Nov. 17, 1936. F. J. McHUGH 2,060,819

FUSE PLUG

Filed Nov. 9, 1933

FIG. 1.

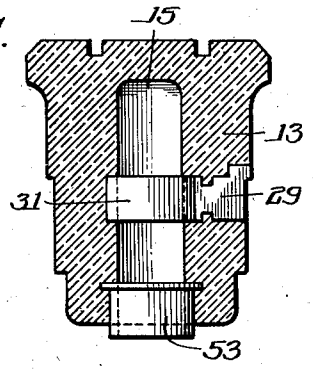


FIG. 2.



FIG. 4.

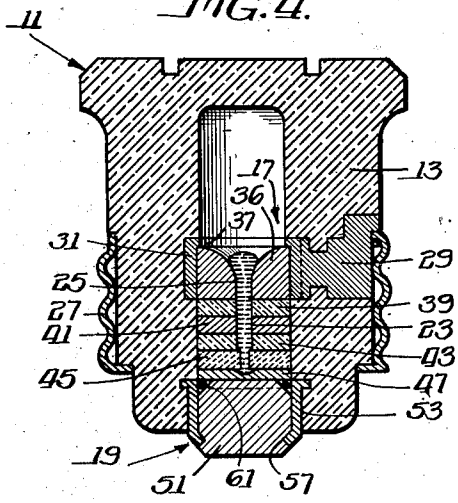


FIG. 5.

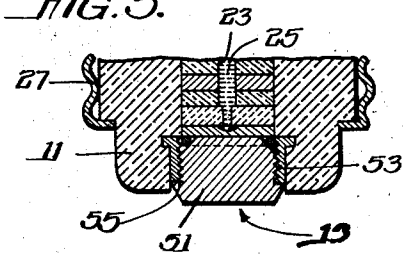
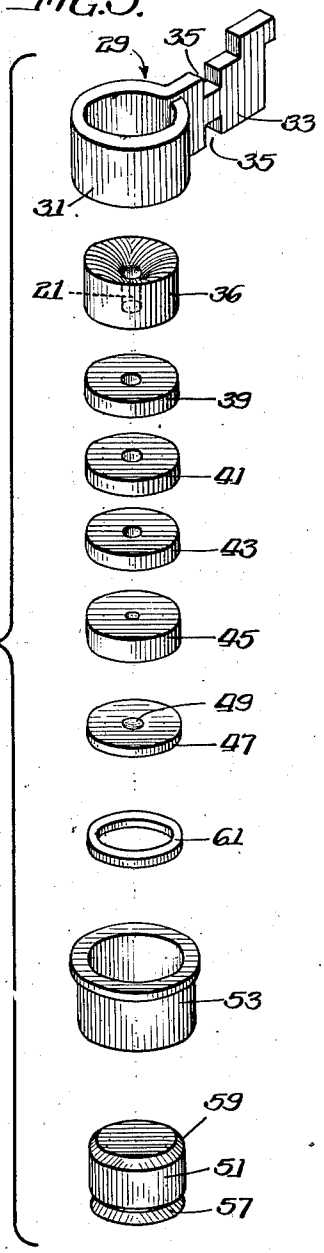


FIG. 3.



Inventor:
Frank J. McHugh
By:- Cox & Moore
attys.

Patented Nov. 17, 1936 2,060,819

UNITED STATES PATENT OFFICE

2,060,819

FUSE PLUG

Frank J. McHugh, Chicago, Ill., assignor to The Shake-Back Corporation, Chicago, Ill., a corporation of Illinois

Application November 8, 1933, Serial No. 697,262

10 Claims. (Cl. 200—113)

My invention relates in general to protective devices for electrical circuits and has more particular reference to safety breakers or cut-out devices for interrupting a circuit when the same becomes overloaded, the invention comprising improvements in and a continuation of the invention disclosed in my co-pending application, Serial Number 678,404, filed June 30, 1933, for Fuse plug.

An important object of the invention is to provide a breaker of the type having a liquid current-carrying medium which, when overload conditions prevail, is adapted for expulsion from normal current-carrying position to thereby rupture and open the protected circuit and the invention further contemplates provision for the return of the current-carrying medium to current-carrying position after expulsion in order to render the device again effective for further use in protecting the circuit.

Another important object is to provide a cut-out device of the character described having a liquid current-carrying medium normally arranged in a restricted channel when in circuit-making position and from which channel the medium may be expelled in order to interrupt the circuit when the same becomes overloaded, the device being arranged to confine arcing upon interruption of the circuit in said restricted channel.

A further object is to provide a permanent conductor of fusible material in series relation with the liquid medium when in current-carrying position, said fusible material being adapted to be melted to thus interrupt the circuit upon overload in the protected circuit in the event that the liquid medium, for any reason, fails to be expelled from circuit-making position.

Another important object is to provide a circuit-protecting breaker, in which a conductor medium is normally positioned in a channel or duct from which the medium is expelled in breaking the protected circuit and to provide means to prevent enlargement of the duct or channel and consequent increase in the maximum current-carrying capacity of the conductor medium without expulsion as a result of arcing in the channel upon interruption of the protected circuit.

A further object is to form the arcing channel or duct by stacking perforated plates in alignment.

Another important object is to form the arcing duct or channel of arc-resisting material.

Another important object is to form the arc-resisting duct or channel of stacked disks of fibre, lava, asbestos, or similar heat and arc-resisting materials having aligned perforations forming the arcing channel, and a further object resides in forming at least one of the disks of metal, as, for instance, steel, whereby to assist in retaining the liquid-current-carrying medium in circuit-making position in the channel or duct.

Another object is to utilize mercury as the liquid-current-carrying medium and a further object is to form at least a part of the walls of the channel or duct, in which the mercury extends when in circuit-making position, as a zone of material attractive to mercury whereby to utilize surface tension and the adhesive effect between the mercury and the material forming the channel zone to assist in retaining the mercury in circuit-making position in the channel or duct.

Another important object resides in the simplified construction of the cut-out device, the same being inexpensive and easily manufactured.

Another important object resides in the facility with which the several parts of the device may be manufactured and assembled to form a commercially saleable fuse.

A further object is to provide an electrical circuit breaker or fuse, which may be used repeatedly and substantially indefinitely to interrupt overloaded circuits.

Another important object is to provide an electrical circuit breaker or fuse comprising a sealed channel having an enlarged portion forming an expansion chamber and a duct or relatively restricted channel of substantially capillary character opening into the expansion chamber through a perforated terminal member, the remote end of said duct or restricted channel having a second terminal member in spaced relationship and insulated from the perforated terminal member and the duct or channel containing a quantity of liquid current-carrying medium, preferably mercury, sufficient to fill the restricted channel and to form an electrical connection between said spaced terminal members whereby, when the circuit is subjected to normal conditions, current may travel through the liquid column between said spaced terminals and when abnormal conditions prevail in the circuit, said mercury will become heated and be expelled from the restricted duct or channel, through the perforated terminal member, into the expansion chamber, thus interrupting the circuit between the terminal members.

Numerous other objects and advantages will be

apparent from the following description, which, taken in connection with the accompanying drawing, discloses preferred embodiments of the invention.

Referring to the drawing:

Figure 1 is a sectional view taken through a housing forming a part of a device embodying my present invention;

Figure 2 is a sectional view through a shell adapted for assembly on the housing shown in Figure 1 in building a device embodying the present invention;

Figure 3 comprises perspective views of elements adapted for assembly within the housing shown in Figure 1 in forming a device embodying the present invention, the parts shown in Figure 3 being illustrated in the relative positions occupied thereby in the complete assembly;

Figure 4 is a sectional view taken through a device embodying the invention, showing the several parts in assembled position; and

Figure 5 is a sectional view illustrating a modified construction.

To illustrate my invention, I have shown on the drawing a circuit protector of the character commonly termed a blow-out fuse, and although my invention is not necessarily restricted to any particular fuse type, I have shown a plug form particularly well adapted for use in receptacle sockets, such as are commonly used in commercial power circuits. The invention, however, may be embodied in other fuse forms, as, for instance, the so-called "cartridge type" fuse and may also be incorporated in outlet plugs in the manner taught in my aforesaid copending application.

The present invention involves the utilization of a restricted, substantially capillary, channel or duct, in which a quantity of a suitable liquid, current-carrying medium, such as mercury, may be normally arranged to provide a liquid current-carrying column extending between spaced terminals exposed in said channel or duct to thereby form an operative current-carrying path between the terminals. Means is also provided for connecting the spaced terminals in an external circuit to be protected by the device against overload conditions. When the circuit becomes overloaded, the liquid-carrying medium becomes heated because its maximum current-carrying capacity is exceeded and the liquid is expelled from the substantially capillary duct or passage into an expansion chamber provided for the purpose. The protected surface is thus interrupted intermediate the spaced terminals and any arcing, which may occur upon the interruption of the circuit, is confined in the channel between the terminals exposed therein. By properly manipulating the device, as by shaking it, after the liquid current-carrying medium has been thus expelled into the expansion chamber, the liquid may be caused to return into the capillary channel between the spaced electrodes in order to recondition the fuse for further use as a circuit-protecting device.

It will be obvious to those skilled in the electrical art that the size of the liquid column in the restricted duct or channel, between the electrodes, determines the maximum amount of current which may pass through the liquid column without causing the same to become overheated and thus be expelled into the expansion chamber; that is to say, the size of the restricted channel determines the maximum current flowing between the electrodes, which, if exceeded, causes the liquid to be ejected and the circuit broken. I have observed in connection with the devices illustrated in my aforesaid co-pending application, that the arcing, which occurs in the restricted channel when the circuit is interrupted, gradually enlarges the channel. Such enlargement increases the amount of current which can be carried by the liquid column without causing its expulsion and consequent rupture of the circuit. In order to minimize enlargement of the restricted channel and consequent gradual increase in the current-carrying capacity of the device during its useful life, I now propose to form said channel of suitable materials, which will resist arcing in order that enlargement of the arcing channel may be substantially prevented and the fuse have substantially constant capacity throughout its effective life, which is highly desirable in electrical circuit breakers.

The embodiment shown in the drawing to illustrate my invention comprises a circuit breaker 11, comprising a housing 13 of any suitable insulating material and preferably a moldable composition, such as the reactive product of phenol and formaldehyde with or without the addition of suitable fillers. Other molding compositions or other suitable materials, such as porcelain, may be utilized in forming the housing 13. The housing is formed with a preferably central bore or channel forming a chamber 15 open at one end of the housing and closed in any suitable fashion at the opposite end of the housing. The housing also is preferably cylindrical, the chamber 15 being formed axially therein. Within the chamber 15, means is assembled to provide a pair of spaced terminals 17 and 19 and a relatively restricted arcing channel communicating with both terminals and opening through one into an unrestricted portion of the chamber 15, which forms an expansion space or chamber preferably in the closed end of the chamber 15. The terminal 17 is preferably located substantially midway between the ends of the chamber 15 and the terminal 19 is positioned in the open end of the chamber and forms a chamber seal. The terminal 17 also is formed with a central perforation 21 therethrough, said perforation preferably having a bell-shaped or widened mouth opening toward the expansion space in the closed end of the chamber 15. The means forming the duct or restricted channel is arranged in the chamber 15 between the terminals 17 and 19 and comprises arc-resisting material positioned in the chamber 15 and having the channel 23 formed therein, said channel 23 communicating at one end with the perforation 21 of the terminal 17 and at the other end with the terminal 19. The chamber 15 also contains a quantity 25 of suitable liquid current-carrying material, such as mercury, sufficient to fill the restricted channel 23 and form a column contacting the surface of the terminal 19, which is exposed at one end of the restricted channel 23 and extending through the opening 21 of the terminal 17, whereby to complete a rupturable electrical circuit between said terminals through the restricted channel 23. The housing 13 also carries means whereby the terminals 17 and 19 may be connected in an external electrical circuit to be protected.

In the illustrated embodiment, the terminal 19 is electrically connected with means forming a contact stud 51 exposed at one end of the housing in position to directly contact the central terminal of a standard fuse receptacle. The housing 13 also carries a contact shell 27 pro-

vided with screw threads for engaging the other contact of a standard fuse receptacle and connector means 29 carried by the housing is provided for electrically connecting the terminal shell 27 with the internal terminal 17. Obviously any suitable expedient may be employed for electrically connecting the terminals 17 and 19 in an external circuit.

One of the important features of my present invention resides in the simplicity of construction facilitating assembly whereby the circuit breaker or fuse of my present invention may be easily and cheaply manufactured. To this end, the connecting member 29, as shown in Figure 3 of the drawing, is preferably formed as a strip of suitable electrical conducting material, such as copper, having a portion curled to form a ring-like terminal seat 31 and a tail 33 extending radially outwardly of the ring-like portion.

The ring-like portion 31 preferably has an internal diameter equal to the diameter of the chamber 15 as originally molded in the housing 13 and the connector 29 is preferably molded in the shell with the inner surface of the ring-like portion 31 lying flush with the inner walls of the chamber 15, the tail 33 extending radially through the walls of the housing with its end exposed on the outer surfaces of the housing 13 so that the shell 27, after being assembled on the housing, may be soldered or otherwise electrically connected to the exposed end of the tail. The tail also is preferably provided with notches 35 in its opposed edges to assist in firmly anchoring the member 29 in the walls of the molded housing. The terminal 17 is preferably formed as a disk 36, the outer diameter of which is slightly greater than the bore of the chamber 15 and the bore is enlarged as by reaming from its lower end to permit the terminal 17 to be inserted and pressed snugly into place within the ring-like portion 31 to make a good electrical connection therewith. It is desirable to introduce the current-carrying fluid 25 into the channel after the same has been reamed but before the disk 36 is inserted. It is not, however, necessary to form the terminal 17 and connector 29 as separate pieces. They may be combined and formed as an integral element if desired, but I prefer to form the parts as shown for the sake of convenience in manufacture and assembly.

In reaming out the chamber 15, I also ream the inner surfaces of the ring-like portion 31 to provide smooth finished surfaces to contact the sides of the terminal 17 and to provide a flange 37 upon which the terminal may bear in an axial direction and by which the terminal may be held in place. Between the terminal 17 and the terminal 19 closing the open end of the bore 15, I arrange means forming a channel lining of arc-resisting means, such as horn fibre, lava, porcelain, asbestos, and the like, arranged in the form of disks having central perforations to facilitate manufacture and assembly, and to increase the mechanical strength of the liner. The disks, forming the arc-resistant channel lining are of uniform diameter and have central perforations which, when the disks are assembled in the chamber, are in alignment and form the restricted arc-resisting channel 23.

I prefer to utilize a fibre disk 39 immediately adjacent the terminal 17, a disk 41 of material attractive to the liquid 25 next to the fibre disk and a second fibre disk 43 next to the disk 41. Where mercury is employed, the disk 41 may be of steel. Next to the second fibre disk 43, I prefer to employ a disk 45 of somewhat greater width with a slightly smaller central perforation, and to make the disk of highly arc-resisting material. By restricting the channel 23 at the central perforation of the disk 45, the arc may be made to start at this point and the disk is made of highly arc resistant material where the most destructive effect is encountered.

The terminal 19 may be of any suitable or convenient form and is anchored firmly in the open end of the channel 15 after the terminal 17 and disks 39, 41, 43, and 45 have been assembled, the disks being snugly compressed by and between the terminals 17 and 19 and the edges of the terminal disk 36 being pressed snugly against the flange 37 of the ringlike holder 31. I prefer, however, to form the terminal 19 as a preferably copper disk 47 of a size adapted to fit into the reamed channel next to the disk 45 in position to close the end of the channel 23, the disk 47 being preferably formed with a central depression or socket 49 in position to extend across the end of the channel 23 to afford increased electrical contact with the fluid 25 when the same is in the channel.

A contact stud 51 is secured in the end of the channel to hold the various disks in place and the stud extends outwardly of the open end of the channel to provide an electrical connection between the disk 47 and the contact of a receptacle in which the device may be mounted to connect the device in an external circuit. The plug may be fastened in the end of the channel in any convenient manner, although I prefer to anchor the plug in place by fastening it either by threading, as shown in Figure 5, or preferably by crimping it, as shown in Figure 4, in a holding collar which is preferably mounted in the housing as by being molded therein at the open end of the channel, the stud and collar for this purpose being provided either with interfitting screw threads 55 as shown in Figure 5, or the stud having an annular groove 57 adapted to crimpingly receive the edge of the collar 53 as shown in Figure 4.

The face of the stud 51, which faces inwardly of the channel, also is preferably beveled as at 59 to accommodate a sealing washer 61, preferably of soft material, such as lead, whereby to seal the space between the stud and its encircling sleeve 53 and prevent the escape of mercury or mercury vapor from the chamber 15 during the operating life of the device.

It will be noted that the space in the chamber on the side of the terminal 17 opposite from the restricted arc-resisting channel 23, affords an enlarged expansion space into which the mercury 25 may pass through the central perforation 21 of the terminal 17 from the restricted duct or channel in order to interrupt the circuit between the terminals 17 and 19 when overload conditions prevail; that is to say, when a current in excess of the maximum current-carrying capacity of the mercury column in the duct or channel 23 is flowing between the terminals 17 and 19. After the mercury has been so expelled, the small size of the channel will normally prevent the column from re-entering the channel 23 to re-establish the circuit. The mercury may, however, be returned to circuit-making position by simply shaking the device to shake the mercury down into the duct or channel 23 after which the surface tension of the mercury on the terminal 17 and its adhesion on the steel washer 41 will cause it to remain in place until again

expelled into the expansion space as a result of excessive current in the mercury column.

The connector, if desired, may be made of fusible material, such as lead, and the notches 35 may be arranged in the tail 33 in such a way as to constitute the tail a fuse link in series with the mercury column in the channel 23. The fuse link may be formed to carry, without fusing, slightly more current than that at which the mercury column should be expelled from the channel 23 so as to give protection in the event that, for some reason, such as eventual enlargement of the bore of the duct or channel 23, the mercury column is not expelled when rated overload conditions prevail. Even where arc-resisting materials are employed, the channel 23 may eventually become enlarged to such an extent that the current-carrying capacity of the enlarged mercury column becomes greater than the maximum rating of the device. Under such circumstances, the connector 29 itself is adapted to melt away and permanently disable the device.

It is thought that the invention and numerous of its attendant advantages will be understood from the foregoing description and it is obvious that numerous changes may be made in the form, construction, and arrangement of the several parts without departing from the spirit or scope of my invention or sacrificing any of its attendant advantages; the forms herein described being preferred embodiments for the purpose of illustrating my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows:

1. A circuit breaker of the character described, comprising a housing, a pair of spaced electrodes on said housing, means comprising a plurality of plates having perforations stacked between said electrodes with the perforations in alignment whereby to provide a duct communicating with both electrodes, and a quantity of mercury sufficient to fill said duct between said electrodes, at least one of said electrodes having a perforation through which the mercury may escape from the duct to a remote part of the housing and may be returned through the perforated electrode into the duct.

2. A circuit breaker of the character described comprising a pair of spaced electrodes and an insulating body having a channel in which said electrodes are mounted, one electrode being embedded in the body at a point intermediate the ends of the channel and the other electrode serving to close an open end of the channel, said channel forming an expansion space adjacent one of said electrodes, a stack of disc-like elements having perforations and disposed in said channel between said electrodes with the perforations of the several discs in alignment and defining a duct communicating with said electrodes and opening into said expansion space and a liquid-current-carrying medium adapted to enter said duct and form a current-carrying circuit between said electrodes and, when excessive current conditions prevail in said path, to be expelled from said duct into said expansion space in order to interrupt the current-carrying circuit between said electrodes, said duct and expansion space being arranged so that the mercury may be returned from the duct into the channel in order to reset the breaker.

3. A circuit breaker of the character described comprising a pair of spaced electrodes and an insulating body having a channel in which said electrodes are mounted, a connector embedded in said body and having a portion extending to and exposed on the sides of the body and a portion forming an annular seat exposed in the channel substantially mid-way between its ends, said channel forming an expansion chamber on one side of said seat and having an end opening at an end of the body on the other side of the seat, a central electrode comprising a disk having a central perforation mounted in said seat, said perforation widening toward said expansion chamber, means forming a second electrode fitted into and closing said open end of the channel and forming a contact exposed at the end of the body, means comprising a plurality of disks having central openings snugly fitted into the channel between said central and second electrodes and held in position thereby with said openings in alignment with the perforation of the central electrodes to define a duct communicating with said electrodes and opening into said expansion space and a liquid current-carrying medium adapted to enter said duct and form a current-carrying circuit between said electrodes, and, when excessive current conditions prevail in said path, to be expelled from said duct into said expansion space in order to interrupt the current-carrying circuit between said electrodes.

4. A circuit breaker of the class described, comprising a body formed with a socket having a closed and an open end and an intermediate electrode seat facing the open end, a quantity of current-carrying fluid in the socket, a perforated electrode on said seat, and perforated spacing washers in stacked relationship in said open end adjacent the electrode with the perforations of the electrode and washers in alignment forming a duct communicating with the bottom of the socket and another electrode sealed in the open end of said socket to hold the parts in place.

5. A circuit breaker of the class described comprising a moulded element forming a housing having a channel formed with an opening at one end and a seat facing said opening intermediate the ends of the channel, a perforated electrode in the seat, perforated spacing washers in the channel between the electrode and the opening, said electrode and washers being supported with their perforations in alignment to form a duct between the open end and the channel portion extending on the side of the electrode opposite from the open end, another electrode sealed in the open end of the channel in position to close the end of the duct, and a quantity of current carrying fluid in said housing sufficient to fill the duct between the electrodes.

6. A circuit breaker of the character described comprising a housing having a channel, a pair of spaced electrodes in said channel, a plurality of plates having perforations and stacked in said channel between said electrodes with said perforations in alignment to form a duct communicating with both electrodes, said channel forming an expansion space adjacent one of said electrodes, a liquid current-carrying medium in sufficient quantity to fill said duct and form an electrical connection between said electrodes, said duct communicating with said expansion space whereby the current carrying medium may be expelled from said duct to interrupt electrical connection between said electrodes and may then be returned to current carrying position in said duct.

7. A circuit breaker, as set forth in claim 6, wherein at least one of said plates between the

electrodes comprises metallic material to which the liquid current carrying medium tends to adhere whereby to assist in retaining the medium in said duct under normal conditions.

8. A circuit breaker as set forth in claim 6, wherein the perforations of at least one of said plates is of smaller dimension than the perforations in the other plates, said plate comprising highly arc-resistant material.

9. A circuit breaker as set forth in claim 6, wherein one of said electrodes comprises a central electrode mounted in a seat formed intermediate the ends of said channel and facing an end thereof, the other electrode comprising an end electrode secured in the said end of the channel and the plates and central electrode being held in the channel in compression by and between the end electrode and the seat.

10. A circuit breaker as set forth in claim 6, wherein an annular element of conducting material is embedded in said housing in position exposed in the channel and forming a seat intermediate the ends of said channel and facing an end thereof, one of said electrodes comprising a perforated disc of conducting material and mounted in the seat formed by said annular element with the perforation of said disc in alignment with the perforations of said plates, the other electrode comprising an end electrode secured in the said end of the channel and the plates and central electrode being held in the channel in compression by and between the end electrode and the seat.

FRANK J. McHUGH.