broke the first string, irrespective of differences in resistance and other properties of the two strings. The only variable factors affect-

ing the breaking point are the tension of the string and the position of contact 26.

In Fig. 3 is shown a modification of the source of electromotive force as employed in the arrangement of Fig. 2. In the modified form the battery 30 is replaced by a condenser 35. A battery 36 in series with a resistance 37 may be connected at desired intervals across the plates of the condenser. In this arrangement the charging battery may be connected continuously but need be applied only occasionally, possibly daily or weekly, except in case the circuit breaker is operated.

In the arrangements of both Fig. 2 and Fig. 3 the circuit breaker will operate under either direct or alternating current. The circuit breaker however is somewhat less reliable where the frequency of the current is such as to cause the string to resonate or where the frequency exceeds the resonant frequency of the string. Under these conditions the response of the string to the current is non-linear and a corresponding irregularity in the breaking current will obtain.

While the electromagnetic device of Fig. 1 has been described as a part of a circuit breaking arrangement it is to be understood that the former is not limited in its application to circuit breakers, but may be used generally where it is desired to close one circuit in response to a very feeble current in another.

What is claimed is:

1. An electromagnetic device comprising a conducting string forming part of a circuit, said string being suspended within a magnetic field and free to move in response to the current in the string, a second circuit adapted to be closed in response to the current in the string, said second circuit comprising a contact member adjacent to the string and adapted to contact therewith upon sufficient deflection of the string.

2. An electromagnetic device as defined in claim 1, in which the string is under tension, and which comprises means for adjusting said tension whereby to regulate the current necessary to close the second circuit.

3. An electromagnetic device as defined in claim 1 which comprises means for adjusting the position of the contact member relatively to the string, whereby the value of current in the string necessary to close the second circuit may be regulated.

4. In a circuit breaking device, a fusible conducting wire mounted in a portion of space, means for setting up in said space a magnetic field, and means for automatically breaking said wire when the current therein exceeds a predetermined value, said means comprising a source of electromotive force, and means actuated by the current in said wire for connecting said source across said wire or a portion thereof.

5. A circuit breaking device comprising a conducting string suspended at both ends in a magnetic field and means for automatically breaking the string when the current therein exceeds a predetermined value, said means comprising a source of electromotive force having one terminal connected to one end of the string and another terminal adapted to contact automatically with an intermediate point on the string in response to a current through the string of predetermined value, and resilient means tending to withdraw the other end of the string from the source of electromotive force.

6. In a circuit breaking device, a fusible conducting wire suspended at both ends within a magnetic field and free to move in response to the current in the wire, means for breaking the wire when the current therein exceeds a predetermined value, said means comprising a source of electromotive force having one terminal connected to one end of the wire and another terminal connected to a contact member adjacent to an intermediate point on the wire, whereby sufficient deflection of the wire is effective to cause said intermediate point on the wire to engage the contact member.

7. A circuit breaking device as defined in claim 6 in which the wire is under tension, and which comprises means for adjusting the tension of the wire whereby to regulate the value of current necessary to break the wire.

8. A circuit breaking device as defined in claim 6 which comprises means for adjusting the position of the contact member, whereby the value of current necessary to break the wire may be regulated.

In witness whereof, I hereunto subscribe my name this 10th day of April, 1930.

EVERETT T. BURTON.