July 19, 1966 F. J. KOZACKA 3,261,952

TIME-LAG FUSE WITH RIBBON FUSE LINK HAVING TWO SYSTEMS OF BENDS

Filed Nov. 30, 1964

FIG. 1

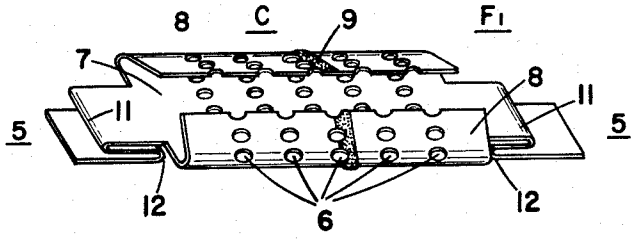


FIG. 2

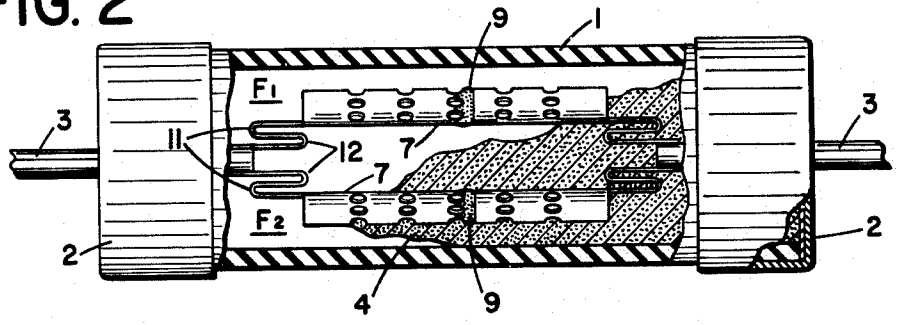


FIG. 3

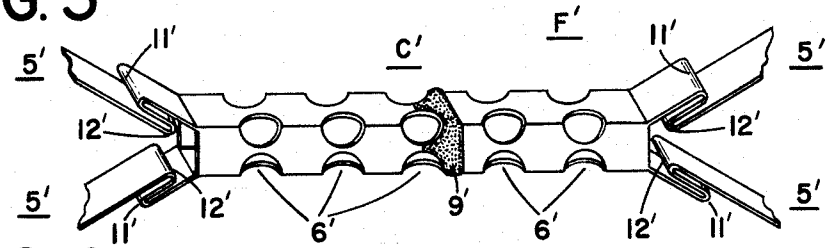
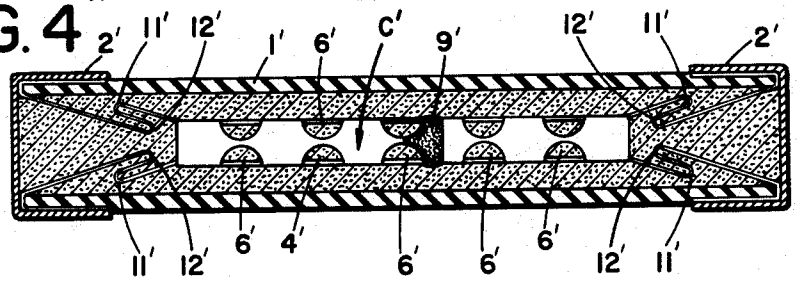


FIG. 4



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TIME-LAG FUSE WITH RIBBON FUSE LINK HAVING TWO SYSTEMS OF BENDS

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5 Claims. (Cl. 200—131)

This invention is concerned with, and relates to, electric fuses, and more particularly time-lag fuses.

It is one object of this invention to provide electric fuses incorporating the teachings of U.S. Patent 3,123,693; issued March 4, 1964 for Time-Lag Fuses of the Blade Contact Type, and in U.S. Patent 3,143,615; issued August 4, 1964 for Springless Time-Lag Fuses for Motor Circuits, yet having significant advantages over the fuses disclosed in these two patents.

If fuses according to the two above patents are filled with an arc-quenching filler having a lower thermal conductivity than quartz sand, their time-lag at about five times the rated current is sufficiently long to preclude blowing at the occurrence of relatively high motor starting inrush currents. The use of such arc-quenching fillers limits, however, the interrupting capacity of the fuse structure. Substitution, in such fuses, of quartz sand for an arc-quenching filler having a relatively lower thermal conductivity results in an increase of the rated current of the fuse structures, and in a reduction of the time-lag thereof, thus limiting their applicability in motor circuits, or making it altogether impossible to use such fuse structures in motor circuits.

It is, therefore, an object of this invention to provide electric time-lag fuses incorporating the teachings of the two aforementioned patents, and having all the advantages of the fuses described and claimed in the two aforementioned patents, yet capable of achieving even in the presence of quartz sand as arc-quenching medium the maximum degree of time-lag ever required in motor circuits.

Another object of the invention is to provide time-lag fuses which generate high arc-voltages due to the presence of a silicious arc-quenching filler having a high thermal conductivity, particularly quartz sand, and which fuses have a high interrupting capacity and much longer time-lags than any comparable prior art fuses.

Another object of this invention is to provide fuse structures making it possible to control and increase time-lag to a greater extent than had been possible heretofore, and to effect such a control and increase of time-lag even in the presence of quartz sand as arc-quenching filler.

Another object of this invention is to provide electric fuses having a fuse link structure including a link-severing overlay of a metal having a relatively low fusing point operative on occurrence of relatively small protracted overload currents to sever the fuse link structure by a metallurgical reaction, wherein the fuse link structure is designed to effectively interrupt high short-circuit currents when submersed in an appropriate arc-quenching medium and wherein the fuse link structure is designed to achieve any time-lag required for application of the fuses in motor circuits having high motor starting inrush currents.

Another object of this invention is to provide electric fuses capable of achieving any time-lag required for application of the same in motor circuits having high motor starting inrush currents without resorting to spring-biased solder joints for controlling small protracted overload currents, without breaking the continuity of the fuse link structure between the fuse terminals as required when spring-biased solder joints are being used for controlling small protracted overload currents, and without resorting to arc-quenching media having a smaller arc-quenching action than quartz sand.

In the fuses of the two aforementioned U.S. Patents 3,123,693 and 3,143,615 long time-lags are achieved mainly by folding the center portion of a fuse link transversely to define a duct extending in a direction longitudinally of the casing of the fuse, thus limiting heat exchange between the fuse link and ambient space and adjacent structures. According to the present invention the connector tabs of the fuse link are folded longitudinally to assume substantially zig-zag configuration, this kind of folding being in addition to the aforementioned transverse folding of the center portion of the fuse link. As a result of this kind of composite folding of the fuse link in transverse and longitudinal directions, heat losses through heat transfer are further reduced, resulting in a relatively heavy fuse link structure, or one involving a relatively large mass, to achieve a given current rating. Consequently the lag-times of such fuses are particularly long.

For a better understanding of the invention reference may be had to the accompanying drawings wherein:

FIG. 1 is an isometric view of a fuse link intended for the fuse structure of FIG. 2;

FIG. 2 is a part a front elevation and in part a longitudinal section of a fuse structure including two fuse links of the kind shown in FIG. 1;

FIG. 3 is an isometric view of a fuse link intended for the structure of FIG. 4; and

FIG. 4 is a longitudinal section of a fuse structure including a fuse link of the kind shown in FIG. 3.

Referring now to the drawings, and more particularly to FIGS. 1 and 2 thereof, reference character **1** has been applied to indicate a casing of insulating material such as, for instance, a synthetic-resin-glass-cloth laminate. Both ends of casing **1** are closed by terminal caps **2**. Blade contacts **3** project from the outside of casing **1** transversely across terminal caps **2** into the inside of casing **1**. The inside of casing **1** is filled with a pulverulent arc-quenching filler 4, preferably granular quartz or quartz sand. Casing **1** houses a pair of ribbon fuse links F_1, F_2 of a current-limiting metal. The term current-limiting metal is used in this context as generic term including silver and copper, and excluding other metals. Fuse links F_1 and F_2 are identical. Each comprises a center portion generally designated by the reference character C and connector tabs designated by the reference number **5**. Center portion C is perforated or, to be more specific, it has five transverse lines **6** of perforations. Each center portion C is formed by sheet metal bent substantially to the shape of a channel including web surfaces **7** and flange surfaces **8**. The flange surfaces **8** enclose with the web surface **7** angles of about 30 degrees. The two web surfaces **7** of fuse links F_1, F_2 extend parallel to the general plane defined by blade contacts **3**. The two web surfaces **7** are relatively narrowly spaced resulting in mutual heating thereof. The flange surfaces **8** of fuse links F_1, F_2 are relatively widely spaced. The channels defined by center portions C of fuse links F_1, F_2 extend in a direction longitudinally of casing **1**. The cross-sectional area and the width of the center portions C of fuse links F_1, F_2 have maximum values at the points situated between the lines **6** of perforations, and the cross-sectional area and the width of the center portions C of fuse links F_1, F_2 have minimum values at the points where the transverse lines **6** of perforations are located. Each fuse link F_1, F_2 is provided with a link-severing overlay **9** of a metal having a relatively low fusing point, or a fusing point less than that of the base metal, or current-limiting metal. Overlay **9** may, for instance, be of a tin or indium. The cross-sectional area and the width of each of connector tabs **5** is less than

the maximum cross-sectional area and the maximum width of center portions C of which connector tabs 5 form axial extensions and integral parts. On the other hand, the cross-sectional area and the widths of each connector tab 5 is larger than the minimum cross-sectional area and the minimum width of each center portion C. The term minimum width of each center portion 6 is used in this context to denote the total width of each portion C, i.e. the aggregate width of its web portion 7 and its two flange portions 8, minus the aggregate width of all the perforations in one of the lines 6 of circular perforations. Each connector tab 5 is folded at two spaced points 11, 12. Points 11 have a predetermined spacing from the center portion C and points 12 have a predetermined spacing from center portions C, the former spacing being larger than the latter spacing. Each connector tab 5 forms at the point 11 thereof a backward loop toward center portion C and at the point 12 thereof a forward loop toward the knife blade contact 3 immediately adjacent theerto. The axially outer ends of connector tabs 5 may be silver-brazed to blade contacts 3. It will be apparent from FIG. 2 that the two loops formed by each connector tab 5 extend in a direction substantially longitudinally of casing 1. Thus connector tabs 5 have generally a zig-zag geometry, each constituent loop thereof being substantially in the shape of a U whose constituent portions extend in a direction longitudinally of casing 1.

The structure of FIGS. 1 and 2 is intended for relatively high current ratings say, in the order of several hundred amperes, while the structure of FIGS. 3 and 4 predicated on the same design principles as that of FIGS. 1 and 2 is intended for smaller current ratings, such as current ratings of less than 100 amperes.

In FIGS. 3 and 4 the same reference characters as in FIGS. 1 and 2, however, with a prime added, have been applied to designate like parts. Thus reference character 1′ has been applied to designate a tubular casing of insulating material closed at the ends thereof by a pair of metal caps 2′. Casing 1′ is filled with a pulverulent arc-quenching filler 4′, preferably quartz sand. Fuse link F′ comprises a perforated axially inner center portion C′ and axially outer connector tabs 5′. Center portion C′ is folded transversely to form a multilateral prism extending in a direction longitudinally of casing 1′. Center portion C′ has a minimum cross-sectional area and a minimum width at the points where its five transverse lines 6′ of circular perforations are located. At the points between transverse lines 6′ of perforations the width and the cross-sectional area of the center portion C′ of fuse link F′ are at maxima. Reference character 9′ has been applied to indicate a link-severing overlay of a metal having a relatively low fusing point, e.g. tin or indium, or appropriate alloys thereof. In the structure of FIGS. 3 and 4 the center portion C′ of fuse link F′ is bent into the shape of a four-sided prism which is square in cross-section, and overlay 9′ extends transversely across all four sides of the prism. The connector tabs 5′ arranged on opposite sides of center portion C′ are bent around the rims of casing 1′ to the outer surface thereof and overlapped by terminal caps 2′. Solder joints (not shown) are formed at the points where caps 2′ engage connector tabs 5′. The two connector tabs 5′ on each of the axially outer ends of center portion C′ have an aggregate cross-sectional area, and an aggregate width, less than the maximum cross-sectional area, and less than the maximum width, of center portion C′, but larger than the minimum cross-sectional area, and the minimum width, of the center portion C′. Each connector tab 5′ is folded at two points 11′, 12′. The spacing of point 11′ from the center portion C′ exceeds that of point 12′. Each connector tab 5′ forms at its point 11′ a backward loop toward center portion C′, and each connector tab 5′ forms at point 12′ a forward loop toward the terminal cap 2′ immediately adjacent thereto.

In the structures of FIGS. 1 to 4, in response to major fault currents, fusion occurs at the five serially related points of minimum cross-sectional area defined by the five transverse lines 6 and 6′, respectively, of circular perforations. The arc voltage generated at these points is sufficiently high to cause interruption of the faulted circuit prior to the next natural current zero. The aforementioned relations of the cross-sectional areas and the width of parts C, C′ and 5, 5″ precludes fusion of parts 5, 5′ rather than of parts C, C′ on occasion of major fault currents.

In case of relatively small overload currents of inadmissible duration the fuse links F_1, F_2, F′ are severed by a metallurgical reaction at the point of narrowest cross-section formed by the transverse center lines 6 and 6′, respectively, of perforations. The geometry of the particular kind of link-severing overlay shown in FIGS. 1 to 4, inclusive, has been disclosed and claimed in U.S. Patent 2,988,620 to F. J. Kozacka, Time-Lag Fuses, June 13, 1961 assigned to the same assignee as the present invention, and reference may be had to the aforementioned patent for additional information regarding the geometry of the link-severing overlay and its relation to the geometry of the fuse link proper.

The transverse and the longitudinal folds in the fuse links F_1, F_2 and F′ minimize heat exchange, or heat dissipation or, in other words, they increase the thermal efficiency of the fuse structure, and hence require the fuse links to be made of relatively thick and wide sheet metal to achieve a given current carrying capacity, or current rating. This is conducive to long time-lags, or delay times.

The time-current characteristic of a fuse structure as shown in FIGS. 1 and 2 is substantially the same as that shown in the aforementioned U.S. Patent 3,123,693 illustrating the performance of the kind of fuses disclosed and claimed in that patent. While the link configuration disclosed in U.S. Patent 3,123,693, in order to achieve with it such a time-current curve, requires an arc-quenching filler having a smaller thermal conductivity than quartz sand and generating relatively small arc-voltages, the structures of FIGS. 1–4 allow to achieve such a time-current curve in the presence of quartz sand as arc-quenching medium. The fuse link structures of FIGS. 1–4 also allow to increase time-lag above and beyond that possible with fuses according to U.S. Patent 3,123,693 if these fuse link structures are combined with a pulverulent arc-quenching filler having a smaller thermal conductivity than quartz sand.

While, in accordance with the patent statutes, I have disclosed the specific details of two embodiments of the invention, it is to be understood that these details are merely illustrative, and that many variations thereof may be made without departing from the spirit and scope of the invention. It is my desire, therefore, that the language of the accompanying claims be interpreted as broadly as possible, and that it be limited only as required by the prior state of the art.

I claim as my invention:

1. An electric fuse comprising in combination:

a tubular casing of insulating material; electroconductive terminal elements arranged at the ends of said casing; a pulverulent arc-quenching filler inside of said casing; a ribbon fuse link of a current-limiting metal inside said casing, submersed in said filler, conductively interconnecting said terminal elements, said fuse link including a perforated center portion having a predetermined maximum cross-sectional area and a predetermined minimum cross-sectional area, said center portion being folded transversely to define a duct extending in a direction longitudinally of said casing, a link severing overlay of a metal having a fusing point lower than the fusing point of said current-limiting metal supported by said center portion of said fuse link; said fuse link further in-

cluding a pair of connector tabs each at one of the axially outer ends of said center portion, each of said pair of connector tabs having a substantially smaller cross-sectional area than said maximum cross-sectional area of said center portion and having a larger cross-sectional area than said minimum cross-sectional area of said center portion, and each of said pair of connector tabs being folded twice in a direction longitudinally of said casing to form a pair of loops both extending substantially in a direction longitudinally of said casing.

2. An electric time-lag fuse comprising in combination:

a tubular casing of insulating material; a pair of electro-conductive terminal elements each arranged at one of the ends of said casing; a quartz arc-quenching filler inside of said casing; a ribbon fuse link of a current-limiting metal arranged inside said casing, submersed in said filler, conductively interconnecting said pair of terminal elements, said fuse link including a perforated center portion having a predetermined maximum cross-sectional area and a predetermined minimum cross-sectional area and being folded transversely to define a duct extending in a direction longitudinally of said casing; a link-severing overlay of a metal having a relatively low fusing point supported by said center portion; said fuse link further including a pair of connector tabs each at one of the axially outer ends of said center portion and each having a cross-sectional area smaller than said maximum cross-sectional area of said center portion and larger than said minimum cross-sectional area of said center portion, each of said pair of connector tabs being folded at a first point thereof having a predetermined axial spacing from said center portion to form a backward loop toward said center portion, and each of said pair of connector tabs being further folded at a second point thereof having a smaller axial spacing from said center portion than said first point to form a forward loop toward one of said pair of terminal elements immediately adjacent thereto.

3. An electric fuse comprising in combination:

a tubular casing of insulating material; electroconductive terminal elements arranged at the ends of said casing; a pulverulent arc-quenching filler inside said casing; a pair of ribbon fuse links of a current-limiting metal inside said casing, submersed in said filler, conductively interconnecting said terminal elements, said pair of fuse links including perforated center portions having a pair of substantially parallel surfaces relatively narrowly spaced from each other, said center portions further having surfaces relatively widely spaced from each other projecting away from said relatively narrowly spaced surfaces and defining jointly with said pair of relatively narrowly spaced surfaces a pair of parallel ducts extending in a direction longitudinally of said casing, each of said center portions having a predetermined maximum cross-sectional area and a predetermined minimum cross-sectional area; link-severing overlays of a metal having a lower fusing point than said current-limiting metal supported by said center portions; each of said pair of fuse links further including a pair of connector tabs at the axially outer ends thereof having a substantially smaller cross-sectional area than said maximum cross-sectional area of each of said center portions and having a larger cross-sectional area than said minimum cross-sectional area of each of said center portions, each of said pair of connector tabs being folded longitudinally to assume a zig-zag configuration involving a first loop toward said center portions of said pair of fuse links and a second loop away from said center portions of said pair of fuse links.

4. An electric fuse comprising in combination:

a tubular casing of insulating material; a pair of terminal caps closing the ends of said casing; a pair of blade contacts each projecting from the outside of said casing transversely through one of said pair of caps into the inside of said casing; a granular quartz filler inside said casing; a pair of ribbon fuse links of a current-limiting metal inside said casing, submersed in said filler, conductively interconnecting the axially inner ends of said pair of blade contacts, said pair of fuse links including perforated substantially channel-shaped center portions having web surfaces arranged in planes parallel to the general plane defined by said pair of blade contacts and flange surfaces defining jointly with said web surface a pair of channel spaces extending in a direction longitudinally of said casing, each of said center portions having a predetermined maximum cross-sectional area and a predetermined minimum cross-sectional area; link-severing overlays of a metal having a lower fusing point than said current-limting metal supported by said center portions; each of said pair of fuse links further including a pair of connector tabs sandwiching axially inner ends of said pair of blade contacts, each of said pair of connector tabs having a substantially smaller cross-sectional area than said maximum cross-sectional area of each of said center portions and each of said pair of connector tabs having a larger cross-sectional area than said minimum cross-sectional area of each of said center portions, and each of said pair of connector tabs being folded twice in a direction substantially longitudinally of said casing to form a pair of loops both extending substantially in a direction longitudinally of said casing.

5. An electric fuse comprising in combination:

a tubular casing of insulating material; a pair of terminal caps closing the ends of said casing; a granular quartz filler inside said casing; a ribbon fuse link of a current-limiting metal inside said casing, submersed in said filler, conductively interconnecting said pair of terminal caps, said fuse link including a center portion folded transversely to form a multilateral prism extending in a direction longitudinally of said casing, said center portion having a predetermined maximum cross-sectional area and a predetermined minimum cross-sectional area; a link-severing overlay of a metal having a lower fusing point than said current-limiting metal supported by said center portion; said fuse link further including a pair of connector tabs at each end of said center portion thereof bent around the rims of said casing to the outer surface thereof and overlapped by said pair of terminal caps, said pair of connector tabs having an aggregate cross-sectional area less than said maximum cross-sectional area of said center portion and said pair of connector tabs having an aggregate cross-sectional area exceeding said minimum cross-sectional area of said center portion, each of said pair of connector tabs being folded at a first point thereof having a predetermined axial spacing from said center portion to form a backward loop toward said center portion, and each of said pair of connector tabs being further folded at a second point thereof having an axial spacing from said center portion less than said first point to form a forward loop toward one of said pair of terminal caps immediately adjacent thereto.

No references cited.

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