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COMPOSITE FUSE LINKS OF SILVER AND COPPER

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Fig. 1.

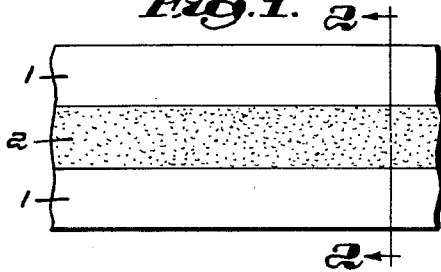


Fig. 2.

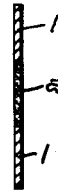


Fig. 3.

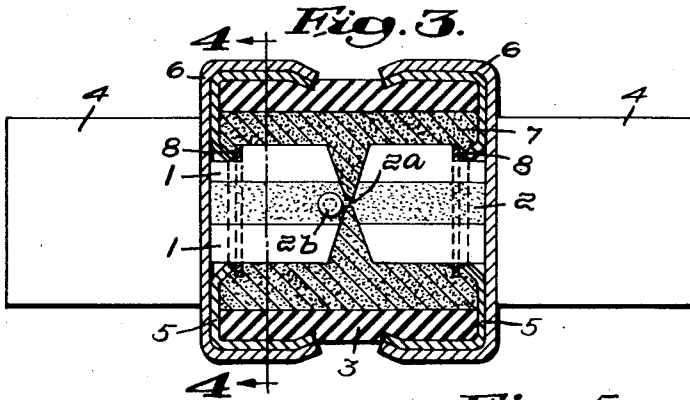


Fig. 4.

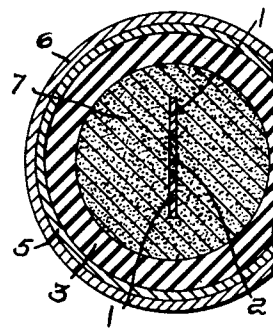


Fig. 5.

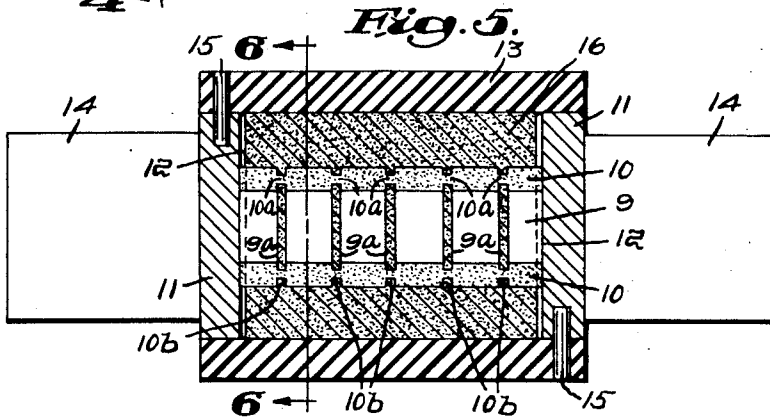
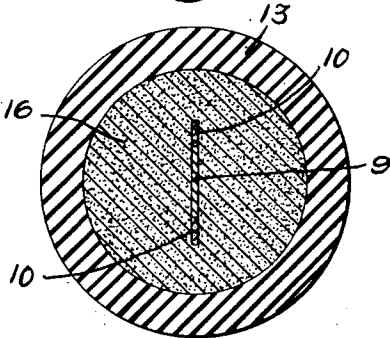
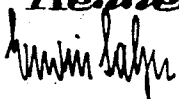


Fig. 6.



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COMPOSITE FUSE LINKS OF SILVER AND COPPER

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13 Claims. (Cl. 200—135)

This invention relates to the protection of electric circuits, electric apparatus and electric machinery by electric fuses.

It is one object of this invention to take advantage of the difference of the properties of silver and copper, respectively, to produce fuse links for current-limiting fuses capable of effecting rapid initiation of the interrupting process, i. e. rapid arc initiation, at the occurrence of major fault currents, which fuse links have a relatively high heat absorbing capacity and heat dissipating ability conducive to time lag in the small overload range, and conducive to a relatively high current-carrying ability.

Another object of the invention is to provide fuse links for so-called silver-sand fuses wherein a portion of the link silver heretofore needed in so-called silver-sand fuses of comparable rating is dispensed with, and replaced by, an amount of copper tending to increase the current rating of the fuse.

Another object of the invention is to provide composite fuse links of silver and copper having an uninterrupted current path of silver from one end or terminal of the link, to the other end or terminal thereof.

Still another object of the invention is to provide composite fuse links of silver and copper which lend themselves readily to the formation of multibreaks in series, and thus to producing high arc voltages, and in which fuse links each of the breaks is formed at a reduced cross-sectional area consisting wholly of silver.

Further objects and advantages of the invention will become more apparent as the following description proceeds, and the features of novelty characterising the invention will be pointed out with particularity in the claims annexed to, and forming part of, this specification.

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

Fig. 1 is a side elevation of the material used for manufacturing fuse links embodying my invention;

Fig. 2 is a section along 2—2 of Fig. 1;

Fig. 3 is substantially a longitudinal section through a fuse including a fuse link embodying my invention;

Fig. 4 is a transverse section along 4—4 of Fig. 3;

Fig. 5 is in substance a longitudinal section through a fuse including a fusing link embodying my invention and designed to produce multibreaks resulting in relatively high arc voltages; and

Fig. 6 is a section along 6—6 of Fig. 5.

The material shown in Figs. 1 and 2 comprises a strip of silver 2 and two spaced strips of copper 1 each arranged one side of the strip of silver 2. Strips 2 and 1 are bonded together to form a substantially unitary strip of sheet metal. The process for producing such composite metals are well known in the art, and therefore do not need to be described here in detail. The aggregate cross-sectional area of the strips of copper 1 is larger than the cross-sectional area of the strip of silver 2. This tends to minimize the cost of the composite strip per unit of current carrying ability thereof, and has additional advantages as will be readily apparent from the ensuing description of Figs. 3—6.

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Referring now to Figs. 3 and 4, the fuse shown therein comprises a fuse link made of a composite metal of the kind shown in Figs. 1 and 2. Strips 1 of copper and strip 2 of silver bonded together along longitudinal edges thereof extend in a direction longitudinally of the fuse and conductively interconnect the two terminal caps or ferrules 5. The two ferrules 5 are mounted on a tubular casing of an appropriate insulating material, e. g. a glass-cloth-synthetic-resin laminate. Each of the ferrules 5 is provided with a slot for insertion of one terminal of the fuse link 1, 2. The terminals or axially outer ends of fuse link 1, 2 may be slightly reduced in width compared to what may be called the overall width of the link 1, 2. Such a reduction in width may be desirable for manufacturing reasons but has no effect upon the performance characteristics of the fuse since the size reduction is effected at an inactive point of the fuse link. Each slot in each of the caps or ferrules 5 is substantially closed by a washer 8 to preclude the silicious arc-quenching filler 7 within casing 3 to flow through the slots in ferrules 5 out of the casing 3. Each ferrule 5 is soldered, as generally done in the art, to one of the axially outer ends of terminals of fuse link 1, 2 to minimize the resistance of the current-path through the fuse. An axially outer cap or ferrule 6 is mounted under pressure on each of the axially inner caps or ferrules 5, and both the outer and the inner caps or ferrules are crimped at their axially inner ends to produce a firm and gas-tight connection with casing 3. Each of the outer caps or ferrules 6 is provided with a blade contact 4 extending away from the casing 3 of the fuse. Fuse link 1, 2 is provided with a neck 2a, or reduced cross-section portion, the cross-sectional area of which determines the fault current which must flow through the fuse to cause the neck to fuse and to vaporize, and thus to initiate the interrupting process, or to initiate arcing within the fuse. Neck 2a is formed by punching two juxtaposed portions out of the link, and thus making two juxtaposed incisions into the link. The transverse width of these incisions exceeds the width of each of the two copper strips 1 resulting in a local complete interruption of the current-path through the copper strips 1, and a local reduction of the cross-sectional area of the current-path through the strip of silver 2. The specific heat of silver is .058 and the specific heat of copper is .092. The specific heat of a metal is indicative of the amount of energy required to cause fusion of a conductor having a predetermined geometry, and under comparable conditions silver is the metal which requires a minimum of fusing energy. The neck 2a consisting wholly of silver is therefore conducive to limiting the peak of the let-through current which may flow through the fuse on occurrence of a short-circuit current, or an equivalent major fault current. The outer strips 1 of copper are effective heat absorbers and heat dissipators. It will be apparent from the above figure relative to the specific heat of copper that the heat absorbing and cooling action of the two strips, or fins, of copper is more effective than that of the lateral portions of a comparable ribbon type fuse link made entirely of silver, and consequently considerably more expensive than the fuse link 1, 2 shown in Fig. 2.

It is important that all copper be removed from the region of arc initiation to limit as much as possible the amount of heat required to cause fusion and vaporization of the narrowest point of the link 1, 2.

Referring now to Figs. 5 and 6, the fuse link provided in the structure shown therein comprises a pair of spaced strips 10 of silver and an intermediate, substantially coextensive strip 9 of copper bonded at the longitudinal edges thereof to said pair of strips of silver to form a virtually unitary strip of sheet metal. The pair of strips 10 of silver have one or more pairs of juxtaposed incisions 10b,

each reducing the cross-sectional area of one of the pair of strips 10 of silver without interrupting the continuity thereof. The copper strip 9 is provided with one or a plurality of punched out portions 9a, each substantially in registry with one of said pair of juxtaposed incision 10b. The punched out portion or portions 9a are wider than and completely sever the copper strip 9 into parts solely held together by said pair of strips 10 of silver. In addition thereto, the punched out portion or portions 9a effect a further reduction of the cross-sectional area of the strips 10 of silver, i. e. a reduction of the cross-sectional area of strips 10 beyond that effected by juxtaposed incisions 10b. As a result of incisions 10b in silver strips 10 and of the punched out portions or perforations 9b in copper strip 9 which extend into silver strips 10 a plurality of pairs of necks, or reduced cross-section portions 10a are formed in silver strips 10. Each of these pairs of necks or reduced cross-section portions 10a in silver strips 10 is adapted to form a pair of parallel current paths. Since these current paths are zones of minimum cross-sectional area, initial fusion and arc initiation will occur at these particular points on the occurrence of short-circuit currents, or like major fault currents. Each pair of necks 10a will result in the formation of two arclets or breaks in parallel, and serially related pairs of necks 10a will result in the formation of serially related pairs of arclets or breaks. Since each neck 10a consists wholly of silver the instantaneous current required for initiating the interrupting process tends to be very low, yet the current carrying capacity of the link tends to be high on account of the heat dissipating action of the portions or section of copper situated to both sides of each perforation 9a.

Fuse link 10, 9, 10 is conductively connected to terminal blocks 11 which are disc shaped and provided with radial grooves 12 for accommodating the axially outer ends of link 10, 9, 10. Each terminal block 11 is provided with a blade contact 14 forming an integral part thereof, and the tubular casing 13 of insulating material is mounted on, and supported by, terminal blocks 11. Transverse pins 15 of steel establish a firm mechanical connection between casing 13 and terminal blocks 11. The inside of casing 13 is filled with a pulverulent arc extinguishing filler 16, preferably clean quartz sand, i. e. quartz sand from which iron and other impurities have been carefully removed.

To increase as much as possible the saving of silver which this design enables to achieve, the aggregate cross-sectional area of the pair of spaced strips 10 of silver ought to be relatively small compared to the cross-sectional area of the intermediate substantially coextensive strip 9 of copper. As applied in this context the term cross-sectional area refers to the points of the fuse link where the silver strips 10 and the copper strip 9 have their normal width rather than to the points of the link where the cross-sectional area of the silver strips 10 has been reduced and where the copper strip 9 has been severed.

It will be apparent from the foregoing that the incisions 10b and the perforations 9a which may both be produced by simultaneously performed punching operations subdivide link 10, 9, 10 into a plurality of serially related current paths of relatively large cross-sectional area formed jointly by copper and silver alternating with current paths of relatively small cross-sectional area formed by silver only. At the points where the current path is formed by silver as well as copper the current flows preponderantly in silver sections rather than in copper sections. This is mainly due to the geometrical configuration of the link causing the copper sections to operate mainly as heat dissipators rather than as conductors of current.

The transverse punched out portions 9a do not necessarily need to be square in shape. This shape has been found to be particularly desirable, but the punched out portions 9a may be even circular, if desired.

In some instances it may be desirable to add some

derating means to the fuse link to increase the time lag thereof. Such a derating means has been shown in Fig. 3 in the form of a tin rivet 2b inserted into the strip of silver 2 immediately adjacent to neck 2a.

The term silver as used in this context is intended to include alloys of silver which have substantially the same low melting energy as silver, and the term copper as being used in this context is intended to include alloys of copper which have thermal properties comparable to those of copper.

It will be understood that I have illustrated and described herein preferred embodiments of the invention and that various alterations may be made in the details thereof without departing from the spirit or the scope of the invention as defined in the appended claims.

I claim:

1. A composite ribbon-type fuse link for current-limiting fuses comprising at least one strip of copper and at least one strip of silver bonded together along the longitudinal edges thereof to form a virtually unitary strip of sheet metal, said strip of copper projecting laterally from at least one of the longitudinal edges of said strip of silver to operate as a lateral cooling fin for said strip of silver, and said strip of copper and said strip of silver having at least one punched out portion of larger width than the width of said strip of copper resulting in a local interruption of the current-path through said strip of copper and a local reduction of the cross-sectional area of the current-path through said strip of silver.

2. A composite ribbon-type fuse link for current-limiting fuses comprising at least one strip of copper and at least one strip of silver bonded together along the longitudinal edges thereof to form a substantially unitary strip of sheet metal, said copper strip and said silver strip being generally coextensive from one terminal of said link to the other terminal thereof, said copper strip and said silver strip having a punched out portion at least at one point thereof situated between the terminals of said link, and the width of said punched out portion exceeding the width of said copper strip.

3. A composite ribbon-type fuse link for current-limiting fuses comprising strips of copper and of silver, including a pair of parallel strips of the same metal and a strip of a different metal arranged between and bonded to said pair of strips of the same metal to form a virtually unitary strip of sheet metal, said pair of strips of the same metal projecting laterally from the longitudinal edges of said strip of a different metal, and said link having at least one punched out portion situated between the ends thereof larger in width than the width of the constituent copper of said link at the point thereof where said portion is situated to cause a local interruption of the current-path through copper and a local reduction of the cross-sectional area of the current-path through silver.

4. A composite ribbon-type fuse link for current-limiting fuses comprising substantially coextensive strips of copper and of silver bonded together at the longitudinal edges thereof to form a virtually unitary strip of sheet metal, the cross-sectional area of copper in said link generally exceeding the cross-sectional area of silver therein, and said link having between the ends thereof at least one pair of lateral incisions each larger in width than the width of each of said strips of copper.

5. A composite ribbon-type fuse link for current-limiting fuses comprising a pair of substantially coextensive spaced strips of copper and an intermediate strip of silver bonded together at the longitudinal edges thereof to form a virtually unitary strip of sheet metal, the cross-sectional area of copper in said link generally exceeding the cross-sectional area of silver therein, and said link having substantially midway between the ends thereof one point of generally reduced cross-sectional area formed by a pair of perforations each of larger width than the width of each of said pair of strips of copper.

6. A composite ribbon-type fuse link for current-limit-

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ing fuses comprising strips of copper and of silver including a pair of parallel spaced strips of the same metal extending in a direction longitudinally of said link and a strip of a different metal arranged between and bonded to said pair of strips of the same metal at the longitudinal edges thereof to form a virtually unitary strip of sheet metal, and said link having a substantially transverse punched out portion substantially midway between the ends thereof, the width of said punched out portion being less than the total width of said link but exceeding the total width of said strips of copper.

7. A composite fuse link for current-limiting fuses comprising a pair of spaced strips of copper and an intermediate generally coextensive strip of silver extending in a direction longitudinally of said link and bonded at the longitudinal edges thereof to said pair of strips of copper to form a virtually unitary strip of sheet metal, said link having at least one pair of juxtaposed substantially V-shaped incisions each of greater depth than the width of one of said pair of copper strips and each completely severing one of said pair of copper strips at a predetermined point between the ends thereof, and said pair of incisions reducing the cross-sectional area of said silver strip without interrupting the current-path therethrough.

8. A composite fuse link for current-limiting fuses comprising a pair of spaced strips of silver having a relatively small aggregate cross-sectional area and an intermediate substantially coextensive strip of copper having a relatively large cross-sectional area bonded at the longitudinal edges thereof to said pair of strips of silver to form a virtually unitary strip of sheet metal, said link having at least one pair of neck portions wholly consisting of silver adapted to lie in parallel in an electric circuit into which said link is inserted.

9. A composite ribbon-type fuse link for current-limiting fuses comprising at least one strip of copper and at least one strip of silver bonded together at the longitudinal edges thereof to form a virtually unitary strip of sheet metal, said link having between the ends thereof at least one substantially transverse incision of larger width than said strip of copper totally severing said one strip of copper.

10. A composite ribbon-type fuse link for current-limiting fuses comprising at least one strip of copper and at least one strip of silver bonded together at the longitudinal edges thereof to form a virtually unitary strip of sheet metal, said link having a plurality of serially arranged punchings subdividing said link into a plurality of serially related current-paths of relatively large cross-sectional area formed jointly by copper and silver alternating with current-paths of relatively small cross-sectional area formed by silver alone.

11. A composite ribbon-type fuse link for current-limiting fuses comprising at least one strip of copper and at least one strip of silver bonded together at the

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longitudinal edges thereof to form a virtually unitary strip of sheet metal, the cross-sectional area of copper in said virtually unitary strip being large compared to the cross-sectional area of silver therein, and a plurality of punched out portions spaced in a direction longitudinally of said virtually unitary strip, the width of each of said punched out portions exceeding the width of said strip of copper and each of said punched out portions constituting a complete break of the current-path through copper and a reduction of the cross-sectional area of the current-path through silver.

12. A composite ribbon-type fuse link for current-limiting fuses comprising a pair of spaced strips of silver and a strip of copper arranged between and bonded at the longitudinal edges thereof to said pair of strips of silver to form a virtually unitary strip of sheet metal, the cross-sectional area of said strip of copper exceeding the aggregate cross-sectional areas of said pair of strips of silver, and a plurality of spaced punched out portions in said virtually unitary strip extending substantially in transverse direction thereof, each of said punched out portions exceeding in width the width of said strip of copper and each of said punched out portions constituting a complete local break of the current path through copper and a local reduction of the cross-sectional area of the current-path through silver.

13. A composite ribbon-type fuse link for current-limiting fuses comprising a pair of spaced strips of silver and a strip of copper arranged between and bonded at the longitudinal edges thereof to said pair of strips of silver to form a virtually unitary strip of sheet metal, the cross-sectional area of said strip of copper exceeding the aggregate cross-sectional areas of said pair of strips of silver, a punched out portion in said virtually unitary strip extending substantially in transverse direction thereof and being of larger width than the width of said strip of copper to locally completely break the current-path through said strip of copper and to locally reduce the cross-sectional area of the current-path through each of said pair of strips of silver, and a pair of lateral incisions in each of said pair of strips of silver locally reducing the cross-sectional area of the current-path through each of said pair of strips of silver to a larger extent than effected by said punched out portion.

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