May 18, 1948. R. H. EARLE 2,441,692

FUSE

Filed June 5, 1944 4 Sheets-Sheet 1

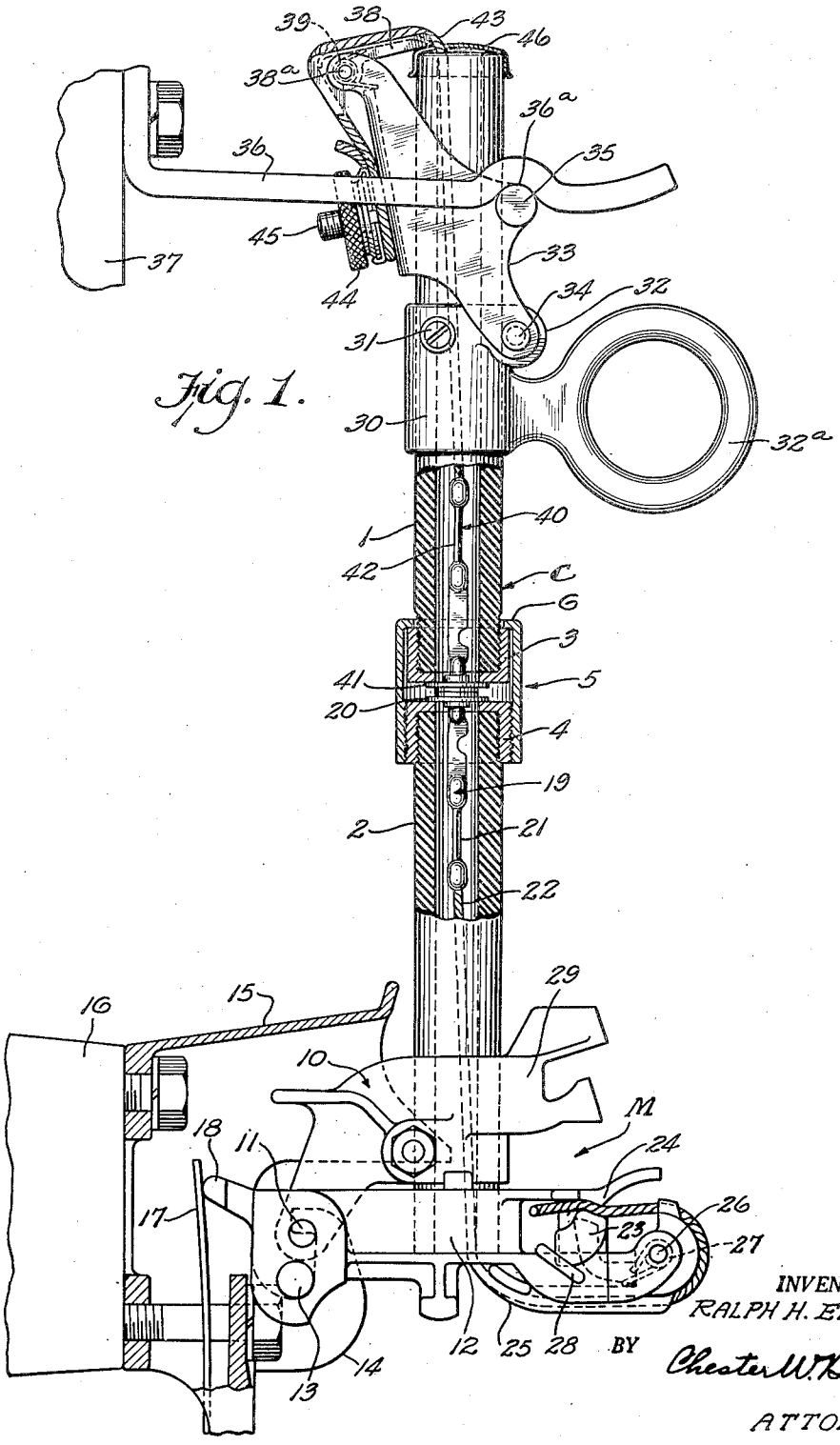

Fig. 1.

INVENTOR.
RALPH H. EARLE
BY Chester W. Brown
ATTORNEY.

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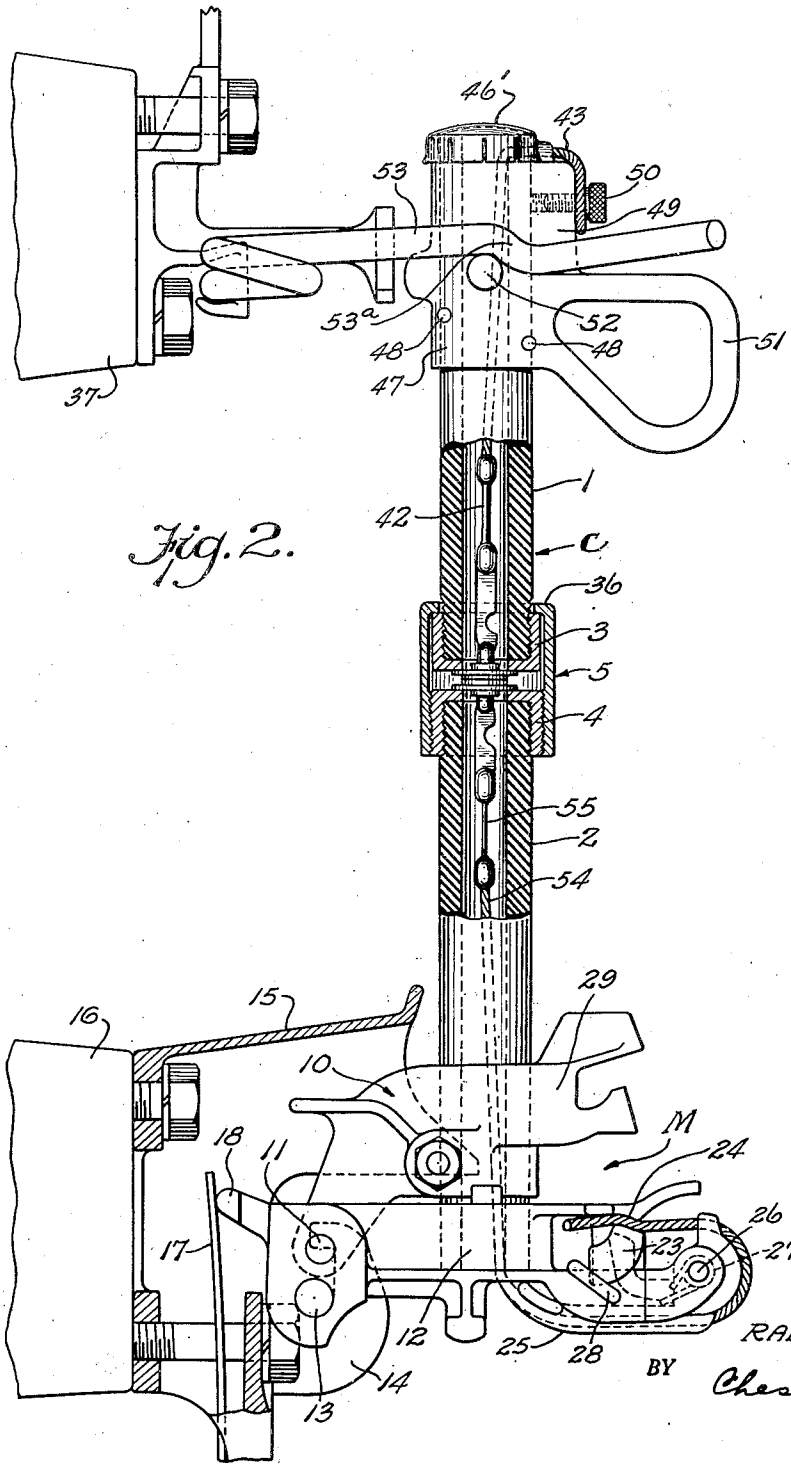

Fig. 2.

INVENTOR.
RALPH H. EARLE
BY Chester W. Brown
ATTORNEY.

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Fig. 3.

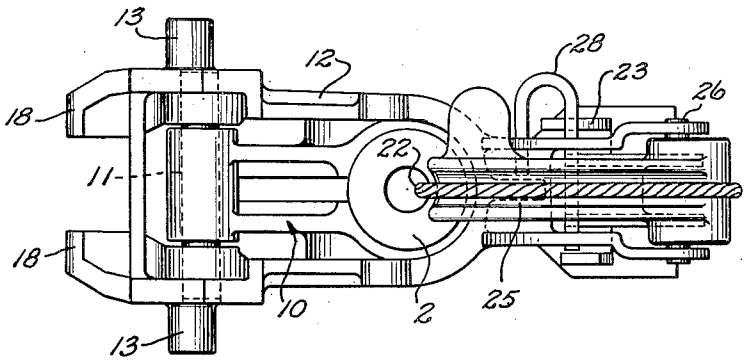
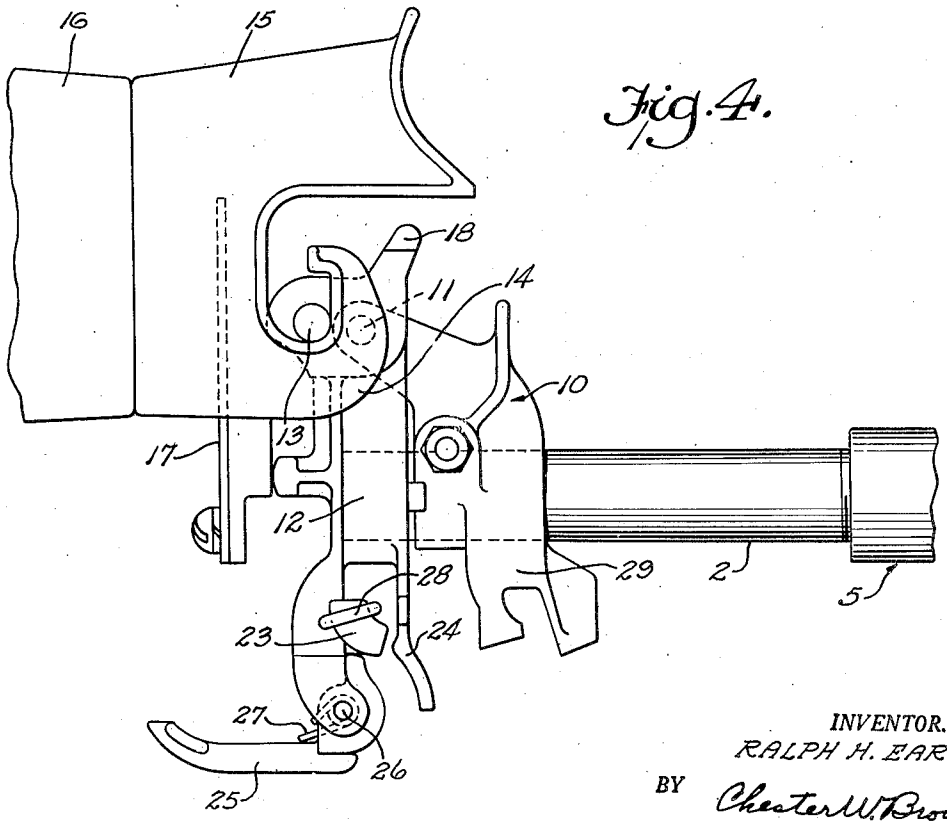


Fig. 4.



INVENTOR.
RALPH H. EARLE
BY Chester W. Brown
ATTORNEY.

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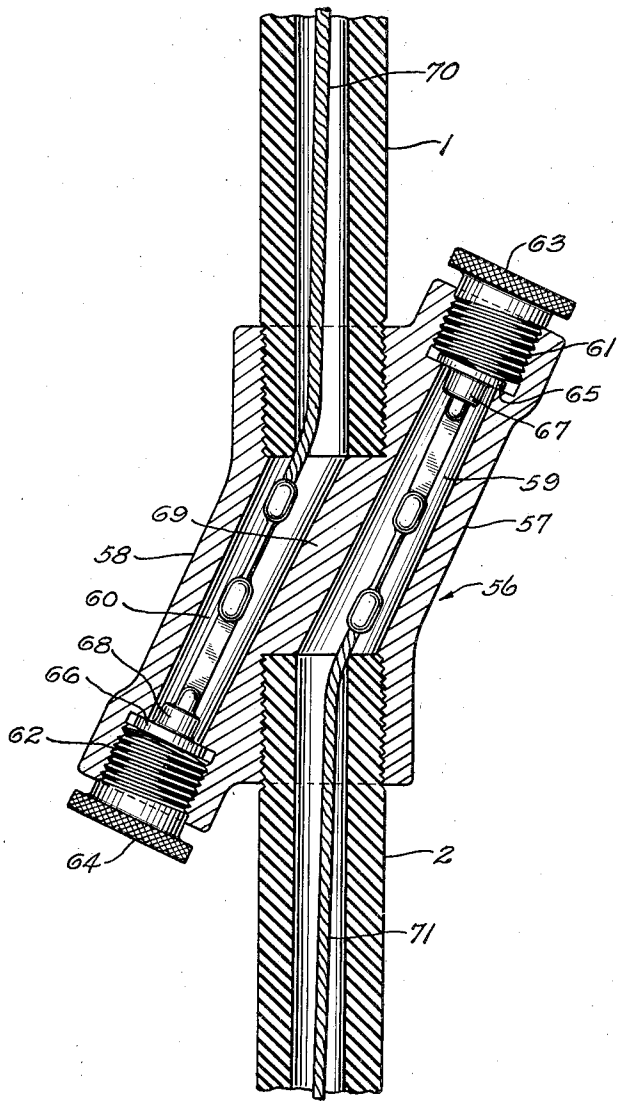
Fig. 5.



INVENTOR.
RALPH H. EARLE
BY Chester M. Brown
ATTORNEY.

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UNITED STATES PATENT OFFICE

2,441,692

FUSE

Ralph H. Earle, Wauwatosa, Wis., assignor to Line Material Company, Milwaukee, Wis., a corporation of Delaware

Application June 5, 1944, Serial No. 538,769

10 Claims. (Cl. 200—114)

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The invention herein disclosed relates to improvements in a fuse for an electric circuit.

Electric power distribution systems are occasionally subject to abnormal "fault currents" which, if continued, will cause damage to apparatus in the system. Therefore, so-called expulsion fuses and power fuses are placed at advantageous positions in the systems for interrupting the flow of current when such "fault currents" occur and thus protect the apparatus against damage.

"Fault currents" may range from a slight flow of current in excess of the rated normal current of a distribution circuit to an abnormal value produced by a so-called "dead short circuit," depending upon the impedance of the circuit through which the "fault current" flows.

The average distribution system is protected by fuses of conventional designs adapted to satisfactorily operate over the range of "fault currents" normally encountered and adapted also to be reconditioned for successive operations by merely replacing an inexpensive fuse link therein. As the power output of a distribution system is increased, it is found that the values of the "fault currents" increase. Ultimately the power output may reach a point where the possible "fault currents" are too high to be handled safely or satisfactorily by a conventional fuse. Under such conditions fuses known as "power fuses" are used. These "power fuses" are designed for an extra high rupturing capacity, are more expensive than the conventional fuses, and are not generally suitable for more than one operation, whether or not the "fault current" interrupted thereby is of a relatively low value as compared to one of an excessively high value.

The primary object of this invention is to provide fuses which may be reconditioned after each successive operation and which will safely and satisfactorily operate on "fault currents" of higher values than the conventional types of distribution fuses now in general use.

Another object is to provide a fuse, embodying the aforementioned characteristics, which is automatically movable from closed circuit to open circuit positions upon operation thereof.

More specifically, an object is to provide a fuse unit comprising two expulsion fuses of conventional design connected in series relation, each fuse when operating introducing a substantial resistance in the circuit and thus reducing the value of the "fault currents" below what it would normally be if a single fuse operated.

The fuse unit of this invention permits the use of a comparatively short tube in each fuse, thus freely venting the gases produced by the arc and preventing the creation of excessive pressures which might burst the tube.

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The fuse unit is further characterized by the fact that the arc produced in each fuse can be stretched to the full length of the cartridge. When the arcs are thus stretched on relatively low fault currents, a maximum surface of the fiber lining of the cartridges is exposed to the arcs which as a result are quickly extinguished. On the other hand, when the arcs are similarly elongated on high fault currents they offer a substantial resistance to the flow of current, thus limiting the value to which the fault current can rise and the pressures tending to burst the cartridges.

In the drawings which accompany this specification:

Fig. 1 is a view in side elevation, partly in vertical section, illustrating a fuse unit embodying the invention herein disclosed.

Fig. 2 is a view in side elevation, partly in vertical section, illustrating a modified form of my invention.

Fig. 3 is an enlarged bottom view of Figs. 1 and 2.

Fig. 4 is an enlarged fragmentary view in side elevation, showing the lower part of the fuse units herein described and the position assumed thereby after interruption of an electric circuit.

Fig. 5 is a sectional fragmentary view in side elevation illustrating a modified construction of an intermediate portion of the fuse unit herein described.

The fuse unit illustrated in Fig. 1 is of the dropout type wherein, upon rupture of the fusible elements, the fuse cartridge is released from the upper terminal contacts and swings about its lower pivot to an inoperative position. The fuse cartridge C comprises a pair of aligned tubes 1 and 2 having an inner surface from which arc extinguishing gases may be evolved in the presence of an arc. The tubes are each provided with a ferrule 3 and 4, respectively, having an aperture concentric with the bore of the tubes. A clamping sleeve 5 is rotatably mounted by means of the inwardly projecting flange 6 upon the upper ferrule 3 and is threadedly engaged with the outer periphery of the sleeve 4 to draw the ferrules into clamping engagement with the fuse link buttons, as will more specifically appear hereinafter.

The cartridge C is provided with a mounting M, comprising an arm 10 embracing the lower

end of the tube 2 and pivotally secured at 11 to the lever 12 which in turn is provided with trunnions 13 rotatably carried by the hook-like bearings 14 on the terminal housing 15. The housing 15 is mounted fixedly on a supporting insulator 16 suitably secured to a base (not shown). A spring contact terminal 17 is secured to the housing in a suitable manner (not shown) and bears against the contact finger 18 on the lever 12. All of this structure is specifically disclosed in the patent to William O. Schultz, No. 2,378,109, issued June 12, 1945, for Fuse construction.

The fuse link 19 within the tube 2 comprises a contact button 20 engaging the ferrule 4, a fusible section 21 and a flexible section 22 which extends outwardly at the lower end of the tube and is clamped to the lever 12 by mechanism specifically disclosed in the aforementioned William O. Schultz application. Briefly, this clamping mechanism, as may be seen in Fig. 3, comprises a movable clamping jaw 23 mounted on the lever 12 and co-operating with the gripping jaw 24 to normally bite the flexible section of the fuse link and hold it against withdrawal. A flipout lever 25 is pivoted at 26 on the lever 12 and is held against movement under the influence of the spring 27 by means of the flexible section of the fuse link. A temporary latching lever 28 is mounted on the lever 12 for holding the clamping jaw 23 inoperative while the assembly is being re-fused.

The arm 10 embracing the lower end of the tube 2 has a projecting portion 29 which is adapted to receive a switch stick for lifting the cartridge C into and out of the hook-like bearing 14 when the cartridge is in the position shown in Fig. 4.

The upper tube 1 of the cartridge C is provided with a latching arrangement comprising sleeve 30 secured thereto by any suitable means such as setscrew 31 and having a pivot lug 32 and pull ring 32*a* integral therewith; a channeled latching lever 33 pivoted at 34 on the lug 32 and having lugs 35 for engagement with the contact prongs 36 at the notched portion 36*a*, the prongs being mounted on the insulator 37 which is secured to a base (not shown); and a flipout lever 38 pivoted at 38*a* on the upper end of the latching lever 33 and urged upwardly about the pivot 38 by means of spring 39.

Disposed in the upper tube 1 of the cartridge C is a fuse link 40 similar to the fuse link 19 and comprising a contact button 41 clamped between the ferrule 3 and the button 20 on the fuse link 19, a fusible section 42 and a flexible section 43 which extends from the upper end of the tube 1 and over the flipout lever 38 to the clamping nut 44. The clamping nut 44 is threaded on the stud bolt 45 on the latching lever 33 and secures the flexible section thereto.

A spring cap 46 may be loosely fitted on the upper end of the tube 1 and is adapted to prevent water from entering the tube. This cap will be blown from the tube by gases evolved and expanded therein when the fuse link 40 is ruptured under overload conditions.

The operation of the unit shown in Fig. 1 is as follows:

When the unit is in circuit as illustrated, current will flow between the upper and lower terminals 36 and 17, respectively, through the latching lever 33, fuse links 40 and 19, and the supporting lever 12. Under normal conditions in the circuit, the upper fuse link 40 holds the latching lever 33 against rotation counterclockwise on its pivot 34

and the fuse link 19 holds the supporting lever 12 against rotation clockwise on its pivot 13, thereby retaining the unit in the circuit closing position shown.

In the event the fuse link 40 is ruptured by reason of abnormal conditions in the circuit, the fusible section 42 will be severed. The flipout 38 will then be permitted to move counterclockwise under the influence of the spring 39 to widen the gap created by the severance of the fusible section, and the latching lever 33 will be permitted to rotate counterclockwise under the pressure of the upper terminal prongs 36 and gravity to disengage the lugs 35 from the notched portion 36*a* on the prongs 36. It will be observed that as the latching lever 33 moves counterclockwise it pulls the flexible section 43 from the tube 1 to further widen the gap in the fuse link and that, as the lever 33 so moves, the upper end of the cartridge swings clockwise about the pivot 13 and ultimately away from the upper prongs 36.

In the event the fuse link 19 is ruptured under abnormal conditions, the fusible section 21 will be severed and the supporting lever 12 will be released for clockwise movement about the pivot 13. In so moving, the lever 12 will carry the pivot 11 downwardly and permit the cartridge C to withdraw the lugs 35 from the notches 36*a* on the prongs 36, and thereby permit the cartridge to swing in a clockwise direction about the pivots 11 and 13.

As the supporting lever 12 moves to release the cartridge, the flipout lever 25 will also move downwardly under the influence of the spring 27. Thus the flexible section 22 of the fuse link 19 will be drawn axially downwardly from the tube 2 by the combined action of the supporting lever 12 and flipout 25, thereby lengthening the gap in the severed portion of the fuse link.

From the foregoing it will be apparent that if either or both of the fuse links 19 and 40 are ruptured, the cartridge will be released for movement to open circuit position.

In Fig. 1, I have shown the tubes 1 and 2 of substantially the same internal diameter, but the lower tube 2 is slightly shorter than the upper tube 1. Assuming that the tubes are of the same material, such as fiber, and of the same bore and length, and that the fuse links 19 and 40 are of the substantially same calibration, then for all practical purposes the rupturing capacity of both portions of the cartridge may be considered as the same and will, in the event of the occurrence of abnormal conditions in a circuit to which the fuse links are responsive, operate simultaneously to interrupt the circuit by introducing a gap in each fuse link. This, in effect, introduces two gaps in series in the electric circuit and affords superior circuit interrupting operations over that attainable in a fuse unit embodying a single fuse link.

I am not prepared at this time to state positively why two fuses in series relation exhibit an improved operation over a single fuse. However, in general, the arc in each fuse appears to exhibit a current limiting effect on a fault current and when two or more such fuses are placed in series relation, each apparently co-operates with the other or others to limit the flow of current therethrough and thus reduces the rupturing load to which each is subjected and, consequently, lowering of the value of the fault current below that which might otherwise be present during circuit interrupting operations.

It is common practice to provide expulsion

fuses with fiber lined cartridges. When these fuses are designed for a 5000 volt circuit, the cartridges will be approximately 5'' long and are adequate for interrupting small fault currents of an average value. However desirable it may be that such cartridges be longer where the smallest fault currents are encountered, this is not practical because the longer cartridges cause higher pressures to build up and increase the danger of bursting on heavy fault currents. Accordingly, the length of the cartridges in conventional fuses is a compromise between a length which is preferable for most small fault currents and a length which is preferable for most large fault currents.

As will be apparent from the disclosure herein, I have provided a fuse unit which secures the desirable characteristics of a cartridge which will extinguish arcs produced by very small fault currents and one which will not burst on very heavy fault currents. By connecting two 5000 volt cartridges in series, each of which is 5'' long, I secure the advantage of a single arc 10'' long and do not sacrifice the advantage of the freer venting of a 5'' cartridge. Furthermore, I secure an advantage in that each of the arcs produces a resistance to the flow of current and thereby materially reduce the fault current to a safe value.

Another example which will illustrate the advantages of my invention is in the use of this device in a 15,000 volt circuit. A conventional fuse designed for use in this circuit would usually have a cartridge 15'' long and if closed at one end would burst on extremely high fault currents. However, if the fuse unit of my invention is used, the cartridges may each be only 7½'' long. Thus the total length of the two arcs will be 15'' long, but due to the shorter length of each cartridge, the venting will be freer and much larger fault currents will be handled without bursting the cartridges.

In Fig. 2 there is shown another embodiment of my invention, which differs from the device of Fig. 1 only with respect to its upper contact structure and the fusible link in the lower tube.

The upper contact structure of Fig. 2 has a ferrule 47 which is secured to the upper end of the fuse tube by means of the pins 48. At the upper end of the ferrule 47 and integral therewith is a laterally projecting portion 49 having a threaded aperture receiving a bolt 50 which is secured therein and which damps the flexible leader 43 of the fuse link 40 to the portion 49.

Integral with the ferrule 47 are a pull ring 51 and a pair of contact arms 52 projecting outwardly in opposite directions from the ferrule. These contact arms are engaged by the downwardly urged spring arms 53 at the latching portions 53a, the spring arms being mounted on the insulator 37 which is secured to a base (not shown).

The fuse link 54 in the lower tubular member 2 has a fusible section 55 of lower amperage than the fusible section 42 in the upper tubular member 1. A lower amperage fuse is provided in the lower tubular member 2 so that the lower fuse link 54 will ordinarily blow before the upper does.

The operation of the lower tubular member 2 upon the blowing of its fuse is the same as that described for the lower tubular member of Fig. 1. In the upper tubular member, however, the operation is different. The fusible section 42 will melt under heavy overload or short circuit conditions and the gases evolved will force the spring cap 46' from the cartridge and may eject the unburned portion of the fuse link.

Under ordinary overload conditions the lower fuse will blow first. It is possible that the upper fuse will never blow, but its presence insures protection under abnormal conditions. When such conditions are present, both fuses may blow simultaneously or in series.

Fig. 5 shows a modified construction of the intermediate portion of the fuse units hereinbefore described. It is adaptable to either of the devices illustrated in Figs. 1 and 2. Here the clamping sleeve 5 of Figs. 1 and 2 is replaced by a cast fitting 56 into which are threaded the tubular members 1 and 2.

Fitting 56 has two arms 57 and 58 containing acutely angular passageways 59 and 60, threaded internally at 61 and 62 to receive plugs 63 and 64 and having shoulders 65 and 66 upon which are seated the buttonhead terminals 67 and 68. Partition 69 is positioned between the acutely angular passageways to prevent prospective arcs from bridging the gap between the two leaders 70 and 71.

What is claimed is:

1. In a fuse structure including upper and lower terminals, a fuse unit comprising upper and lower cartridges, connecting means for said cartridges, latching means at each end of said unit conjointly releasably engaging the upper cartridge with said upper terminal, said latching means being movable relative to said unit to permit withdrawal from said upper terminal, and a pair of fuse links each located in one of said cartridges and serially connected, said latching means being controlled by each of said fuse links through the conjoint action of said means.

2. In a fuse structure including upper and lower relatively spaced insulated terminals, a fuse unit bridging said terminals and comprising a pair of fuse cartridges in end to end relation and each open for expulsion of gases therein at its opposite end, means connecting the adjacent ends of said cartridges and forming a closure, a fuse link in each of said cartridges electrically connected in series to the other by said means, and latching means at each end of said unit conjointly holding said unit electrically connected to said terminals, said latching means being operatively controlled by each of said fuse links through the conjoint action of said latching means.

3. In a fuse structure including upper and lower relatively spaced insulated terminals, a fuse unit pivotally mounted on said lower terminal and latched to said upper terminal, said unit being open at opposite ends for the expulsion of gases therein and being closed intermediate its ends to form separate arcing chambers, said unit having a pivot mounting comprising a supporting lever pivoted on said unit and on said lower terminal and having a latching lever pivoted on said unit adjacent said upper terminal for latching engagement therewith, a first fuse link in one of said chambers restraining said supporting lever, and a second fuse link in the other of said chambers restraining said latching lever.

4. In a fuse structure including upper and lower relatively spaced insulated terminals, a fuse unit pivotally mounted on said lower terminal and latched to said upper terminal, said unit being open at opposite ends for the expulsion of gases therein and being closed intermediate its ends to form separate arcing chambers,

said unit having a pivot mounting comprising a supporting lever pivoted on said unit and on said lower terminal, a first fuse link in one of said chambers restraining said supporting lever, and a second fuse link in the other of said chambers electrically connected with said upper terminal.

5. In a fuse structure including upper and lower relatively spaced insulated terminals, a fuse unit pivotally mounted on said lower terminal and latched to said upper terminal, said unit being open at opposite ends for the expulsion of gases therein and being closed intermediate its ends to form separate arcing chambers, said unit having pivot means affording movement relative to said lower terminal to withdraw the latched end of said unit from said upper terminal in a direction longitudinally of said unit, a first fuse link in one of said chambers restraining said unit against said movement, and a second fuse link in the other of said chambers electrically connected to said upper terminal.

6. In a fuse structure including upper and lower relatively spaced insulated terminals, a fuse unit pivotally mounted on said lower terminal and latched to said upper terminal, said unit being open at opposite ends for the expulsion of gases therein and being closed intermediate its ends to form separate arcing chambers, said unit having pivot means affording movement relative to said lower terminal to withdraw the latched end of said unit from said upper terminal in a direction longitudinally of said unit and said unit having a movable latching member mounted thereon adjacent said upper terminal for engagement therewith, a first fuse link in one of said chambers restraining said unit against said movement, and a second fuse link in the other of said chambers restraining said latching member.

7. In a fuse structure including a pair of spaced insulated terminals, a fuse unit bridging said terminals and comprising a cartridge having a plurality of arcing chambers and a plurality of fuse links each respectively located in one of said chambers and connected in series with each other, each of said fuse links having a buttonhead terminal, said buttonhead terminals forming a closure for each of said arcing chambers, means joining said arcing chambers and holding said buttonhead terminals in a contiguous relationship, a lower supporting and contact structure including a flipout mechanism for said fuse cartridge, an upper latching and contact structure including a flipout mechanism for said fuse cartridge.

8. In a fuse, a pair of spaced fixed terminals, a cartridge open at both ends normally bridging said terminals and pivotally supported at its lower end, said cartridge being movable on its pivotal support and comprising an upper and a lower tube, a fuse link in each of said tubes, one of said fuse links being of a lower ampere rating than the other of said fuse links, each of said fuse links having a buttonhead terminal, means joining said upper and lower tube and holding said buttonhead terminals in end to end electrical contact, said fuse links including each a flexible leader projecting out of opposite ends of said cartridge, means disposed respectively at the ends of said cartridge for anchoring said leaders individually, a latching means controlled by the fuse link in said upper tube carried by said cartridge at its upper end for releasably engaging a contiguous fixed terminal and maintaining said cartridge in latched engagement with one of said contiguous fixed terminal, the fuse link in said lower tube normally maintaining said cartridge immobile on said pivot support, said cartridge being operative to drop out of latching position upon severance of either of said fuse links.

9. In a fuse structure including a pair of spaced fixed terminals, an elongate fuse cartridge normally bridging said terminals and operative to drop out of bridging relation thereto, said cartridge being open at both ends and comprising a pair of arcing chambers, each of said arcing chambers containing a fuse link, each of said fuse links having a buttonhead terminal forming a closure for each of said arcing chambers at the intermediate section of said cartridge, a clamping sleeve joining said arcing chambers and holding said buttonhead terminals in a contiguous relationship, said fuse cartridge having a flipout mechanism at each of its opposite ends, whereby two distinct fuse units, each having an independent means of operation, are comprised in a single fuse structure.

10. A fuse unit for bridging spaced insulated terminals, said unit comprising a pair of expulsion tubes in end to end relation and reach having a contact at its open end, a pair of fuse links each located in one of said tubes and having a buttonhead contacting the other buttonhead and a flexible leader connected with one of said contacts, said buttonheads jointly forming a closure for adjacent ends of said tubes, and a clamping sleeve joining said adjacent ends of said tubes and holding said buttonheads in contacting engagement.

RALPH H. EARLE.

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