Aug. 5, 1941. F. S. KLEIN 2,251,409

ELECTRIC FUSE

Filed May 15, 1939

Fig. 1.

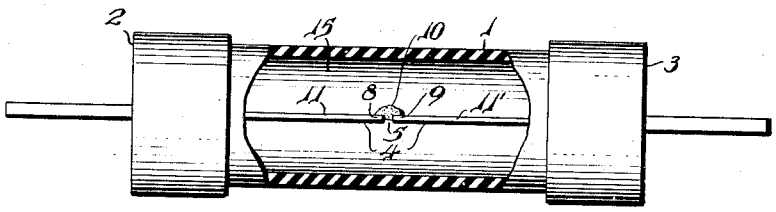


Fig. 2.

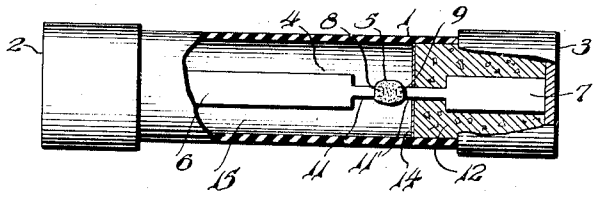


Fig. 4

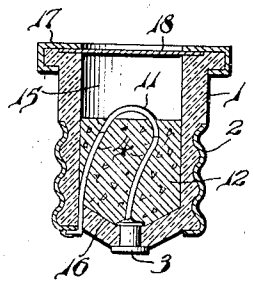
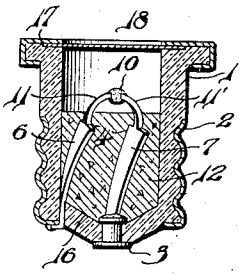


Fig. 3



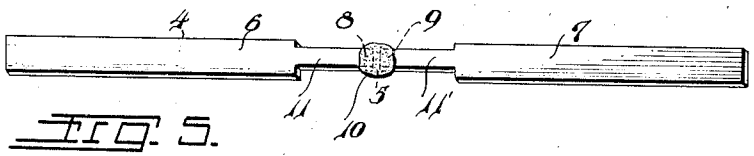


Fig. 5.

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2,251,409

ELECTRIC FUSE

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Application May 15, 1939, Serial No. 273,882

5 Claims. (Cl. 200—119)

This invention relates to electric fuses of the type known as "delayed action" or "time lag" fuses which are designed to provide the necessary protection to the components of an electric circuit without blowing needlessly; and like such fuses, my new fuse can be overloaded with several times its rated capacity for a sufficient length of time to allow the passage of a harmless transient overload of current such as the unavoidable heavy current for starting an alternating current motor; but the same fuse will open the circuit when a relatively light overload tends to continue for such a length of time as would be harmful; or blow promptly when a short circuit or dangerous overload occurs. Thereby providing all the protection necessary while avoiding a needless disruption of the fuse.

In each of the prior delayed action fuses that I know of, there is one or more of several objectionable features which are avoided in my improved fuse; for instance, strain or tension imposed on a fusible element by means of weight or a spring, causes a disruption of the fusible element before the metal thereof is actually melted by an overload of current; and to compensate for this fault, said tension is reduced, or the body of fusible metal increased or fusible metal of higher melting point is used, but such expedients are not favorable to safety.

Some delayed action fuses include a high resistance element where purposely, the current generates heat, which, when the fuse is overloaded, is sufficient to melt a fusible element and open the circuit. In one of these fuses the high resistance element is in the form of a coiled wire; in another, graphite; in another, granulated carbon; and in another, a carbon rod. These are all expensive adjuncts to a fuse and are further objectionable in that resistance elements cause perceptible heat and a waste of current, especially when operated near the rated capacity of the fuse.

In some of these prior fuses, tension is necessarily applied to a fusible element to help open the circuit and stop the electric arc by means of a springy device, usually of metal which eventually loses necessary tension because of frequent heating by a resistance element, thereby unfavorably increasing the expected time lag, or volatilization when the link is opened, i. e., electrically disrupted; and in many instances it is evident that the arc operates more swiftly than the element under tension and consumes much metal; moreover, elements for tension add to the cost of a fuse.

In my improved fuse, it will be seen that, a destructive arc is curtailed, a delayed action provided, tamperproofing provided, and the aforementioned objectionable features of prior fuses avoided, by means which, in comparison with prior fuses, are so economical and effective as to be important to both manufacturers and consumers.

In prior applications bearing the Serial No. 273,883 filed May 15, 1939, and substituted for an application bearing Serial No. 157,288 filed August 4, 1937, and in the copending application bearing Serial No. 206,473 filed May 6, 1938, I have described fuses having arc blocking, time lag, and tamperproof features; these are to be found in this later fuse of which the principal object is to provide a "delayed action" or "time lag" fuse which will cost less, and function better and longer than prior fuses of the same type.

In attaining my objects, I use a basic fuse link designed to carry a temporary and relatively heavy overload, in other words a transient overload of possibly as much as eight times the normal capacity of the circuit served, and then only for a safe length of time which varies according to the magnitude of the current; obviously this allows various harmless transient heavy overloads without disrupting or opening the fuse link unnecessarily; and in the middle of that section of the link which is most susceptible to heat and the initiation of volatilization, I sever the link and provide two of such sections having ends, and then reconnect or bridge these severed ends with a body of metal which is adapted to carry a predetermined and greater current than either of said two sections and be displaced by the heat caused in said two sections by a relatively light overload which may delay action in said two sections and cause damage in the circuit.

Then I enclose the fuse link in a suitable casing composed of nonelectric conducting or dielectric material; and in combination with the casing and the fuse link described above, I use a material, preferably in the form of cement, which is dielectric, flameproof, heat conducting, and refractory or unmanageable; and arrange that material so that it adheres to the fuse casing, so as to form, substantially, a part of the dielectric material of the casing, and with the casing form an unmanageable mass which includes a substantial portion of at least one of the aforementioned fusible sections of the link, but preferably the major part of the whole link including both ends of the link. So as to leave only a relatively short portion of the fusible section or sections of the

link extending from said mass with the aforementioned body of low melting point metal a relatively short distance from the mass. Whereby, the mass will conduct heat from the fuse link and delay the melting of the body of low melting point metal, and limit a disruption to a relatively short portion of the whole link by blocking an arc close to the beginning of a rupture in the link, and furthermore, prevent tampering with the value of the fuse link before or after a rupture of the link.

In the accompanying drawing, Fig. 1 is a sectional view of my improved cartridge fuse; Fig. 2 is a sectional view of a cartridge fuse including further improvements; Figs. 3 and 4 are sectional views of improved screw plug fuses; Fig. 5 is an enlarged view of the fusible element of the new fuse.

In further detail, and in each figure of the drawing, a dielectric casing is shown at the number 1, having contact terminals at 2 and 3, and a fuse link at 4, which is severed, that is, divided, at 5 the place most susceptible to heat and a disruption, which is usually, but not always, the middle of the link where the least heat is absorbed by other portions such as heavier end portions or terminal connections.

Where the link is severed a small section of the metal is removed to provide a definite space as at 5 between the two severed ends 8 and 9 which are bridged with metal 10 having a lower melting point than the potentially fusible metal in the link 4; this bridge or joint at 10 is clearly shown on an enlarged scale in Fig. 5.

This new fuse may include any of the different metals or alloys, peculiar advantages are to be found in lately discovered alloys, but for example, I will assume the link at 4 to be of copper for I shall use copper in many instances because it serves well to set forth my invention, and copper is relatively stable and slow to melt at high temperature, it has high conductivity for heat and current, the melting point is 1065° C. and less metal need be used and volatilized; all of this contrasts well with the lower melting point of many metals which may be used to form a bridge at 10 which must be relatively less stable at high temperature than the basic link 4.

The bridge at 10 may be made of zinc, tin, lead, or any alloy having the desired melting point, and may possibly be a mixture of 32% lead, 50% tin, and 18% cadmium and known to melt at 150° C.; of course the time lag desired determines which metals are to be used, for, while some machines withstand quite heavy overloads, delicate devices need a sensitive fuse.

Since a metal having a relatively low melting point has relatively greater resistance to current, the bridge 10 must have sufficient cross-sectional area to provide greater conductivity for current than the basic link 4; and as shown, the metal at 10 is to be soldered as that is the best connection for the conduction of heat into the bridge.

The body of metal forming the bridge 10 is to have such characteristics and to be so proportioned, with respect to the basic link 4, that the weight or electrical resistance of the bridge will not be a factor of its displacement before the melting point of the bridge is reached.

With reasonable care the proper metal can be selected to make the bridge 10 of little weight and smaller size than those bridges shown in the drawing, which perforce must illustrate details; an object, is to present the least metal to feed an electric arc.

In fuses of low current rating, the weight of the bridge at 10 may not be sufficient to displace the bridge when melted, nevertheless, it will be displaced by volatilization because of the increased resistance of the bridge metal when in a melted state.

In a fuse link having a bridge as described above, various heavy but harmless temporary surges of current, will not melt the relatively stable metal in the basic link 4 or heat that link sufficiently to melt the bridge 10 which has the capacity to carry such overloads, and because such overloads are so often normal and expected in the electric circuit served by a fuse link, they are hereinafter termed "normal temporary overloads," but when a relatively light overload tends to become permanent and harmful, in other words an "abnormal overload," heat will gradually increase in the two potentially fusible sections 11 and 11' and melt and displace the lower melting point metal of the bridge 10; also a dangerous overload or short circuit will disrupt such a link at the sections 11 and 11' as promptly as it would disrupt any other fuse which is rated for the normal current in the circuit served.

Fig. 1 shows a fuse of the cartridge type which includes a tubular casing 1, metal ferrules and blades 2 and 3 for contact terminals which may be of any other type desired and may also be removable to renew the fuse link; and the fuse link at 4 is the same as the new link described in detail above.

Fig. 2 also shows a cartridge fuse having a casing and terminals as described in Fig. 1 but in this cartridge I follow a common practice and use a fuse link having end portions 6 and 7 which are relatively long portions of the link and together constitute the major part of the whole link, also an intermediate longitudinal section at 11 which is reduced in cross-section and a relatively short and particularly fusible section of the link which will carry more current than the same cross-section throughout a fuse link, and thereby curtail the metal volatilized and localize a disruption; this link is also severed at 5 to provide two of said short sections as at 11 and 11' having ends 8 and 9 which are bridged at 10 as shown and described in Figs. 1 and 5.

In Fig. 2, at 12 is an arc blocking device which will minimize a disruption in the fuse and its violence. This arrangement is substantially the same as described in the aforementioned application No. 206,473, and likewise, this drawing shows at 12 an unmanageable mass of cement which is dielectric, flameproof, and contains particles of porcelain or other material which will conduct heat from the fuse link.

The arc blocking device at 12 is a dielectric material arranged to form a cross-section of the casing 1 into a solid, and considerable mass safely embedding a substantial portion of the particularly fusible section 11' to prevent destruction of the same by an arc, and leaving the remainder of that fusible section 11' and the bridge 10, to extend from and clear of said mass to disrupt freely either at the bridge 10 or at said sections 11 and 11' according to the magnitude of an overload; and whatever the overload may be, the disruption will be limited to the fusible sections 11 and 11' which, including the bridge 10, constitute a very short portion of this link.

While I have specified a cross-section of a fuse casing arranged to form a solid and considerable mass I trust that I am not to be restricted to the same, for I contemplate other means for

embedding portions of the fuse link as described, without filling a full cross-section of the casing.

At Fig. 2 is shown an economical arrangement of the arc blocking mass 12; which is a thin washer 14 of incombustible material threaded tightly over the link 4 and forming a stop at the proper place on the fusible section 11' for a cement 12 which is poured into the combustion chamber 15 and embeds part of said section 11'; in renewable fuse cases this arc blocking device may be of any other convenient arrangement to permit replacements.

At Fig. 3 my invention is included in a fuse of the plug type, and I have chosen to show a fuse having a dielectric casing 1, an annular screw shell contact terminal 2, a bottom contact terminal 3, a combustion chamber 15 having a bottom end closed at 16, and a top part including a cap 17 having a window 18 of transparent material, and a fuse link 4 which, in detail, is the same as other links 4 with bridges 10 described above, standing in the combustion chamber 15 so as to form a loop which extends toward said top part 17 of the chamber 15 with the bridge 10 and fusible sections 11 and 11' forming the upper part of the loop.

Fig. 3 includes an arc blocking device substantially the same as that described in Fig. 2 but in this instance the cement 12 comprising this device, is poured into the bottom end or lower cross-section of the combustion chamber in sufficient mass to safely embed the major portion of each end of the fuse link and end parts of each fusible section 11 and 11' in arc blocking material, which preferably is to be of a refractory character, leaving the bridge 10 and its adjacent portions of the fusible sections 11 and 11' forming a relatively small loop which stands above and clear of the cement.

In the fuse at Fig. 3 a disruption will be brief and limited to a relatively small part of the link and those portions of the link which are embedded in the cement 12 are tamperproof and to reestablish a circuit through this casing, is impractical. At the same time this cement materially extends any delay of action that may otherwise be expected in a fuse link.

At Fig. 4 is shown a fuse plug the details of which are the same as described at Fig. 3 above, excepting that, in this fuse the fuse link is continuous, there is no intermediate joint or bridge or other metal; nevertheless it is a novel fuse in that only a small portion of the whole fuse link is looped to stand clear of the arc blocking body of material at 12.

At Fig. 4 the arc blocking device at 12 is to be made of a mixture containing a large proportion of porcelain or sand to absorb heat from the fuse link and delay the action of a relatively light and temporary overload of current, and furthermore a disruption in this fuse, when necessary, will be free to occur and brief, in other words; there is nothing to prevent a prompt opening of this link in clear and sufficient space for the dispersion of such gas as may occur here, and the duration of the accompanying arc or flow of current through gas will be limited by a relatively small amount of metal being available to an arc, and that metal may be considerably less than that section of the link which I have shown to be extending clear of the arc blocking material at 12 to illustrate the advantages of such an arrangement.

Having described my invention I claim:

1. An enclosed electric fuse having a casing with contact terminals and a fuse link of the delay action type comprising a fusible strip divided into two sections, and having one end of each section bridged together by a relatively short body of metal having a greater current carrying capacity and a lower melting point than said sections, said sections having the capacity to carry a normal temporary overload in an electric circuit and be heated by an abnormal overload and thereby displace said body of metal, and also be fused by a short circuit in said electric circuit; in combination with said casing and fuse link, a body of material which is heat conducting, flameproof, unmanageable, and arranged to form an unmanageable mass which includes a portion of said casing and a substantial portion of at least one of said fusible sections, a relatively short portion of a fusible section of said strip and said body of metal extending clear of said mass whereby, said mass may conduct heat directly from the fusible section to delay the melting of said body of metal, and block an electric arc close to the beginning of a rupture in the link, and prevent tampering with the value of said fuse link.

2. In an electric fuse of the plug type having a casing, contact terminals, a combustion chamber in the casing, and a fuse link in the combustion chamber forming a loop; the combination therewith of a body of material which is dielectric, flameproof, heat conducting, unmanageable, and arranged in part of said combustion chamber to form an unmanageable mass which includes a section of said casing and the major part of said link including both its ends and leaving a relatively short portion of the whole link extending in a loop clear of said mass, whereby, said mass may conduct heat from the major part of said link and delay a rupture of said short portion of the link, cause an abnormal overload to open the circuit promptly at said portion of the link, and prevent tampering with the value of said link.

3. An electric fuse of the screw plug type having a dielectric casing, contact terminals, and a fusible strip having a relatively short section thereof reduced in cross-section, located intermediate less fusible longitudinal portions of the strip and forming a loop toward the top of the casing; in combination with a body of cement which is heat conducting, flameproof, unmanageable, and arranged to form the lower cross-section of said casing and the major part of said strip into an unmanageable mass, the remainder of said strip being only the top portion of said loop extending above said mass whereby, said mass may conduct heat from the fusible strip and delay a disruption thereof, and limit a rupture of said strip to said top portion of the loop by blocking an electric arc close to the rupture, and also prevent tampering with the value of said fusible strip.

4. An electric fuse of the screw plug type having a dielectric casing, contact terminals, a window composed of transparent material, and fuse link having two longitudinal fusible sections connected in series by a body of metal having a greater current carrying capacity and a lower melting point than said sections, said sections forming a loop with said body of metal toward said window, said sections having the capacity to carry a normal temporary overload in an electric circuit, and be heated by an abnormal overload and thereby melt said body of metal,

and also be fused by a short circuit in said electric circuit; in combination with, a body of material which is heat conducting, flameproof, dielectric, unmanageable, and arranged to form an unmanageable mass which includes a cross-section of said casing and the major part of said fuse link, the remainder of said link being said body of metal and a portion of each of said fusible sections forming a relatively small loop extending above said mass whereby, said mass may conduct heat from the fusible sections and delay the fusing of said body of metal, and limit a rupture of the fuse link to said relatively small loop by blocking an electric arc close to the loop, and also prevent tampering with the value of the fuse link.

5. An enclosed electric fuse having a casing, contact terminals, and a fuse link having a relatively short section of its length adapted to delay the action of a normal temporary overload of current through the link and also adapted to be opened by an abnormal overload of current; in combination with, a body of material which is heat conducting, flameproof, unmanageable, and arranged to form an unmanageable mass which includes a substantial cross-section of said casing and the major part of said fuse link, with a portion of said relatively short section of the length of the link extending clear of said mass whereby, said mass may further delay the action of an overload of current by conducting heat directly from said relatively short section of the fuse link, and limit a rupture of the link to said relatively short portion extending from the mass by blocking an electric arc close to the rupture, and also prevent tampering with the value of the fuse link.

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