

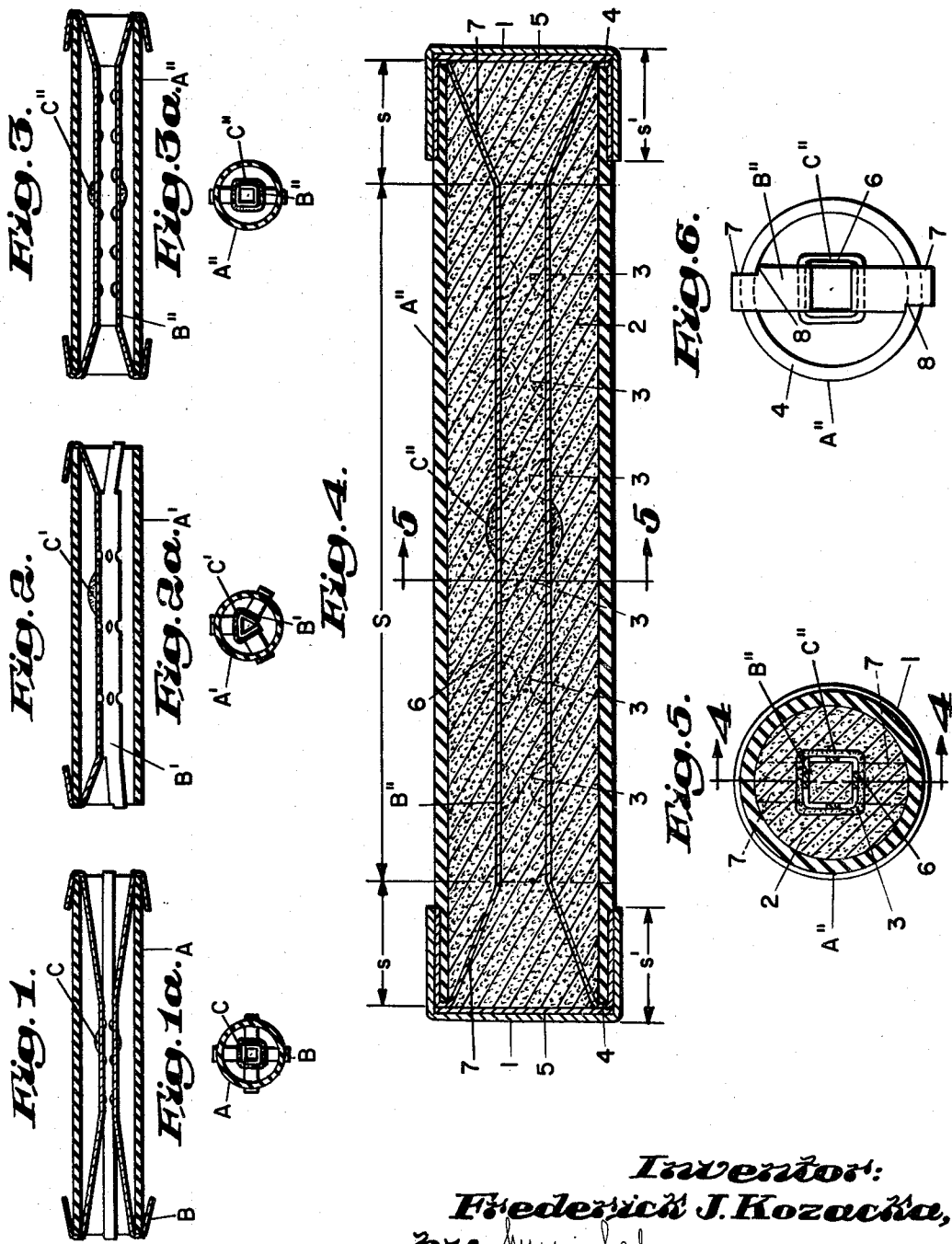
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SPRINGLESS TIME-LAG FUSES FOR MOTOR CIRCUITS

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SPRINGLESS TIME-LAG FUSES FOR MOTOR CIRCUITS

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This invention has reference to electric fuses, and more particularly to time-lag fuses.

It is one object of this invention to provide springless time-lag fuses adapted to be inserted into motor circuits.

This application is a continuation-in-part of my co-pending patent application Ser. No. 21,044, filed June 13, 1961, for Time-Lag Fuses, now U.S. Patent 3,029,328, issued April 10, 1962.

It is another object of this invention to provide time-lag fuses whose geometry is similar to, and whose mode of operation is substantially the same as that of, the fuses disclosed in my above U.S. Patent 3,029,328, but which have improved operating characteristics, particularly in regard to the arc voltage generated incident to blowing of the fuses as a result of major fault currents.

Another object of the present invention is to provide time-lag fuses whose fuse links have a center portion of increased length and end portions of reduced length and which fuses have substantially the same time-current curves as the time-lag fuses described in U.S. Patent 3,029,328, but are capable of generating substantially higher arc voltage than the fuses described in the above patent.

Another object of this invention is to provide electric time-lag fuses similar to those shown in U.S. Patent 3,029,328, but having more effective arc voltage generating means and more compact heat dam means or heating means immediately adjacent the terminals thereof.

Another object of the invention is to provide springless time-lag fuses of the terminal cap type adapted for relatively low current ratings, e.g. current ratings of 30 to 60 amps. and capable of delaying blowing at the occurrence of transient inrush currents such as found in motor circuits upon starting of a motor.

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

For a more complete understanding of the invention reference may be had to the following detailed description thereof taken in connection with the accompanying drawings wherein—

FIG. 1 is a diagrammatic illustration of the basic structure of U.S. Patent 3,029,328 shown in an axial section;

FIG. 1a is a cross-section of the structure of FIG. 1;

FIG. 2 is a diagrammatic illustration of the basic structure of a fuse embodying the present invention shown in an axial section;

FIG. 2a is a cross-section of the structure of FIG. 2;

FIG. 3 is a modification of the structure shown in FIG. 2 and shows the same in an axial section;

FIG. 3a is a cross-section of the structure of FIG. 3;

FIG. 4 shows the same structure as FIG. 3 on a larger scale and is a section along 4—4 of FIG. 5;

FIG. 5 is a section along 5—5 of FIG. 4; and

FIG. 6 is an end view of a part assembly comprising the casing and the fuse link of the structure of FIGS. 3, 3a, 4 and 5.

Referring now to the drawings, and more particularly to FIGS. 1 and 1a thereof, reference character A has been applied to indicate a tubular casing of insulating material, e.g. vulcanized fiber. Fuse link B made of a sheet metal having a relatively high fusing point is arranged within casing A. Fuse link B comprises an axially inner portion bent to envelop the longitudinal axis of casing A

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and axially outer portions exceeding in length the length of said axially inner portion. The axially outer portions are bent around the edges or rims of casing A and turned upon the outer surface thereof. The structure of FIGS. 1 and 1a further comprises an overlay C on the axially inner portion of fuse link B of a metal having a lower fusing point than the base metal of link B adapted to sever the axially inner portion of link B by a metallurgical reaction involving diffusion of metals when said lower fusing point is reached. FIGS. 1 and 1a do not show a pair of terminal caps which are present in the completed fuse structure, i.e. which are mounted upon the ends of casing A upon the axially outer portions of link B which are situated on the outer surface of casing A. For additional details of the structure of FIGS. 1 and 1a reference may be had to the aforementioned U.S. Patent 3,029,328. It will also be understood that the casing of the structure of FIGS. 1 and 1a will normally be filled with pulverulent arc-quenching filler as, for instance, gypsum or chalk, not in FIGS. 1 and 1a.

Fuses for the protection of motor circuits require relatively long time-lags at currents in the order of five times the current rating of the fuse. To be more specific, at currents in the order of five times the current rating of the fuse the time-lag should be in the order of 10 sec. Such time-lags could not be achieved heretofore in fuses having small current ratings by springless fuse structures unless resorting to the structure of FIGS. 1 and 1a. In that structure the length of the time-lag is predicated upon the coaction of a number of factor such as the substantially tubular geometry of the axially inner portion of the fuse link, the presence of overlay C having a relatively large heat absorbing capacity, the nature of the arc-quenching filler, and to a critical extent the length of the ends of the fuse link of which each is in the form of four outwardly flaring tabs defining a space in the shape of a truncated cone. These ends function as thermal insulators for the relatively short axially inner portion of the fuse link, tend to reduce the current-carrying capacity of the latter and thus to achieve a relatively substantial time-lag for fuses having a current rating which may be, for instance, in the order of 30 to 60 amps. The structure of FIGS. 1 and 1a has, however, one significant limitation which consists in that a substantial portion of the total length of the fuse structure is occupied by the long radially outwardly flaring thermal insulator ends of the fuse link at the expense of the arc-voltage generating center portion of the fuse link. As a result, the arc-voltages generated by the fuse link by its coaction with a pulverulent arc-quenching filler are relatively low. This tends to limit the capacity of the fuse structure to interrupt very high fault currents, particularly if the circuit voltage is relatively high, say 600 volts.

It is one object of this invention to so modify the structure of FIGS. 1 and 1a that the time-lag characteristics thereof remain unchanged, but that its ability to generate relatively high arc voltages is substantially increased. This is achieved according to this invention by shortening the outwardly flaring ends of the fuse link and by increasing the relative length of the axially inner portion of the fuse link and by providing the axially inner portion of the fuse link with an increased number of points of reduced cross-sectional area which form series breaks on blowing of the fuse at relatively high currents, e.g. currents in the order of 20 times, or 40 times, the rated current of the fuse.

It has been found to be possible to substantially reduce the length of the axially outer ends of the fuse link without substantially changing the time-current curve of the fuse structure by reducing the cross-sectional area of

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the ends of the fuse link. FIGS. 2 and 2a show a structure comprising a tubular casing A' of insulating material, and a fuse link B' having an axially inner portion bent to envelop the longitudinal axis of casing A'. The axially inner portion of fuse link B' is in the shape of a prism which is triangular in cross-section. The ends of the link are formed by tabs whose total cross-section, or cross-sectional area, is substantially less than the cross-section, or cross-sectional area, of the axially inner portion of fuse link B'. The term cross-section of the axially inner portion of fuse link B' refers to the normal cross-section of the axially inner portion rather than to the cross-section at the points of reduced cross-section formed by transverse lines of circular perforations. The aggregate cross-section of the three tabs at each end of the axially inner portion of fuse link B' is slightly larger than the cross-section of the axially inner portion of fuse link B' at the points where the latter has a reduced cross-section by virtue of the presence of a transverse line of circular perforations. The aggregate cross-section of the tabs forming the ends of fuse link B' cannot be further reduced because in case of high fault currents such reduction would result in a transfer of the points of arc initiation from the points of reduced cross-section of the axially inner portion of link B' to the end tabs of fuse link B'. This, in turn, would be conducive to failure of the fuse structure.

FIG. 2 indicates that the cross-section of each end tab is smaller than the cross-section of each side of the prism immediately adjacent to the respective end tab. The structure of FIGS. 2 and 2a is provided with an overlay C' of a metal having a relatively low fusing point operating as a heat absorber and as a means for severing the axially inner portion of the fuse link C' after predetermined time-delays.

In the structure of FIGS. 3 and 3a the axially inner portion of sheet metal fuse link A'' is in the shape of a prism having four sides and being square in cross-section. Each end of the axially inner portion of fuse link B'' has but two end tabs. Each of these end tabs has about the same cross-section as one of the four sides of the axially inner portion or, in other words, the cross-section of the axially outer end tabs is about one half of the cross-section of the axially inner portion of link B'' which is bent to envelop the longitudinal axis of casing A'' and supports overlay C'' of a low fusing point metal.

It will be noted that the link structure of FIGS. 2 and 2a is provided with three transverse lines of circular perforations, and that the link structure of FIGS. 3 and 3a is provided with six such lines of perforations, thus greatly increasing the points of series breaks formed, and the arc voltage generated, incident to the blowing of the fuse at major fault currents. While the reduction of the number of end tabs, and the reduction of their aggregate cross-section, respectively, is primarily intended to allow an increase of the arc voltage incident to blowing on severe fault currents, a secondary desirable result of these features consists in that they facilitate the filling of the casing of the fuse with a pulverulent arc-quenching filler during the process of manufacturing of the fuse structure.

Referring now to FIGS. 4-6, reference character A'' has been applied to indicate a tubular cylindrical casing of insulating material, e.g. vulcanized fiber, closed on both ends thereof by terminal caps 1. Casing A'' is filled with a pulverulent arc-quenching filler 2 having a smaller heat conductivity than quartz sand. The use of such a filler is indicated wherever it is required to achieve very high time-delays in the current range of about five times the rated current of the fuse. Where the time-delay requirements are less stringent quartz may be used as an arc-quenching filler yet, in this case, the casing of the fuse ought to be made of an insulating material which is more heat resistant than vulcanized fiber. A pair of terminal

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caps of pressed sheet metal is mounted on the ends of casing A''. The axially inner ends of caps 1 are preferably crimped radially inwardly to firmly secure caps 1 to casing A''. Casing A'' houses a fuse link B'' of a sheet metal having a relatively high fusing point. Link B'' may be of copper, or silver. It is submersed in the pulverulent arc-quenching filler 2 and includes the axially inner or center portion 6 situated in the center region of casing A'' and bent to form four radially juxtaposed surface elements extending parallel to the generatrices of casing A''. These four surface elements are in the shape of a prism having four sides and being square in cross-section. Fuse link B'' is also fashioned to form outwardly flaring ends 7 bent around the rims 4 of casing A'' and turned upon the outer surface thereof and covered by caps 1. The ends 7 on each end of the center portion 6 have a smaller aggregate cross-section than the center portion at the points thereof where its cross-section is not reduced by perforations. The portions of the ends 7 situated between the center portion 6 and the axially outer rims 4 have an aggregate length less than the center portion 6. In FIG. 4 the length of the center portion has been indicated by the reference character S and the aggregate length of the ends 7 situated between center portion 6 and rims 4 has been indicated by 2s. It will be apparent that $S > 2s$. The length of each cap is s' and it is apparent from FIG. 4 that $s \sim s'$, i.e. that the length of each end 7 situated between center portion 6 and an axially outer rim 4 is approximately equal to the length s' of one of the caps. While this is the ultimate in the process of shortening the ends and increasing the relative length of the arc voltage generating center portion 6, it is generally desirable to impart to s a value slightly exceeding the length s' of caps 1.

It will be apparent from FIG. 4 that a washer of asbestos or of a like fibrous heat resistant material is interposed between rims 4 and the inside of caps 1.

Link B'' is provided with an overlay C'' of a metal having a relatively low fusing point—e.g. tin—coextensive with the perimeter of center portion 6 for severing center portion 6 by a metallurgical reaction involving diffusion of metals upon reaching of said relatively low fusing point by said overlay.

It will be noted from FIGS. 4-6, inclusive, that the number of end tabs is less than the number of the sides of the prismatic center portion 6, the former being two at each end of center portion 6, and the number of the sides of center portion 6 being four.

As clearly shown in FIGS. 4 and 5 the center portion 6 of fuse link B'' is provided with six transverse lines 3 formed by circular perforations. The constituent perforations of each line 3 are arranged along a family of parallel lines extending in a direction longitudinally of casing A'' and center portion 6 of fuse link B'' is bent along lines of said family to form a substantially prismatic structure. In other words, each of the four edges of the prismatic center portion 6 of fuse link B'' is formed by one member of the aforementioned family of lines. It is relatively easy to bend the center portion 6 of fuse link B'' along said family of lines since each of them is a locus of minimal section in a direction longitudinally of portion 6 of link B''.

In the process of manufacturing a fuse structure of the kind shown in FIG. 3 the center portion 6 of link B'' must be positioned exactly in the center region of casing A'' and the end tabs 7 must be bent around rims 4 of casing A'' exactly at the right points. This exacting task is rendered quite easy even for relatively unskilled workers by the provision of an index mark 8 on each end tab 7 indicating the point where the mark 8 must register with rim 4 in order that center portion 6 be properly centered, and indicating the several points where end tabs 7 must be bent around rims 4.

On occurrence of transient overloads of relatively short

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duration overlay C'' will not melt and, therefore, center portion 6 of link B'' will remain intact.

If an overload current is of excessive duration overlay C'' will melt, cause formation of a pair of series breaks along the two transverse lines 3 of perforations between which overlay C'' is arranged, and this results in generation of a sufficiently high arc-voltage to cause rapid interruption of the overloaded circuit.

Short-circuit currents result in the formation of six series breaks, each at one of the six transverse lines 3 of circular perforations.

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

I claim as my invention:

1. A time-lag fuse comprising in combination:

- (a) a tubular cylindrical casing of insulating material;
- (b) a pulverulent arc-quenching filler inside said casing;

(c) a pair of terminal caps each mounted upon one of the ends of said casing and closing said casing;

(d) a fuse link of sheet metal having a relatively high fusing point arranged inside said casing and submerged in said filler, said fuse link including a center portion situated in the center region of said casing and bent to form radially juxtaposed surface elements extending parallel to the generatrices of said casing, and said fuse link being fashioned to form outwardly flaring ends bent around the axially outer rims of said casing and turned upon the outer surface thereof and covered by said pair of caps, said ends on each end of said fuse link being smaller in aggregate cross-section than said center portion and the portion of said ends situated between said center portion and said axially outer rims having an aggregate length less than said center portion; and

(e) an overlay of a metal having a relatively low fusing point coextensive with the perimeter of said center portion and supported by said center portion for severing said center portion by a metallurgical reaction upon reaching of said relatively low fusing point by said overlay.

2. A time-lag fuse as specified in claim 1 wherein said center portion is substantially in the shape of a prism which is square in cross-section and wherein there are less than four of said outwardly flaring ends on each end of said center portion.

3. A time-lag fuse as specified in claim 1 wherein there are but two outwardly flaring ends on each end of said center portion, and wherein the portion of said ends situated between said center portion and said axially outer rims of said casing have a length but slightly exceeding the length of each of said pair of terminal caps.

4. A time-lag fuse comprising in combination:

- (a) a tubular casing of insulating material;
- (b) a pulverulent arc-quenching filler inside said casing;
- (c) a pair of terminal caps each mounted upon one of the ends of said casing and closing said casing;

(d) a fuse link of a sheet metal having a relatively high fusing point arranged inside said casing and submerged in said filler, said fuse link being fashioned to form a substantially tubular structure situated in the center region of said casing in coaxial relation thereto and to further form outwardly flaring ends bent around the axially outer rims of said casing and turned upon the outer surface thereof and covered by said pair of caps, said ends being smaller in cross-section than said tubular structure and the portion of said ends situated between said tubular structure and said rims having a shorter aggregate length than said tubular structure; and

(e) a substantially annular overlay of a metal having

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a relatively low fusing point supported by said tubular structure for severing said fuse link by a metallurgical reaction upon reaching of said relatively low fusing point by said overlay.

5. A time-lag fuse comprising in combination:

- (a) a tubular casing of insulating material;
- (b) a pulverulent arc-quenching filler having a smaller thermal conductivity than quartz-sand inside said casing;

(c) a pair of terminal caps each mounted upon one of the ends of said casing and closing said casing;

(d) a fuse link of sheet metal having a relatively high fusing point arranged inside said casing and submerged in said filler, said fuse link including a center portion situated in the center region of said casing and provided with a plurality of transverse lines of perforations, the constituent perforations of each said transverse lines being arranged along a family of parallel lines extending in a direction longitudinally of said casing and said center portion being bent along lines of said family of lines to form a substantially prismatic structure coaxial to said casing, and said fuse link being fashioned to form outwardly flaring ends bent around the axially outer rims of said casing and turned upon the outer surface thereof and covered by said pair of caps, said ends on each end of said center portion being smaller in aggregate cross-section than said center portion and the portion of said ends situated between said center portion and said axially outer rims having an aggregate length less than said center portion thereof; and

(e) an overlay of a metal having a relatively low fusing point coextensive with one of said transverse lines of perforations of said center portion for severing said center portion by a metallurgical reaction upon reaching of said relatively low fusing point by said overlay.

6. A time-lag fuse as specified in claim 5 wherein each of said transverse lines of perforations defines a region of reduced cross-section having a predetermined cross-sectional area, and wherein the cross-section of said outwardly flaring ends on each end of said center portion is but slightly larger than said predetermined cross-sectional area.

7. A time-lag fuse comprising in combination:

- (a) a tubular casing of insulating material;
- (b) a fuse link of a sheet metal having a relatively high fusing point arranged inside said casing and including a substantially tubular center portion positioned in the center region of said casing in coaxial relation thereto, said center portion being substantially square in cross-section and provided with a plurality of transverse lines of perforations;

(c) a substantially annular overlay of a metal having a relatively low fusing point supported by said center portion adjacent one of said plurality of lines of perforations for severing said center portion by a metallurgical reaction upon reaching of said relatively low fusing point by said overlay; and

(d) means integral with said center portion conductively connecting each end of said center portion and each of said pair of terminal caps at but two points, said connecting means including a pair of tabs angularly displaced 180 degrees on each end of said center portion and forming extensions of two opposite sides of said center portion, said pair of tabs flaring radially out from said center portion, being bent around the axially outer rims of said casing upon the outer surface thereof and covered by said pair of caps, and two opposite sides of each end of said center portion being tab-less.

8. A time-lag fuse as specified in claim 7 wherein each of said pair of tabs forms a shoulder at the point thereof bent around one of said axially outer rims of said casing.

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