Feb. 7, 1956 P. C. JACOBS, JR 2,734,110

MAGNETIC BLAST FUSES

Filed Oct. 2, 1953

Fig. 1.

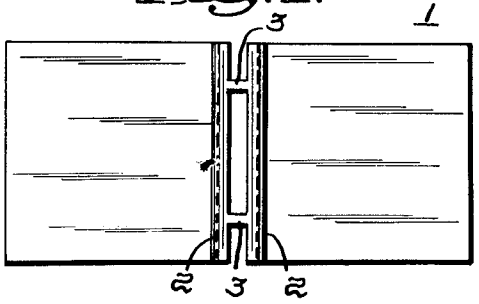


Fig. 2.

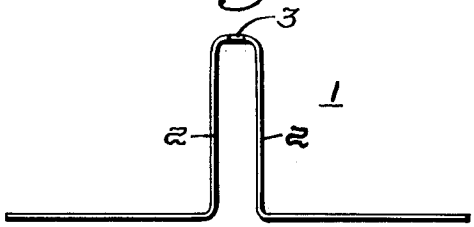


Fig. 3.

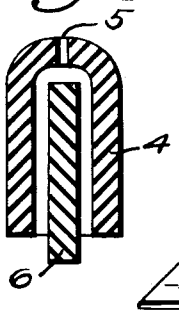


Fig. 4.

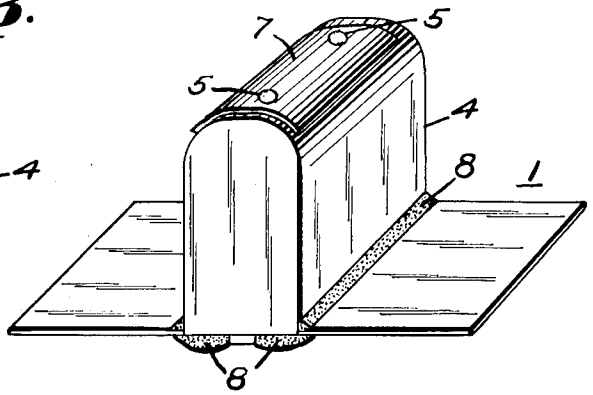


Fig. 5.

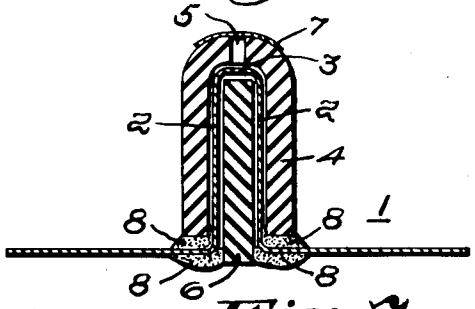


Fig. 6.

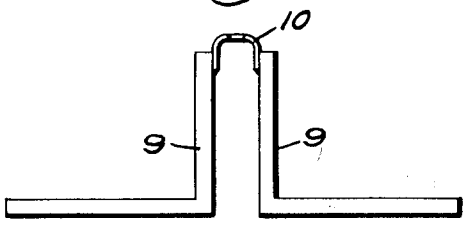
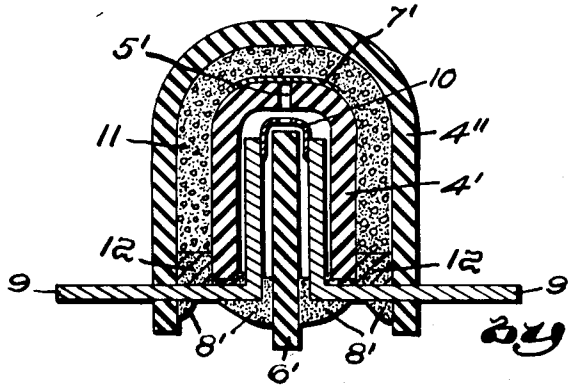


Fig. 7.



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United States Patent Office 2,734,110 Patented Feb. 7, 1956

2,734,110

MAGNETIC BLAST FUSES

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Application October 2, 1953, Serial No. 383,746
5 Claims. (Cl. 200—120)

This invention refers to fuses and more particularly to fuses of the current-limiting type.

The fuse links arranged in conventional current-limiting fuses are surrounded by a pulverulent arc-quenching filler which has a high heat or energy absorbing capacity and is thus capable of absorbing the considerable amounts of energy which are fed into the fuse by the circuit under interruption between the time of arc-initiation and the time of arc-extinction. In current-limiting fuses of the so-called silver-sand type the high latent heat of fusion of the quartz sand supplies the high energy absorbing capacity which is required for current-limiting circuit interruption.

The interrupting process is initiated in any fuse by initial fusion and vaporization of the fuse link at a predetermined point, or predetermined points, thereof. The resistance of the arc gap immediately upon formation thereof is very small, due to the small length which it initially has. Current-limiting interruption of a circuit calls for a very rapid rate of rise of the arc voltage. The requisite rapid rate of rise of the arc voltage is achieved in conventional current-limiting fuses by a design of their fuse links which is conducive to a rapid growth of the arc gap initially formed. There is, however, an inherent draw-back in any fuse wherein gap growth and arc elongation are mainly, or substantially, achieved by the burning action of the arc terminals initially formed on the fuse link. Considering at a given time t_x a substantially linear arc formed by the fusion of a fuse link, the point of arc initiation being situated midway between the terminals of the arc, it is apparent that arc duration is longest at the point of arc initiation and least immediately adjacent the terminals of the arc on the two spaced ends of the link between which the arc extends. The heat generated at any point of the arc is proportional to the duration of the arc at the particular point. It follows therefrom that the heat generated by the arc is largest at the point of arc initiation and least immediately adjacent the terminals of the arc. The rate of dielectric recovery of an arc gap at any given point thereof is inversely proportional to the duration of the arc, or to the total arc energy released at the particular point of the arc gap. It follows therefrom that the point of arc initiation is, or tends to be, a dielectrically weak point in conventional, or prior art, current-limiting fuses.

It is, therefore, an object of this invention to provide a current-limiting fuse wherein the point of arc initiation tends to be dielectrically strong, i. e. does not tend to break down under the impact of the recovery voltage.

Another object of this invention is to provide a current-limiting fuse wherein the arc is, or the incandescent products thereof are, blasted by electromagnetic action away from the point of arc initiation toward a point or a region remote from the point of arc initiation.

Still another object is to provide a current-limiting fuse in which a dynamic blast action rather than static cooling means is primarily responsible for the current-limiting and arc extinguishing action.

A further object of the invention is to provide a current-limiting fuse which includes a structure in the nature of a miniaturized arc chute.

Still another object of the invention is to provide fuses having an improved interrupting ability by virtue of simple, highly effective magnetic blow-out means.

It is also an object of the invention to generally improve fuses, and more particularly current-limiting fuses, including reducing the bulk thereof.

For a better understanding of the invention reference may be had to the accompanying drawing in which:

Fig. 1 is a top plan view of a fuse link;

Fig. 2 is a side elevation of the fuse link shown in Fig. 1;

Fig. 3 is a cross-section of a barrier and of a housing for accommodating the fuse link shown in Figs. 1 and 2;

Fig. 4 is a perspective view of a complete fuse comprising the parts shown in Figs. 1 to 3, inclusive;

Fig. 5 is a vertical cross-section of the fuse structure shown in Fig. 4;

Fig. 6 is a side elevation of the current-carrying parts of another fuse embodying the present invention; and

Fig. 7 is a cross-section of a fuse comprising the current-carrying parts shown in Fig. 6.

Referring now to Figs. 1 to 5, inclusive, reference numeral **1** indicates generally a fuse link of the ribbon type preferably made of silver or copper. Fuse link **1** is provided with a portion **3** of restricted cross-section to initiate arcing at the occurrence of relatively large fault currents in an electric system to be protected. The restricted cross-section portion **3** may consist of one or more current bridges extending between the terminal portions of the link which may have a comparatively large cross-sectional area. In the structure shown in Fig. 1 the terminal portions of the link **1** are bridged by two current bridges of which each may have, say, 1/15 of the cross-sectional area of the terminal portions. As best shown in Fig. 2 fuse link **1** is bent to form a current loop with the apex portion thereof situated adjacent the restricted cross-section portion **3** to produce a magnetic field concentration adjacent the restricted cross-section portion **3**. Reference numeral **2** has been applied to indicate the two sides of the U-loop which are substantially parallel. When the fuse is being assembled a barrier **6** of heat resistant insulating material is inserted between the inner surfaces of the portions **2** of link **1**, and barrier **6** and link portions **2** are inserted into a hood **4** which is also made of a heat resistant insulating material. Barrier or insulating spacer **6** and hood or cover **4** may be made of a suitable ceramic material, e. g. a fired zircon ceramic. The hood or cover structure **4** has an orifice **5** adjacent the restricted cross-section portion **3** of link **1** to permit the escape of products of arcing formed at the restricted cross-section portion **3** upon fusion thereof. Since in the embodiment shown in Figs. 1 to 5, inclusive, the restricted cross-section portion **3** of link **1** consists of two current bridges, a venting orifice **5** in hood **4** is associated with each of the two bridges. The magnetic field concentration adjacent restricted cross-section portion **3** of fuse link **1** results in a magnetic blast removing the products of arcing formed upon fusion of link **1** through orifices **5** from points **3**. If desired orifices **5** may be sealed by a layer of tape **7** adapted to be destroyed by the heat and pressure resulting from high fault current arcs. Tape **7** permits a build-up and sudden break-down of pressure adjacent the points of the link where arc initiation occurs, and such a consecutive build-up and break-down of pressure is conducive to more effective interruption of electric circuits. If desired, a body of a pulverulent cooling medium as, for instance, quartz sand may be arranged at the downstream ends of orifices **5**. In the embodiment of the invention shown in Figs. 1 to 5, inclusive, such a body of cooling medium has been omitted, but such a body of cooling medium has been shown in the embodiment of the invention illustrated in Fig. 7. Link **1**, insulating barrier **6** and hood **5** may be joined together by cement seals **8** to form a self-sustained structural unit, as clearly shown in Fig. 5. Cement seals **8** should be gas-tight to

preclude any escape of products of arcing from the space within hood 4, except through orifices 5.

The portion of restricted cross-section or neck 3 of fuse link 1 is designed to have a current-limiting action, i. e. to fuse initially and to thus initiate interruption of the faulted circuit before the fault current can reach the peak value of the available short-circuit current of the system into which the fuse is inserted. The U-shaped portion 2, 3, 2 of link 1 has its current-limiting neck 3 substantially at the center thereof, and orifices 5 are substantially in registry with neck 3.

Referring now to Figs. 6 and 7, the current-carrying parts of this fuse comprise two spaced angle members 9 having a considerable current-carrying ability and heat absorbing capacity. Members 9 are preferably made of copper. Current bridge 10, preferably made of silver, establishes a current path from one of the angle members 9 to the other. Current bridge 10 is provided with a current-limiting portion of reduced cross-section or neck substantially identical with the current-limiting portion of reduced cross-section or neck shown in Fig. 1. Members or bars 9 have a considerably larger cross-sectional area than current-bridge or link 10. As indicated in Fig. 7, the insulating barrier or spacer 6' is inserted into the gap formed by the two spaced angle members 9. Both the angle members 9 and the current bridge 10 are covered by a first hood 4' having one or more venting orifices 5' substantially in registry with the current-limiting neck portion of current bridge 10. The downstream end of venting orifice 5' is sealed by cellulose tape 7' which is being readily destroyed by arc generated heat and pressure. The first hood 4' is inserted into a second hood 4'' which has the same geometrical configuration as, but is considerably larger than, the first hood 4'. The space between the first hood 4' and the second hood 4'' is filled with a granular or pulverulent cooling medium 11, preferably chemically pure quartz sand. A packing 12 keeps the cooling medium 11 within the U-shaped space formed between hoods 4' and 4''. The angle members or terminal connectors 9, the center insulator or spacer 6' and the two hoods 4' and 4'' are bonded together by means of cement joints 8' to form a self-sustained structural unit.

The composite structure shown in Fig. 6 is a sub-assembly unit which is being inserted as such into the hood 4. Current bridge 10 may be spot-welded or brazed to the angle members or terminal connectors 9. Hood 4'' may be provided with a pair of notches (not shown) permitting to move the two aligned parts of angle member 9 into hood 4'', as shown in Fig. 7.

If the pulverulent cooling medium 11 is quartz sand, fusion thereof will occur substantially simultaneously with the vaporization of current bridge 10 by the heat of the interrupting arc. Fused quartz forms a body glass-like character, frequently referred to as fulgurite, which is a good conductor of electricity as long as it is at an elevated temperature, Since that body of glass-like character is formed outside of hood 4', relatively remote from the arcing zone, the danger of destruction of the fuse by a post-interruption follow-current through the fulgurite, which often impairs the proper operation of current-limiting fuses, is virtually non-existent.

It will be understood that although but two embodiments of this invention have been shown and described in detail the invention is not limited thereto and that the illustrated embodiments may be modified, or other embodiments made, without departing from the spirit or scope of the invention as set forth in the accompanying claims.

It is claimed:

1. A fuse comprising an insulating barrier, a fuse link having a current-limiting restricted cross-section portion situated between a pair of relatively wide cross-section portions arranged at angles of substantially 90 degrees with respect to said restricted cross-section portion, said restricted cross-section portion being substantially in registry with one edge of said insulating barrier and said pair of relatively wide cross-section portions sandwiching said barrier, and an insulating hood mounted on said link and having a venting port adjacent said restricted cross-section portion of said link.

2. A fuse comprising an insulating barrier, a fuse link having a current-limiting restricted cross-section portion situated between a pair of relatively wide cross-section portions arranged at angles of substantially 90 degrees with respect to said restricted cross-section portion, said restricted cross-section portion being substantially in registry with one edge of said insulating barrier and said relatively wide cross-section portions sandwiching said insulating barrier, a first insulating hood mounted on said link and having a venting port adjacent said restricted cross-section portion of said link, a second insulating hood mounted on said link in spaced relation from said first hood, and a granular cooling medium sealed into the space between said first hood and said second hood.

3. A fusible electric proetctive device comprising in combination a pair of spaced angular brackets, an insulating spacer between said pair of brackets, a fusible current-carrying bridge interconnecting said pair of brackets arranged edgewise with respect to said insulating spacer, said current-carrying bridge having a point of restricted cross-sectional area to predetermine the point of initial fusion and arc initiation, and a substantially gas-tight enclosure for said current-carrying bridge having venting means only immediately adjacent said point of restricted cross-sectional area of said current-carrying bridge.

4. A current-limiting fuse comprising a ribbon-type fuse link having a restricted cross-section portion adapted to rapidly fuse at the occurrence of large fault currents, said link being bent substantially in the shape of a U and having a pair of spaced terminals, a pair of terminal bars each having a considerably larger cross-sectional area than said link and each conductively connected to and supporting one of said pair of terminals, and a hood of insulating material supported by said pair of terminal bars, said hood having a recess adapted to accommodate the bent portion of said link, and said hood having venting means in the apex portion thereof to permit the escape of products of arcing formed upon fusion of said restricted cross-section portion.

5. A fuse comprising a pair of spaced terminal bars having a relatively large cross-sectional area, a ribbon-type fuse link having a relatively small cross-sectional area supported by and conductively interconnecting said pair of bars, said link comprising a zone of restricted cross-sectional area adapted to rapidly fuse at the occurrence of large fault currents, said pair of bars and said link jointly defining a loop-shaped current path producing a zone of intense magnetic field concentration adjacent the apex portion thereof, a cover of heat resistant insulating material supported by said pair of bars and having a recess accommodating said link, and venting means in said hood for the products of arcing resulting from the fusion of said link, said venting means being substantially coextensive with said zone of restricted cross-sectional area and with said zone of field concentration.

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