May 28, 1957 P. C. JACOBS, JR 2,794,097

FUSE WITH MINIMIZED $I^2.r$ LOSSES

Filed June 4, 1956 2 Sheets-Sheet 1

FIG. 1

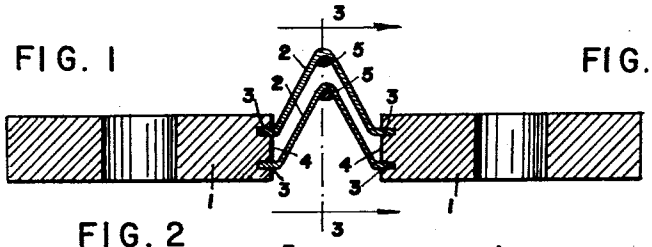


FIG. 3

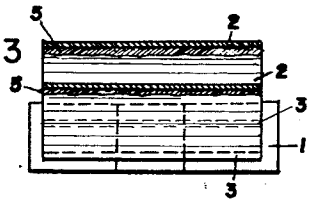


FIG. 2

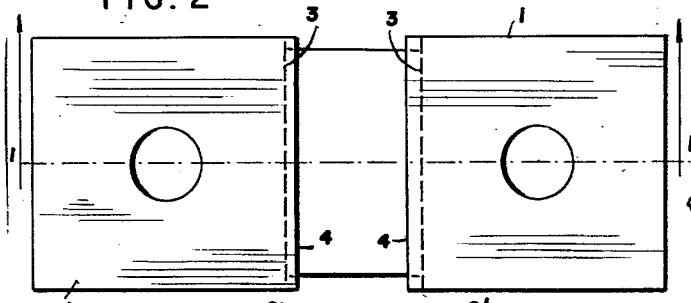
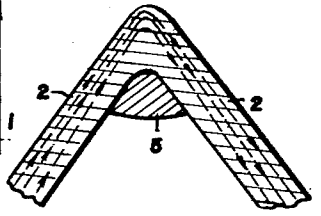


FIG. 5



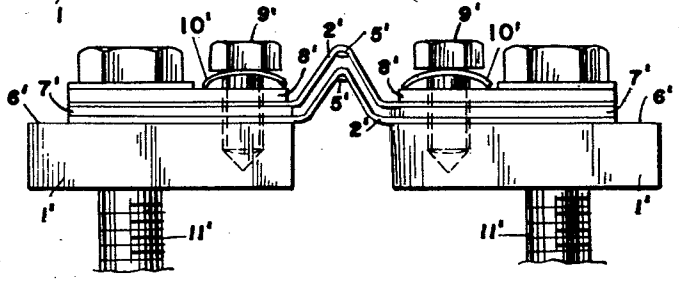


FIG. 4

FIG. 6

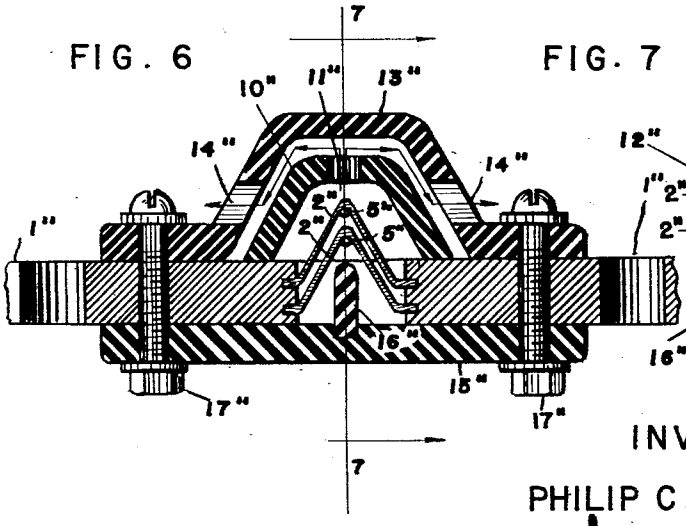
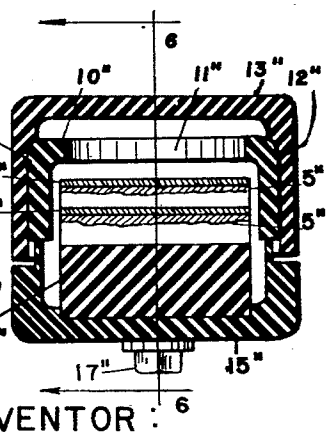


FIG. 7



INVENTOR:

PHILIP C. JACOBS, JR.

BY Irwin Dalgin ATTY.

May 28, 1957 P. C. JACOBS, JR 2,794,097

FUSE WITH MINIMIZED $I^2.r$ LOSSES

Filed June 4, 1956 2 Sheets-Sheet 2

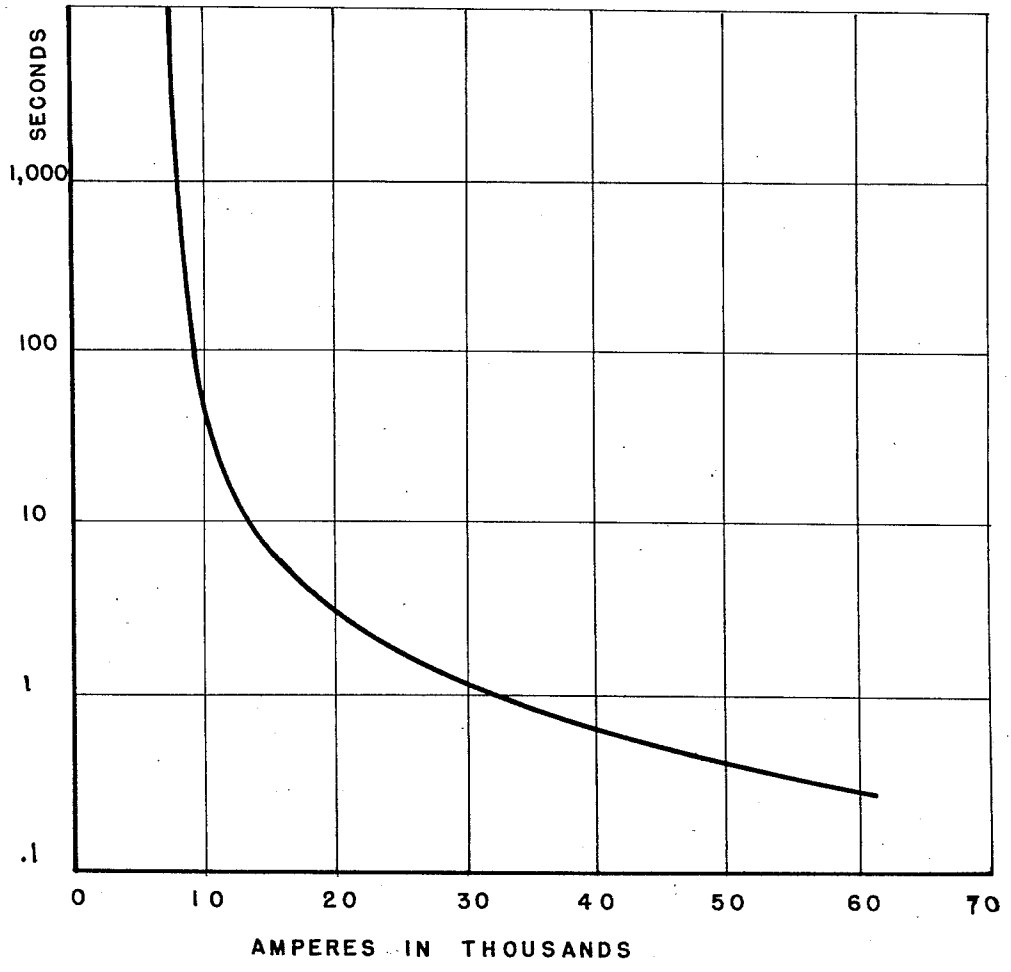


FIG. 8

INVENTOR:

PHILIP C. JACOBS, JR.

BY Kenneth Ralph ATTY.

United States Patent Office

2,794,097

Patented May 28, 1957

2,794,097

FUSE WITH MINIMIZED $I^2 \cdot R$ LOSSES

Philip C. Jacobs, Jr., Newtonville, Mass., assignor to The Chase-Shawmut Company, Newburyport, Mass.

Application June 4, 1956, Serial No. 589,075

8 Claims. (Cl. 200—120)

This invention is concerned with fusible protective devices operative on occurrence of overload currents or short circuit currents, and more particularly with protective devices of that character capable of carrying continuously high load currents, i. e. load currents in the order of several thousand amperes.

It is one object of this invention to provide fusible protective devices wherein $I^2 \cdot r$ watt losses and consequent heat generation are minimized.

Another object of this invention is to provide fusible protective devices whose fuse links do not require and do not comprise any point of reduced cross-sectional area to establish the point of arc initiation, and whose links do not require and do not comprise any point, or points, of reduced cross-sectional area to generate the heat needed to achieve a predetermined time-current characteristic.

A further object of the invention is to provide fuses which have all, or most, of the desirable properties of the fuses disclosed in United States Patent 2,734,110 to Philip C. Jacobs, Jr., Magnetic Blast Fuses, February 7, 1956, yet have a more rugged link construction than the fuses disclosed in this patent.

Other objects and advantages of the invention will, in part, be obvious and in part appear hereinafter.

For a fuller understanding of the nature and the objects of the invention reference should be had to the following detailed description and drawings, in which:

Fig. 1 is a longitudinal sectional view of a fusible device embodying my invention taken along 1—1 of Fig. 2;

Fig. 2 is a top-plan view of the structure shown in Fig. 1;

Fig. 3 is a section taken along 3—3 of Fig. 1;

Fig. 4 is a side elevation of another structure embodying my invention;

Fig. 5 shows a detail of Figs. 1 and 4 on a larger scale;

Fig. 6 is a longitudinal section of another embodiment of the invention taken along 6—6 of Fig. 7;

Fig. 7 is a section taken along 7—7 of Fig. 6; and

Fig. 8 is a time current characteristic of the structure shown in Figs. 1 to 3, inclusive.

Referring now to the drawings, and more particularly to Figs. 1 to 3 thereof, reference numeral 1 has been applied to indicate a pair of flat substantially square metal bars having a relatively high current-carrying capacity and a relatively high heat absorbing capacity. Bars 1 may be made of the kind of stock commonly used for buses. They consist preferably of copper and have proportions enabling them to carry continuously currents in the order of several thousand amperes without significant heating. The spacing between the two bars 1 is relatively small, i. e. smaller than the length of each bar 1. A pair of fuse links 2 each bent substantially in the shape of an inverted V and defining a cavity having a wide open end and a narrow closed end conductively interconnect the pair of bars 1. The length of each link 2 is less than the length of a bar 1. Each link 2 consists of a metal ribbon of substantiallyuniform cross-sectional area throughout the entire active length thereof, i. e. that part of its length situated between bars 1. The metal of which fuse links 2 are made ought to have a relatively high conductivity and a relatively high fusing point and should preferably be copper. The width of fuse links 2 is substantially the same as—preferably slightly less than—the width of bars 1. Bars 1 are provided with parallel, straight grooves 3 on juxtaposed surfaces 4 thereof and each link 2 is inserted into one of grooves 3 in each of bars 1. Solder means (not shown) provided in each of grooves 3 tend to minimize the resistance to current flow between bars 1 and links 2. Each link 2 is covered across substantially the entire width thereof by an overlay 5 of a link-destroying low-fusing-point metal limited to the inner surface of the upper closed end of the V-bent thereof, i. e. the overlay 5 fills but a small portion of the V-shaped cavity defined by each link 2. Overlays 5 may consist of tin, or of suitable alloys of tin. When the tin, or tin alloy, reaches its fusing point, it forms alloys with the base metal having a relatively high resistivity. As a result, heat generation and alloy formation increase progressively, causing links 2 to be severed relatively rapidly by a metallurgical reaction, or metallurgical corrosion.

The structure shown in Figs. 1 to 3 differs in a number of ways from prior art fusible protective devices, and more particularly from the devices disclosed in the aforementioned United States Patent 2,734,110. Perhaps the most important difference is that the fuse links 2 are of equal cross-sectional area throughout the entire length thereof. This greatly increases the dimensional stability of the structure. The fuse links in the aforementioned patent comprise points of drastically reduced cross-sectional area pre-establishing the points of arc initiation and supplying the heat necessary to cause fusion of the points of reduced cross-sectional area at the occurrence of predetermined excess currents. In the present structure the point of arc initiation is pre-established by virtue of the fact that the link-destroying overlay 5 is substantially coextensive with a zone of increased current density produced by magnetic action inherent in the geometrical configuration of the current path rather than by local reduction of the cross-sectional area of the current path.

Referring to Fig. 5 showing, on a larger scale, the naarrow closed end of one of the link-defined cavities, it will be apparent that the current density is highest at the narrow closed end of the cavity and decreases toward the wide open end thereof. The magnetic current-concentration coextensive with the link-destroying overlay 5 is, in effect, a novel equivalent of a point of reduced cross-sectional area, or neck, on a fuse link since both result in high local current concentrations and intense heating limited to a small portion of the total length of the link. It will be apparent that establishing a zone of magnetic current-concentration coextensive with a link-destroying overlay does not affect the mechanical integrity of any link, whereas any local reduction of the cross-sectional area of a link impairs more or less its mechanical integrity. It will be noted that in the structures of Figs. 1 to 3 and 5 the point of break for interrupting overload currents and the point of break for interrupting major faulty currents are integrated into one single point of break, where both interruption of overload currents as well as interruption of major fault currents is effected by a metallurgical reaction occurring at low temperatures. This is conductive to small $I^2 \cdot r$ watt losses and enables to achieve a time-current characteristic such as that shown in Fig. 8. Such a characteristic could not be achieved heretofore without providing fuse links with one or more points of reduced cross-sectional area, or necks, resulting

in a mechanically weaker link structure whose watt losses are relatively high.

The structure shown in Fig. 4 is similar to that shown in Figs. 1 to 3, except for the fact that the fuse links are clamped, rather than soldered, to the terminal bars. Fig. 4 shows two flat, relatively heavy, relatively narrowly spaced copper bars 1' conductively interconnected by a pair of wide ribbon-type fuse links 2' of sheet copper. Each fuse link 2' is bent substantially in the shape of an inverted V and is of substantially uniform cross-sectional area throughout the entire length thereof. Overlays 5' of a link-destroying low-fusing-point metal extend transversely across the entire width of each fuse link at the point thereof where the cavity defined by the link is narrowest, and each overlay 5' occupies but a small portion of said cavity. The lower link 2' rests on the upper surfaces 6' of copper bars 1' and is covered by pressure plates 7'. The upper link 2' rests on the upper surfaces of pressure plates 7' and is covered by pressure plates 8'. Screws 9' acting against spring washers 10' firmly clamp links 2' and pressure plates 7' and 8' against copper bars 1'. Screws 11' are provided for connecting terminal bars 1' into any desired circuit.

Referring now to Figs. 6 and 7, the structure shown therein is substantially identical with that shown in Figs. 1 to 3, inclusive, except for the addition of insulating means defining an arc chute and venting passages for the products of arcing. The metal blocks 1'' are conductively interconnected by V-shaped metal ribbons 2''. The width of metal ribbons 2'' is substantially equal to that of blocks 1'', and each ribbon or link 2'' has an overlay 5'' of a low fusing point metal, such as tin, capable of destroying the base metal of the link by alloy-formation. A hood 10'' of insulating material is provided with a slot 11'' permitting escape of the products of arcing formed incident to blowing of fuse links 2''. Hood 10'' is inserted into a pair of inner recesses 12'' in the casing member 13'' of insulating material. Casing member 13'' is provided with lateral vents 14'', one on each side thereof. If desired a metal grid may be inserted into each vent 14'' to further reduce the temperature of the products of arcing about to be released. Insulating casing member 15'' is provided with an insulating barrier 16'' which projects into the open end of the V-shaped groove defined by the lower fuse link 2''. Barrier 16'' may be made of an organic material evolving gas under the heat of the arc to scavenge the arc path. Casing member 13'' and casing member 15'' are complementary, i. e. they form jointly a casing accommodating all the parts of the device, and are held together and secured to copper bars 1'' by means of bolts and screws 17''. The upper ends of screws 17'' are arranged in such a way as to lie outside of the main stream of hot arc products escaping through vents 14''. It is possible to add a pulverulent arc-quenching filler to the device such as, for instance, quartz sand. This has not been found to be necessary for applications wherein the circuit voltage is relatively low, for which kind of application the device is primarily intended.

It will be understood that although but a few 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 broad spirit and scope of the invention as set forth in the accompanying claims.

I claim as my invention:

1. In a fusible protective device for low-voltage high-current applications the combination of a pair of spaced metal bars having a relatively high current-carrying capacity and relatively high heat-absorbing capacity, a fuse link shorter than each of said pair of bars conductively interconnecting said pair of bars, said link comprising a strip of sheet metal having a relatively high conductivity and being of substantially uniform cross-sectional area throughout the entire length thereof, said strip being bent substantially in the shape of an inverted V defining a cavity having a wide open end and a narrow closed end, and an overlay of a link-destroying low-fusing-point metal extending substantially across the entire width of said strip, said overlay being arranged immediately adjacent said closed end of said cavity and filling but a relatively small portion of the total volume thereof.

2. A protective device as specified in claim 1, comprising a barrier of insulating material arranged edgewise with respect to the plane defined by said pair of bars and projecting into said wide open end of said cavity.

3. In a fusible protective device for low-voltage high-current applications the combination of a pair of spaced metal bars having a relatively high current-carrying capacity and a relatively high heat absorbing capacity, a pair of straight parallel grooves each in one of the juxtaposed surfaces of said pair of bars, a fuse link shorter than each of said pair of bars inserted with each end thereof into one of said pair of grooves to conductively interconnect said pair of bars, said link comprising a strip of sheet metal having a relatively high conductivity and being of substantially uniform cross-sectional area throughout the entire length thereof, said strip being bent substantially in the shape of an inverted V defining a cavity having a wide open end and a narrow closed end, a barrier of insulating material projecting into said wide open end toward said narrow closed end, and an overlay of link-destroying low-fusing-point metal extending substantially across the entire width of said strip and limited to the area of said closed end of said cavity.

4. A fusible protective device comprising a pair of substantially square spaced metal bars having parallel grooves in the juxtaposed surfaces thereof, a plurality of ribbon-type fuse links of sheet copper each inserted with each end thereof into one of said grooves conductively interconnecting said pair of bars, each of said plurality of links having substantially the same cross-sectional area throughout the entire length thereof and being bent to form a current loop tending to establish a narrow area of very high current density extending transversely across the direction of current flow therein, and an overlay comprising tin on each of said plurality of links substantially coextensive with said high current density area thereon.

5. A fusible protective device comprising a pair of spaced metal bars, a ribbon-type fuse link of sheet copper having substantially the same cross-sectional area throughout the entire length and substantially the same width as said pair of bars conductively interconnecting said pair of bars, said link being bent to form a current loop tending to establish a narrow area of very high current density extending transversely across said link, and a link-destroying overlay of a metal having a lower fusing point than copper extending transversely across said link substantially coextensive with said high current density area thereon.

6. In a fusible protective device for low-voltage high-current applications the combination of a pair of metal bars having a relatively high current-carrying capacity and a relatively high heat absorbing capacity spaced from each other to establish a gap therebetween less than the length of each of said pair of bars, a pair of straight parallel grooves each in one of the juxtaposed surfaces of one of said pair of bars, a fuse link of sheet copper of substantially uniform cross-sectional area throughout the entire length thereof inserted into said pair of grooves to conductively interconnect said pair of bars, said link being substantially in the shape of an inverted V of such size as to establish a zone of maximum current density situated outside of the plane defined by said pair of bars, and an overlay of a link-destroying low fusing point metal on said link substantially co-extensive with said zone of maximum current density.

7. In a fusible protective device for low-voltage high-current applications the combination of a pair of spaced

metal bars having a relatively high current-carrying capacity and a relatively high heat-absorbing capacity, a fuse link of sheet copper conductively interconnecting said pair of bars, said link being of substantially uniform cross-sectional area throughout the entire length thereof, and bent substantially in the shape of an inverted V defining a cavity having a wide open end and a narrow closed end, an overlay of a link-destroying low-fusing-point metal arranged immediately adjacent said closed end and extending substantially across the entire width of said strip, a hood-shaped member having a venting slot substantially co-extensive with said narrow closed end of said link covering said link, a pair of complementary casing members each arranged to one side of said pair of bars supported by said pair of bars and enclosing said link and said hood-shaped member, and one of said pair of casing members defining a passage from said venting slot in said hood-shaped member to the space outside said casing members.

8. A protective device as specified in claim 7 wherein one of said casing members supports an insulating barrier projecting into said wide open end of said cavity.

References Cited in the file of this patent

UNITED STATES PATENTS

595,585	Schutt	Dec. 14, 1897
961,308	Murray	June 14, 1910
999,780	Harris	Aug. 8, 1911
2,443,017	Arone et al.	June 8, 1948
2,638,521	Thomas	May 12, 1953

FOREIGN PATENTS

396,175	Germany	Feb. 14, 1925
596,492	France	Aug. 10, 1925
721,236	Germany	May 30, 1942