Oct. 6, 1964 F. J. KOZACKA 3,152,233

BLADE-TYPE ELECTRIC FUSES

Filed March 21, 1961 2 Sheets-Sheet 1

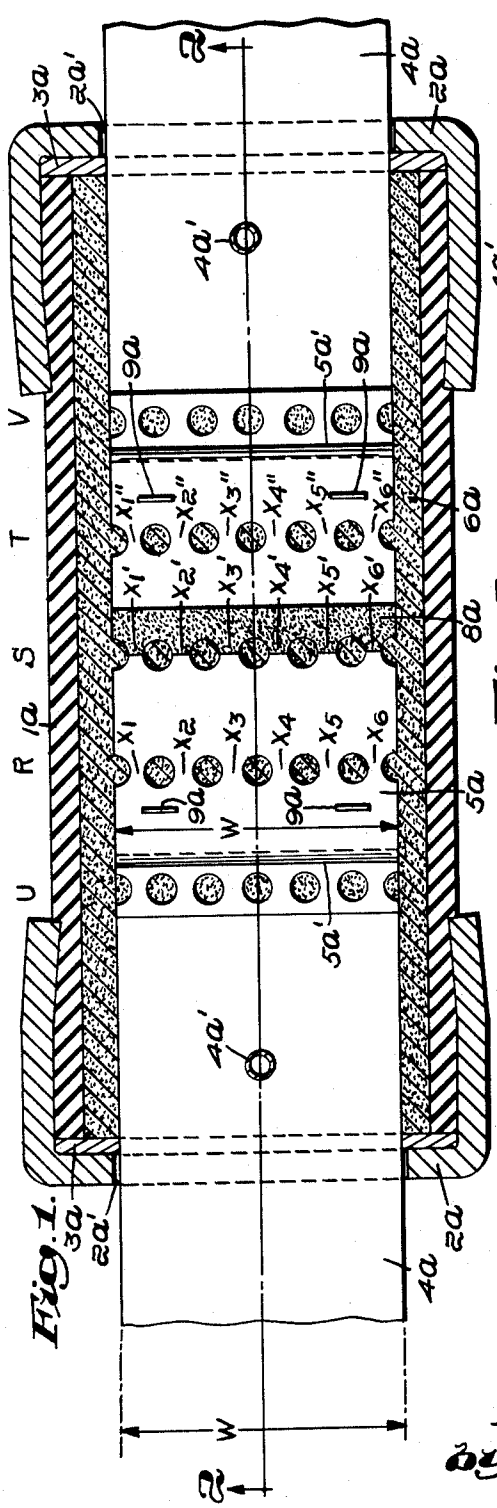


Fig. 1.

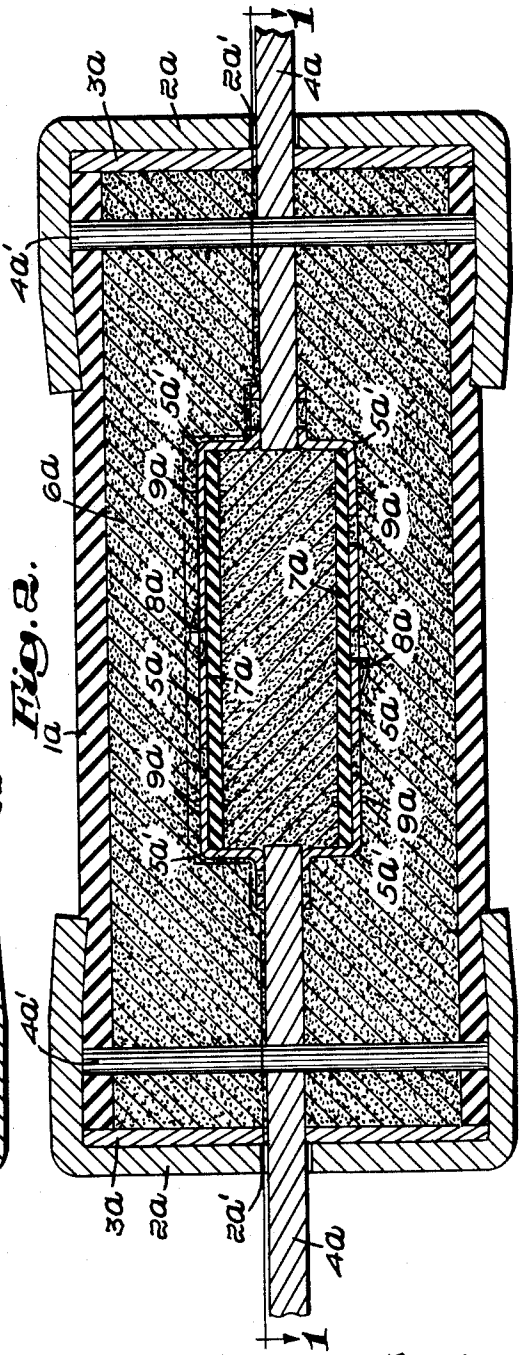


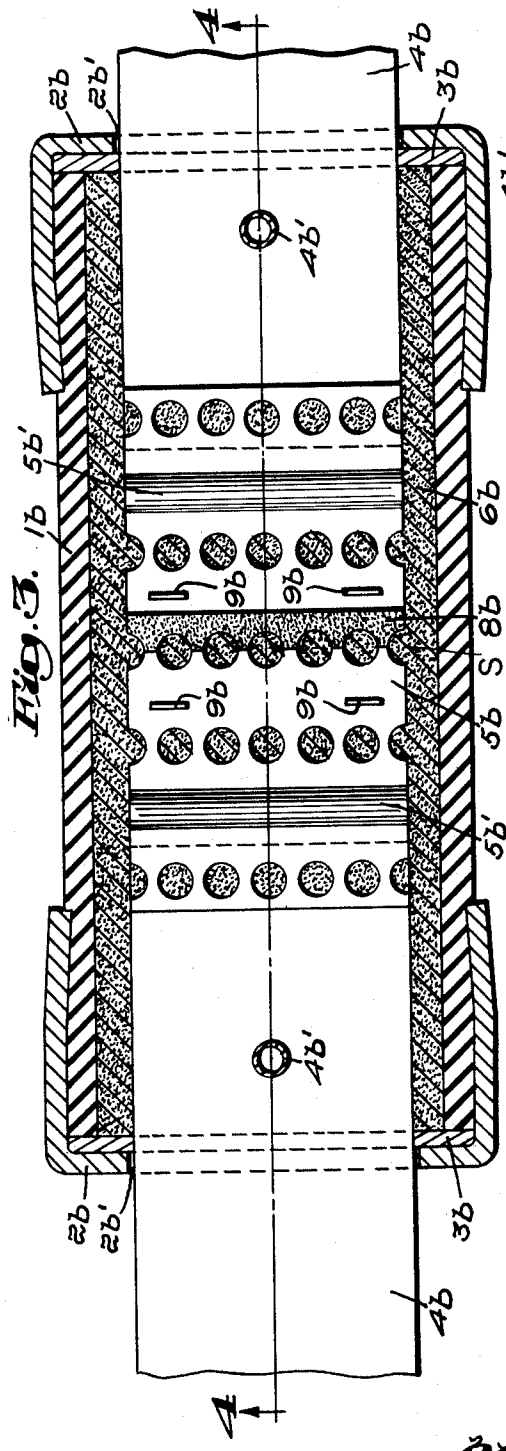
Fig. 2.

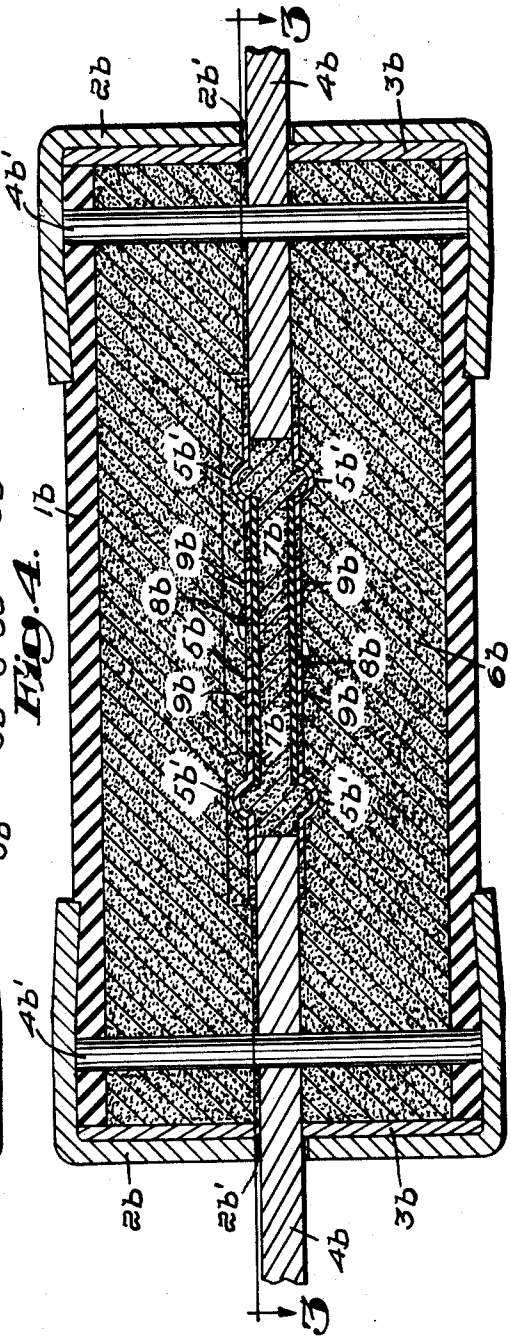
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BLADE-TYPE ELECTRIC FUSES

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3,152,233
BLADE-TYPE ELECTRIC FUSES

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Filed Mar. 21, 1961, Ser. No. 106,994
5 Claims. (Cl. 200—120)

This invention is concerned with electric fuses for protecting electric circuits against excessive currents, and it is more particularly concerned with current-limiting fuses.

It is a widely accepted practice to close the fuse tubes or casings of fuses intended to have a relatively high current carrying capacity and a relatively high interrupting capacity and to be current limiting by copper plugs the axially outer surfaces of which support a pair of aligned blade contacts.

Structures of this kind are relatively expensive. It is, therefore, one object of this invention to provide electric fuses of the blade contact type having a relatively high current carrying capacity and a relatively high interrupting capacity and which are current-limiting, which fuses are easier to manufacture and involve smaller manufacturing cost than the above referred-to type of fuses provided with terminals in the form of copper plugs.

Another object of this invention is to provide electric fuses having a particular kind of fuse links which will hereinafter be referred to as lattice links, in which fuses a pair of lattice links is associated with a pair of blade contacts for connecting that pair of lattice links into an electric circuit.

Another object of the invention is to provide electric fuses which have terminal elements in the form of a pair of blade contacts projecting through a pair of caps closing both ends of the fuse tube or casing, which fuses have a very small voltage drop across said pair of blade contacts when performing their normal current carrying duty, wherein heat generation is thus minimized and which run cool as a result of minimized heat generation.

This application is a continuation-in-part of my copending patent application Ser. No. 764,293, filed September 30, 1958, for Time-Lag Fuses, now United States Patent 2,988,620, issued June 13, 1961.

It is a further object of this invention to provide improved versions of the electric fuse disclosed and claimed in my above referred-to copending patent application.

My above referred-to patent application is concerned with fuses of the time-lag type and it is, therefore, another object of this invention to provide improved electric fuses making it possible to achieve time-lag in the same fashion as disclosed and claimed in the above patent.

Another object of the invention is to provide current-limiting fuses wherein the number of serially related points of reduced cross-section or necks is minimized without impairment of the current-limiting ability of the fuses.

Still another object of the invention is to provide current-limiting fuses wherein the current prevailing at the points of reduced cross-section or neck is relatively small.

Other objects of the invention and advantages thereof 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 description thereof taken in connection with the accompanying drawings, in which:

FIG. 1 is a longitudinal section of an electric fuse embodying this invention taken along 1—1 of FIG 2;

FIG. 2 is a longitudinal section of the fuse shown in FIG. 1 taken along 2—2 of FIG. 1;

FIG. 3 is a longitudinal section of another electric fuse embodying this invention taken along 3—3 of FIG. 4; and

FIG. 4 is a longitudinal section of the fuse shown in FIG. 3 taken along 4—4 of FIG. 3.

Referring now to the drawing, and more particularly to FIGS. 1 and 2 thereof, numeral 1*a* has been applied to indicate a tubular casing of insulating material, e.g. of a synthetic resin-glass-cloth laminate. The axially outer ends of casing or fuse tube 1*a* are closed by a pair of metal caps 2*a* crimped on the axially inner ends thereof into casing 1*a* to establish a strong mechanical connection or tie between casing 1*a* and caps 2*a*. Aligned blade contacts 4*a* made of flat copper stock project from the outside of casing 1*a* transversely through the end surfaces of caps 2*a* into the inside of casing 1*a*. To this end each cap 2*a* is provided with a rectangular cut-out 2*a*′ having substantially the same geometrical configuration as the cross-section of blade contacts 2*a*. Circular washers 3*a* having rectangular cut-outs similar to the cut-outs in caps 2*a* are interposed between caps 2*a* and the axially outer ends of casing 1*a*. Pins or pin-shaped springs 4*a*′ project transversely across casing 1*a* and blade contacts 4*a*. Pins 4*a*′ are intended to secure blade contacts 4*a* to casing 1*a* and to maintain the same axially aligned therein. The aforementioned pin structure has been only diagrammatically indicated in FIGS. 1 and 2. Preferably this structure is designed along the lines fully disclosed in my United States Patent 2,939,935 issued June 7, 1960, for Fuse Structures, and reference may be had to that patent for a full disclosure of the preferred pin structure intended for the embodiment of the invention shown in FIGS. 1 and 2. The axially inner ends of blade contacts 4*a* are conductively interconnected by a pair of ribbon-type fuse links 5*a* of sheet metal and casing 1*a* is filled with a pulverulent arc-quenching filler 6*a*, e.g. quartz sand, in which fuse links 5*a* are submersed. Fuse links or fusible elements 5*a* have the same width as blade contacts 4*a*, the width W of which has been indicated at the left of FIG. 1. The width W is slightly less than the inner diameter of casing 1*a*. It is not absolutely necessary that the width of fuse links 5*a* be exactly equal to that of blade contacts 4*a*, but it is important that the width W of fuse links 5*a* be approximately, or substantially, equal to that of the blade contacts 4*a*, and that the latter is as large as possible. Each of links 5*a* defines a lattice consisting of parallel connected necks and of serially connected necks. A neck of a fuse link is a point thereof where the current density is larger than the current density prevailing at the points of the fuse link where its cross-sectional area is largest and its current-density accordingly smallest. Each fuse link 5*a* is provided with five transverse lines U, R, S, T, V defined by circular perforations forming five transverse lines of necks. The axially outer lines of perforations U, V are superimposed upon blade contacts 4*a* and the axially inner lines of perforations R, S, T define necks generating a circuit-interrupting arc voltage when the fuse blows. Reference characters x_1, x_2 . . . x_5, x_6 have been applied to indicate the necks formed by transverse line of perforations R. Reference character x_1', x_2' . . . x_5', x_6' have been applied to the center line of necks formed by the transverse center line S of perforations, and reference characters x_1'', x_2'' . . . x_5'', x_6'' have been applied to indicate the necks formed by the line of perforations T. The aggregate width 2W of links 5*a* is relatively larger, and the thickness of links 5*a* is relatively smaller, than the width and thickness of conventional fuses having a comparable current rating. This tends to greatly decrease the current density at each neck, and the magnitude of the arc current which flows across each gap formed upon blowing of the fuse at the point of each neck.

It is a generally accepted design principle to increase the number of series necks forming series breaks in pro-

portion to the voltage of the circuit in which a particular fuse is intended to be used. Where a fuse is expected to exhibit a substantial current-limiting action the number of series necks forming series breaks is particularly high since it requires high initial arc voltages to rapidly force a major fault current down to zero. It is a generally accepted practice in the design of low-voltage current-limiting fuses—i.e. current-limiting fuses having a voltage rating of 600 volts or less—to provide the fuse links thereof with a relatively large number of series necks forming series breaks when the fuses blow.

The links or fusible elements of current-limiting fuses having a voltage rating of 600 volts, particularly if such fuses are intended for relatively high current ratings, have generally as much as five serially connected necks forming five series breaks when the fuses blow on major fault currents. FIGS. 1 and 2 (and also FIGS. 3 and 4) show a current-limiting fuse structure having a voltage rating of 600 volts but having only three effective transverse lines R, S, T of necks rather than five such lines. In the structure of FIGS. 1 and 2 the effective number of transverse lines of perforations is three rather than five since the perforations of the axially outer transverse lines U, V are shunted by knife blade contacts *4a* and, therefore, ineffective. This drastic reduction in the number of transverse lines of necks or circular perforations greatly reduces the voltage drop across the blade contacts *4a* while the fuse is performing its normal current carrying duty, and it also reduces greatly the watt losses due to the voltage drop and thus tends to be conducive to a cool running fuse structure.

As shown in FIG. 1 each link *5a* is provided with a system of circular perforations having centers arranged in a lattice pattern. These perforations define a system of necks which are likewise arranged in a lattice pattern. The lattice pattern of circular perforations includes a first family of parallel lines R, S, T extending transversely across each link *5a* and a second family of parallel lines at right angles to said first family and extending in a direction longitudinally of casing *1a*. The second family of lines includes seven parallel spaced lines. There are six parallel lines of series necks between each of said second family of lines of perforations, namely lines of necks x_1, x_1', x_1''; x_2, x_2', x_2'' . . . x_5, x_5', x_5''; x_6, x_6', x''_6. It will be apparent that the number of the above referred-to longitudinal lines exceeds by far the number of transverse lines R, S, T. This is but one way of saying that the number of necks arranged, or connected, in parallel in each of the three transverse lines R, S, T exceeds by far the number of serially connected lines of necks, the first mentioned number being six and the last mentioned number being three. The number of the serially connected lines R, S, T of necks determines the magnitude of the arc voltage immediately upon blowing of the fuse under major fault conditions. That arc voltage increases in proportion to the number of serially connected lines of necks.

Upon having reached a peak value the arc voltage decays at each point of break more or less rapidly, the rate of decay depending inter alia upon the heat generated at the particular point of break and the latter depending upon the density of the arc current at each point of break.

It will now be apparent why the lattice structure shown in FIGS. 1 and 2 makes it possible to achieve in a 600 volt circuit substantially the same current-limiting action which, in comparable prior art current-limiting fuses, called for five series breaks, or five serially connected lines of breaks. The reduction in a number of series necks, or the number of serially connected lines of necks, greatly reduces the initial arc voltage, but the increase of the number of necks in each transverse line of necks greatly reduces the current at each neck or point of break, the heat generated at each point of break and consequently the rate of the decay of the arc voltage at each point of break. This is conducive to a more or less steady or stable arc voltage, or flat top arc voltage, which is the ideal type of arc voltage. This ideal can never be fully attained. Fuse links of the type shown in FIGS. 1 and 2 are, however, conducive to generating a fair approximation to the ideal arc voltage.

The reduction of the number of series necks, or serially connected lines of necks, and the concomitant increase of the number of parallel connected necks per line are not only conducive to arc voltages having relatively small initial peaks and relatively small rates of subsequent decay, but are also conducive to relatively small voltage drops across the fuse while the latter is performing its normal current carrying duty before occurrence of a major fault current.

The cross-sectional area Q max. of a fuse link of perforated sheet stock at any point thereof where the fuse link is not perforated is largely determined by the current carrying capacity which is required of the fuse of which the fuse link forms a part. The cross-sectional area Q min. of a fuse link of perforated sheet stock at any point where its cross-section is reduced to a minimum is determined by the required fusing $i^2 \cdot t$ value of the fuse of which the fuse link forms a part. To decrease in any given design the number of transverse lines of perforations and to increase the number of perforations per line without changing the voltage rating and current rating and the current-limiting ability of the particular fuse structure therefore means to greatly reduce the thickness of the sheet metal of which the fuse link is made, varying its Q max. within limits, and maintaining its Q min. unchanged.

In order to minimize the current per neck two links *5a* are connected in parallel, and each of the two links *5a* is made as wide as possible, i.e. approximately as wide as the pair of wide blade contacts *4a* projecting through caps *2a*. If a fuse intended for a given current carrying capacity is designed in this fashion the ribbon links thereof have a tendency to become thinner than those in conventional fuses having the same current carrying capacity or current rating. This, in turn, makes the fuse links *5a* considerably more fragile. To prevent damage to the very thin and fragile fuse links *5a* each link *5a* is supported by an insulating plate *7a* preferably made of a synthetic resin-glass-cloth laminate, e.g. a melamine-glass-cloth laminate. Plates *7a* are arranged on juxtaposed sides of links *5a*. Links *5a* may be affixed to insulating plates *7a* by means of staples *9a* projecting transversely through the links *5a* and the insulating plates *7a*. In addition to supporting links *5a*, plates *7a* form effective barriers against the flow of products of arcing into the space between links *5a*. The transverse lines of perforations, U, V superimposed upon blade contacts *4a* facilitate soldering of the axially outer ends of links *5a* to the axially inner ends of blade contacts *4a*. These two lines of perforations do not perform any function upon assembly of the fuse when the latter performs its current carrying and interrupting duty and may, therefore, be omitted, if desired. Each link *5a* has axially outer bent portions *5a'* enclosing an angle of 90 degrees with the general plane of blade contacts *4a*. Bends *5a'* are situated between the axially outer ends of metal ribbons *5a* and the axially outer edges of insulating plates *7a*. Bent portions *5a'* impart increased flexibility, or give, to the link structure, which properties are required because of the fragility of the latter. It will be apparent from FIGS. 1 and 2 that forces of compression, tension or torsion resulting from misalignment of blade contacts *4a* are not transmitted to the fragile neck portions of links *5a*.

Each link *5a* is made of a metal having a relatively high conductivity and a relatively high fusing temperature, preferably silver or copper. The conductivity of silver is 62.6 and the fusing point of silver is 960.5 deg. C. The conductivity of copper is 58.8 and the fusing point of copper is 1083 deg. C. The conductivity of

tin is 9.4 and the fusing point of tin is 231.8 deg. C. Tin is a typical low fusing point metal. Zinc has a conductivity of 16.95 and a fusing point of 419.4 deg. C., i.e. its conductivity is less than one third of that of a high conductivity metal such as silver and copper, and its fusing point is less than one half of that of a high fusing point metal such as silver and copper. High conductivity, high fusing point metals such as silver and copper have small fusing $i^2 \cdot t$ values and are, therefore, necessary and desirable for making fuse links for current limiting fuses. Each link **5***a* is provided with an overlay **8***a* of a metal having a relatively low fusing point, e.g. tin, capable, upon fusion thereof, to destroy the base metal by a metallurgical reaction and thus to form a break. Such overlays are well known in the fuse art as a means for achieving time-lag and forming breaks on the occurrence of relatively small protracted overloads, as distinguished from major fault currents. Overlays **8***a* are arranged on remote sides of links **5***a*. It will be apparent from FIG. 1 that overlays **8***a* are coextensive with the entire width of ribbons **5***a* and substantially parallel to the transverse family of lines defining a lattice pattern of necks, and the lattice pattern of circular perforations, respectively. Overlay **8***a* has a family of longitudinal projections extending to, but not beyond, the transverse line S along which necks x_1', x_2' . . . x_5', x_6' are aligned. As a result of this geometry, on occurrence of major fault currents all necks aligned in line S will fuse substantially simultaneously with all necks aligned in lines R and T, whereas on occurrence of small but protracted and inadmissible overloads but the necks aligned in transverse line S will be severed by the action of overlay **8***a*. Thus necks x_1', x_2' . . . x_5', x_6' are dual function necks, forming breaks on occurrence of major fault currents as well as on occurrence of relatively small overloads of inadmissible duration. This dual function feature of the necks aligned along transverse line S makes it possible to rapidly interrupt circuits having a circuit voltage of, and as high as, 600 volts by resorting to but three serialy connected lines R, S, T of necks.

The structure shown in FIGS. 3 and 4 is similar to that shown in FIGS. 1 and 2 and operates in substantially the same fashion as the latter. Referring now to FIGS. 3 and 4, tubular casing **1***b* is closed on both ends thereof by caps **2***b* having rectangular cutouts **2***b'* through which blade contacts **4***b* project from the outside of the casing into the inside thereof. Casing **1***b* is filled with a pulverulent arc-quenching filler **6***b*, e.g. quartz sand, and washers **3***b* preclude the same from leaking out of casing **1***b*. Pin springs **4***b'* project through casing **1***b* and blade contacts **4***b*, integrating these two parts into a structural unit. A pair of ribbon type fuse links **5***b* sandwiches at the axially outer ends thereof the axially inner ends of blade contact **4***b*. Each fuse link is provided with a lattice of circular perforations defining a lattice of necks, both lattices being the same as those shown in FIGS. 1 and 2 and more fully described in connection therewith. The lattice area of both fuse links **5***b* is backed up by insulating plates **7***b* which are coextensive with said area. Staples **9***b* projecting through links **5***b* and insulating plates **9***b* maintain the latter in their proper position. The center line S of perforations and necks is associated with an overlay **8***b* of tin or other low fusing point metal for severing the base metal by a metallurgical reaction on occurrence of relatively small overloads of inadmissible duration. Each fuse link **5***b* is provided with a substantially semicircular bend **5***b'* situated between the axially inner edges of blade contacts **4***b* and the axially outer edges of insulating plates **7***b*. These bends impart a certain flexibility to the structure and help to protect the perforated portion of the links **5***b* against stresses and strains which may result from external forces acting on blade contacts **4***b*.

For reasons of clarity the section plane **1—1** of FIG. 2 and the section plane **3—3** of FIG. 4 are shown in spaced relation from the upper surface of blade contacts **4***a* and **4***b*, respectively, and from the upper surface of fuse links **5***a* and **5***b*, respectively. Actually both these section planes are supposed to coincide with the upper surfaces of the blade contacts and of the upper surfaces of the fuse links. Each circular perforation in fuse links **5***a* and **5***b* respectively accommodates a thin layer of pulverulent arc quenching filler **6***a* and **6***b* respectively clearly shown in FIGS. 1 and 3, and therefore the portions of the blade contacts and the portions of the insulating plates below that thin layer are not exposed to view.

When the fuse structure shown in FIGS. 1 and 2 is carrying current a temperature gradient is established in the direction longitudinally of links **5***a* as well as in transverse direction. The highest spot temperatures occur in necks x_3' and x_4'. When the overlay **8***a* covering necks x_3 and x_4 melts, these two necks are severed by metallurgical reaction and the current continues to flow through the remaining necks x_1', x_2', x_5', x_6' in line S. Soon the overlay on necks x_2', x_5' melts and all the current is then concentrated in necks x_1', x_6'. After these two necks have been severed by the aforementioned metallurgical reaction the current paths through links **5***a* are interrupted.

Interruption on occurrence of major fault currents such as short-circuit currents is effected in a similar sequence of partial link-severing processes. The temperature is highest in necks x_3, x_4; x_3', x_4'; x_3'', x_4'' immediately adjacent the center perforations and decreases toward the two immediately adjacent radially outer perforations. Melting begins at the points where the temperature is highest. Small droplets of liquefied link metal are formed at these points. These droplets have a tendency to flow in transverse direction toward cooler points of the link, this tendency being due to the surface tension of the liquefied metal. There is thus a tendency of formation of transverse gaps beginning with a transverse enlargement of the perforations intersected by plane **2—2**, or a transverse restriction of necks x_3, x_4; x_3', x_4'; x_3'', x_4''. When these necks are completely severed by fusion, fusion and severance of necks x_2, x_5; x_2', x_5'; x_2'', x_5'' begins. When fusion and severance of these necks has been completed, necks x_1, x_6; x_1', x_6'; x_1'', x_6'' are caused to fuse and to be severed. Arcing begins when the last mentioned necks are fused and severed. It has been found that arcing is not limited to the points where fusion occurs last. When links **5***a* are completely severed in transverse direction along lines R, S, T arcing occurs along the entire width of the transverse gaps thus formed. Back burning occurs likewise along the entire width of these gaps, and thus the heat generated during the arcing period is evenly distributed, minimizing the decay of the arc voltage after kindling of series arc at lines R, S, T.

The operation of the structure of FIGS. 3 and 4 is, in substance, the same as that of FIGS. 1 and 2.

Where there is no need for overload protection involving time lag, but merely one for protection against major fault currents or short-circuit currents, overlays **8***a* (FIGS. 1 and 2) and **8***b* (FIGS. 3 and 4) may be omitted.

The fuse structures shown in FIGS. 1–4 are primarily intended for A.C. circuits having a circuit voltage up to and of 600 volts. They are not adapted for interrupting high D.C. currents at voltages as high as 600 volts, but may be used in D.C. circuits if appropriately derated. The back-burning of the ribbon links of these fuse structures is very limited. Hence the total length of ribbons **5***a* and **5***b*, respectively, can be less than 3 inches.

For reasons of greater clarity a different direction of the hatching lines has been adopted in FIGS. 2 and 4 to indicate the arc-quenching filler in the space between the ribbon links **5***a*, **5***b* and outside of the same. It will be understood, however, that there is actually an integral body pulverulent arc-quenching filler throughout the entire casing.

It will be apparent from the foregoing that this invention provides a novel type of high interrupting capacity or current-limiting fuses which is strictly opposed to the current trend in the design of high interrupting capacity or current-limiting fuses inasmuch as the current trend is toward increasing the number of serially connected necks for any given circuit voltage, whereas this invention is predicated upon decreasing the number of serially connected necks for any given circuit voltage. This is made possible by reducing the thickness of the ribbon links and concomitantly increasing both the width thereof and the number of perforations per transverse line of perforation. It thus becomes possible to successfully interrupt circuits having a circuit voltage of 600 volts with ribbon fuse links having but three transverse lines of perforations, or one line of transverse perforations per 200 volts, or for each 200 volts, circuit voltage.

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

I claim:

1. An electric high interrupting capacity fuse comprising in combination:

(*a*) a substantially tubular casing of insulating material having a predetermined inner diameter;

(*b*) a pair of terminal caps closing the ends of said casing;

(*c*) a pair of aligned knife blade contacts having a predetermined width but slightly less than said diameter each projecting from the outside of said casing through the end surface of one of said pair of terminal caps into the inside of said casing;

(*d*) a pair of spaced thin sheet metal ribbons of a metal having a relatively high conductivity and a relatively high fusing point approximately equal in width to said predetermined width conductively interconnecting the axially inner ends of said pair of blade contacts, each of said pair of ribbons including a lattice pattern area of necks connected in parallel and of serially connected necks, said lattice pattern area being formed by substantially transverse lines of perforations, each of said lines of perforations including a predetermined number of perforations per line, the number of perforations per line being substantially in excess of the number of lines of perforations, each of said pair of ribbons having axially outer ends sandwiching therebetween the axially inner ends of said pair of knife blade contacts, and each of said pair of ribbons having a pair of flexible bends situated adjacent to one of the axially outer ends thereof;

(*e*) a filled of quartz sand inside of said casing embedding said pair of ribbons; and

(*f*) two pairs of insulating plates each substantially coextensive with said lattice pattern area of one of said pair of ribbons and each affixed to one of said pair of ribbons on juxtaposed sides thereof.

2. An electric high interrupting capacity fuse comprising in combination

(*a*) a substantially tubular casing of insulating material having a predetermined inner diameter;

(*b*) a pair of terminal caps closing the ends of said casing;

(*c*) a pair of aligned knife blade contacts having a predetermined width but slightly less than said diameter each projecting from the outside of said casing through the end surface of one of said pair of terminal caps into the inside of said casing;

(*d*) a pair of spaced thin sheet metal ribbons of a metal having a relatively high conductivity and a relatively high fusing point approximately equal in width to said predetermined width conductively interconnecting the axially inner ends of said pair of blade contacts, each of said pair of ribbons including a lattice pattern area of necks connected in parallel and of serially connected necks, said lattice pattern area being formed by substantially transverse lines of perforations each including a predetermined number of perforations per line, the number of perforations per line being approximately twice the number of lines of perforations, each of said pair of ribbons having axially outer ends sandwiching therebetween the axially inner ends of said pair of knife blade contacts, each of said pair of ribbons having a pair of flexible bends situated adjacent to one of the axially outer ends thereof;

(*e*) a filler of quartz sand inside of said casing embedding said pair of ribbons; and

(*f*) two pairs of insulating plates each substantially coextensive with said lattice pattern area of one of said pair of ribbons and each affixed to one of said pair of ribbons.

3. An electric high interrupting capacity fuse comprising in combination:

(*a*) a substantially tubular casing of insulating material having a predetermined inner diameter;

(*b*) a pair of terminal caps closing the ends of said casing;

(*c*) a pair of aligned knife blade contacts having a predetermined width but slightly less than said diameter each projecting from the outside of said casing through the end surface of one of said pair of terminal caps into the inside of said casing;

(*d*) a pair of spaced thin sheet metal ribbons of a metal having a relatively high conductivity and a relatively high fusing point approximately equal in width to said predetermined width conductively interconnecting the axially inner ends of said pair of blade contacts, each of said pair of ribbons including a lattice pattern area of necks connected in parallel and serially connected necks, said lattice pattern area being formed by substantially transverse lines of perforations each including a predetermined number of perforations per line, the number of said transverse lines being three and the number of perforations per line being at least six, each of said pair of ribbons having axially outer ends sandwiching therebetween the axially inner ends of said pair of knife blade contacts, each of said pair of ribbons having a pair of flexible bends situated adjacent to the axially outer ends thereof;

(*e*) a filler of quartz sand inside of said casing embedding said pair of ribbons; and

(*f*) two pairs of insulating plates each substantially coextensive with said lattice pattern area of one of said pair of ribbons and each affixed to one of said pair of ribbons.

4. In combination an electric circuit having a predetermined circuit voltage and an electric high interrupting capacity fuse inserted into said circuit, said fuse including:

(*a*) a substantially tubular casing of insulating material having a predetermined inner diameter;

(*b*) a pair of terminal caps closing the ends of said casing;

(*c*) a pair of aligned knife blade contacts having a predetermined width but slightly less than said diameter each projecting from the outside of said casing through the end surface of one of said pair of terminal caps into the inside of said casing;

(*d*) a pair of spaced thin sheet metal ribbons of a metal having a relatively high conductivity and a relatively high fusing point approximately equal in width to said predetermined width conductively interconnecting the axially inner ends of said pair of blade contacts, each of said pair of ribbons including a lattice pattern area of necks connected in paral-

lel and serially connected necks, said lattice pattern area being formed by substantially transverse lines of perforations each including a predetermined number of perforations per line, the number of said transverse lines being equal to said circuit voltage divided by 200 and the number of perforations per line being approximately twice said number of lines, each of said pair of ribbons having axially outer ends sandwiching therebetween the axially inner ends of said pair of knife blade contacts, each of said pair of ribbons having a pair of flexible bends situated adjacent the axially outer ends thereof;

(*e*) a filler of quartz sand inside of said casing embedding said pair of ribbons; and

(*f*) two pairs of insulating plates each substantially coextensive with said lattice pattern area of one of said pair of ribbons and each affixed to one of said pair of ribbons.

5. In combination an electric circuit having a circuit voltage of 600 volts and an electric high interrupting capacity fuse inserted into said circuit, said fuse including:

(*a*) a substantially tubular casing of insulating material having a predetermined inner diameter;

(*b*) a pair of terminal caps closing the ends of said casing;

(*c*) a pair of aligned knife blade contacts having a predetermined width but slightly less than said diameter each projecting from the outside of said casing through the end surface of one of said pair of terminal caps into the inside of said casing;

(*d*) a pair of spaced thin sheet metal ribbons of a

metal having a relatively high conductivity and a relatively high fusing point approximately equal in width to said predetermined width conductively interconnecting the axially inner ends of said pair of blade contacts, each of said pair of ribbons including a lattice pattern area of necks connected in parallel and serially connected necks, said lattice pattern area being formed by but three transverse lines of perforations each including about six perforations per line, each of said pair of ribbons having axially outer ends sandwiching therebetween the axially inner ends of said pair of knife blade contacts, each of said pair of ribbons having a pair of flexible bends situated adjacent the axially outer ends thereof;

(*e*) a filler of quartz sand inside of said casing embedding said pair of ribbons; and

(*f*) two pairs of insulating plates each substantially coextensive with said lattice pattern area of one of said pair of ribbons and each affixed to one of said pair of ribbons.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,152,233 October 6, 1964

Frederick J. Kozacka

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 59, for "neck" read -- necks --; column 3, line 68, for "a" read -- the --; column 6, line 17, for "x_3 and x_4" read -- x_3' and x_4' --; column 7, line 53, column 8, lines 13 and 48, column 9, line 11, and column 10, line 13, after "bends", each occurrence, insert -- each --; column 7, line 55, for "filled" read -- filler --; column 7, line 57, column 8, lines 17 and 52, column 9, line 15, and column 10, line 17, strike out "pairs of", each occurrence.

Signed and sealed this 24th day of August 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents

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