July 12, 1955 K. W. SWAIN 2,713,098

CURRENT-LIMITING FUSIBLE PROTECTIVE DEVICES

Filed July 31, 1951

Fig. 1.

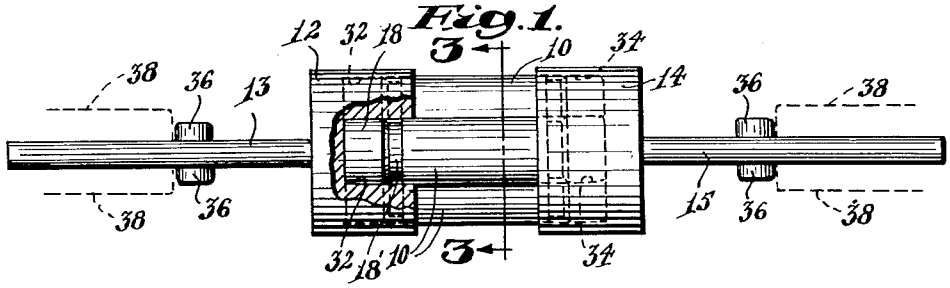


Fig. 2.

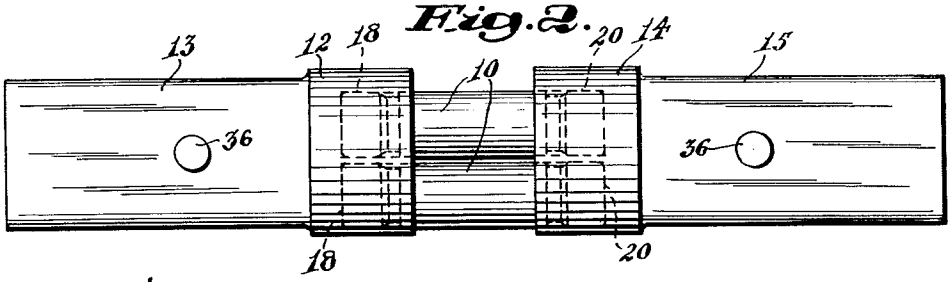


Fig. 4.

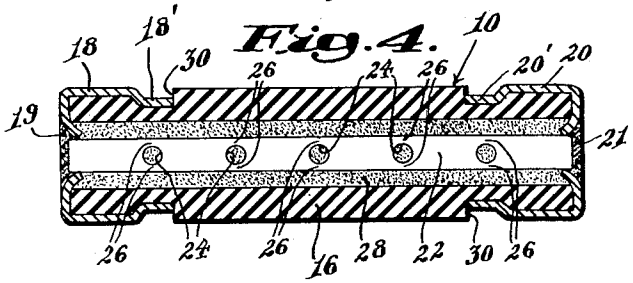


Fig. 3.

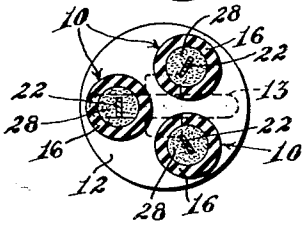


Fig. 5.

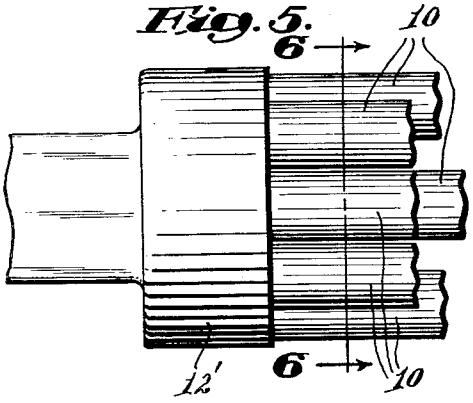
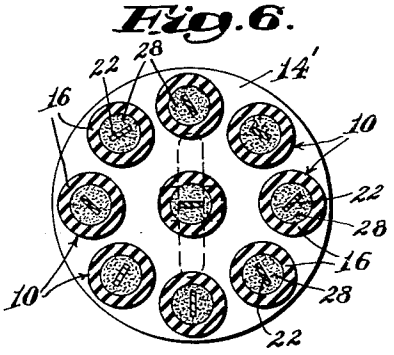


Fig. 6.



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CURRENT-LIMITING FUSIBLE PROTECTIVE DEVICES

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8 Claims. (Cl. 200—120)

This invention relates to improvements in current-limiting fusible protective devices and more particularly to current-limiting fusible protective devices of the general type wherein a plurality or multiplicity of separately enclosed individual current-limiting fuses are connected in parallel between two relatively large terminal members. Such protective devices are required to operate so rapidly that the maximum current which can occur in a protected circuit, in response to an overload in the nature of a short-circuit, is limited to values substantially less than the available short-circuit current of the circuit. Current-limiting protective devices of the general type to which the present invention relates are disclosed in Patents Nos. 2,592,399; 2,647,970; and 2,653,203, dated respectively April 8, 1952, August 4, 1953, and September 22, 1953, which are owned by the assignee of the present application.

It is among the objects of the present invention to provide a current-limiting fusible protective device wherein a plurality of separately enclosed individual current-limiting fuses have individual capped tubular casings whose end caps have a strong mechanical connection to the casings and effectively resist interior pressures developed within the casings in response to operation of the fuses, whereby the said interior pressures are unable to displace the end caps axially of the casings, whereby a plurality or multiplicity of the individually enclosed fuses may be connected in parallel between two relatively large terminal members and constitute the only means mechanically connecting the terminal members. The opposite end caps of the individually enclosed current-limiting fuses have force fit in appropriate recesses in the respective terminal members where the terminal members are frictionally held on the opposite capped ends of the individually enclosed fuses with the plurality or multiplicity of individual casings extending between the terminal members in spaced substantial parallelism and exposed to the cooling effects of the surrounding atmosphere. Friction alone can effectively maintain a wanted rigidity of the composite fuse structure inasmuch as no appreciable pressure is transmitted to the terminal members when the individual current-limiting fuses operate, as distinguished from the prior comparable structures wherein an outer casing encloses the individual fuses and mechanically connects together the terminal members.

Another object of the invention is to provide a current-limiting fusible protective device wherein a plurality or a multiplicity of individually enclosed current-limiting fuses are connected in parallel between two relatively massive heat absorbing terminal members and wherein each of the said individually enclosed current-limiting fuses comprises a tubular casing of considerable mechanical strength, capable of withstanding high internal pressures, and provided with an exterior annular groove at each end portion into which grooves annular flanges of opposite metallic end caps on the casing are rolled to effect a strong mechanical connection of the end caps to the casing, the opposite end caps of each casing being

pressed into appropriate oppositely disposed recesses in said terminal members and frictionally held therein, and the said capped casings of the individually enclosed current-limiting fuses constituting the only means maintaining said fuses and the terminal members in associated relation. By employing fuse casings of considerable mechanical strength, and preferably having high heat resistance, such as casings made of glass-cloth-silicon-resin laminates and glass-cloth-melamine-resin laminates, the flanges of the end caps may be effectively rolled or otherwise depressed into annular grooves cut in the casing material at exterior opposite end regions of the casings to strongly secure the end caps against relative outward displacement axially of the casings.

It is, moreover, my purpose and object generally to improve and simplify the structure of current-limiting fusible protective devices and the manner of assembling them, and more especially such devices wherein a plurality or multiplicity of individually enclosed current-limiting fuses are connected in parallel between a pair of relatively massive heat-absorbing terminal members.

In the accompanying drawing:

Fig. 1 is a top plan view of a current-limiting fusible protective device embodying features of the invention, a portion of one terminal member being broken away;

Fig. 2 is a side elevation of the protective device of Fig. 1;

Fig. 3 is a cross-sectional view on line 3—3 of Fig. 1;

Fig. 4 is a medial cross-sectional view of one of the individually enclosed current-limiting fuses of the protective device of Figs. 1–3, on a larger scale, the fuse link being shown in elevation;

Fig. 5 is a fragmentary side elevation of a protective device generally similar to the device of Figs. 1–3 but having a multiplicity of the individually enclosed current-limiting fuses, as compared with the three which are represented in Figs. 1–3; and

Fig. 6 is a cross-sectional view on line 6—6 of Fig. 5.

Referring to the drawing, the current-limiting protective devices of the invention have a suitable number of individually enclosed current-limiting fuses **10** connected in parallel between the two relatively massive terminal members **12**, **14** which have the rigid terminal bars or knife-blades **13**, **15** projecting therefrom and constituting a conventional means by which the illustrated protective device may be mounted in the usual fuse clips in an electric circuit.

Each of the current-limiting fuses **10** has a tubular insulating casing **16** whose opposite ends are closed by metallic end caps **18**, **20**. A fuse link **22** extends within the casing **16** and has one end connected to the end cap **18** as by solder **19** and the other end connected to the end cap **20** as by solder **21**. The fuse link **22** preferably is provided with a plurality of equally spaced reduced cross-section portions which conveniently may be formed by punching a plurality of equally spaced circular holes **24** along the axis of the link, so that each reduced cross-section portion comprises a pair of conducting necks **26**, in parallel. Pulverulent arc-quenching material **28** surrounds the fuse link **22** within each casing **16**.

The casing **16** of each current-limiting fuse **10** has mechanical strength capable of withstanding high internal pressures, and preferably the material of which the casing **16** is made should be of a heat resistant type. Glass-cloth-silicon-resin laminates and glass-cloth-melamine-resin laminates are recommended casing materials having needed mechanical strength and high heat resistance, especially when the casing walls have thickness in the order of half the external radius of the casings. Such a casing may have an annular exterior groove **30** cut therein substantially inward from each end of the casing, and the

flange of the end cap **18** has an annular portion **18'** thereof rolled or otherwise depressed into one groove **30** and the flange of the end cap **20** has an annular portion **20'** thereof rolled or otherwise depressed into the other groove **30**. The end caps effectively seal the opposite ends of the casing **16**, and the strength of their securement to the casing enables them to successfully withstand interior pressures without any appreciable displacement axially of the casing.

Any desired number of current-limiting fuses **10** may be associated together in parallel between the terminal members **12, 14**, and it is a feature of the invention that the fuses **10**, which are maintained by the terminal members in predetermined spaced parallelism, constitute the only means connecting the terminal members **12, 14** together.

In the Figs. 1–3 embodiment, three current-limiting fuses **10** are mounted in spaced general parallelism between the relatively massive terminal members **12, 14** which have relatively large capacity for absorption and dissipation of heat generated within the fuse casings **16**. Terminal member **12** has three recesses **32** in its face which is opposite its face from which the terminal bar or knife-blade **13** projects, and terminal member **14** has three similar recesses **34** in its face which is opposite its face from which the terminal bar or knife-blade **15** projects. The recesses **32, 34** are located in the respective terminal members so that, when the knife-blades **13, 15** are properly aligned in a common plane, each recess **32** in terminal member **12** will be opposite a recess **34** in terminal member **14**. Hence, when the opposite capped ends of each fuse **10** are forced into oppositely disposed recesses **32, 34** in the terminal members **12, 14**, the fuses **10** automatically assume spaced general parallelism between the terminal members and friction between the end caps and the terminal members maintains the fuses and the terminal members in rigid assembled relationship with substantially the full length of the fuse casings between their end caps exposed to the cooling effects of the surrounding atmosphere.

Current-limiting fuses **10** of the general type herein combined with the terminal members **12, 14** and **12'** are more particularly described and claimed in the aforementioned Patent No. 2,592,399, and they never will substantially exceed two inches in overall length. Hence, the terminal members are in relatively close relationship and their inherent capacity for absorbing and dissipating large amounts of heat generated within the fuse casings **16**, which heat has paths of travel to a terminal member never exceeding an inch in length, effectively avoids any build-up of dangerous or destructive temperatures within the fuse casings **16** when the protective device operates to interrupt a circuit. The relatively high interior pressures which develop within the fuse casings are successfully resisted by the casings and their end caps without any appreciable forces being impressed upon the terminal members **12, 14** in directions tending to separate them. Hence, no other means than the friction between the end caps and the terminal members is requisite for maintaining the rigid assembled relationship between the fuses **10** and the terminal members **12, 14**.

In view of the substantially shorter dimension between the outer faces of the terminal members **12, 14**, as compared with the dimension between the outer capped ends of conventional knife-blade fuses, the knife-blades **13** and **15** are substantially longer than conventional knife-blades, for extending to and engaging in conventional fuse clips. Because of this greater length of the knife-blades **13, 15**, it is desirable to provide means for properly centering the body of the protective device between conventional fuse clips and for maintaining it centered. In Figs. 1 and 2, each knife-blade **13, 15** has the abutment elements **36** projecting at opposite faces of each blade, at suitably spaced locations inward from the outer ends of the blades, for coaction with the conventional fuse clips **38** in centering the mounted protective device.

Figs. 5 and 6 illustrate a protective device of larger rated interrupting capacity wherein nine current-limiting fuses **10**, similar to those of the Figs. 1–3 form, extend in spaced general parallelism between the terminal members **12', 14'**.

I claim as my invention:

1. A current-limiting fusible protective device comprising a plurality of individually enclosed current-limiting fuses and a pair of terminal members mounted on the opposite ends of said fuses with the said fuses extending in spaced general parallelism between them, each said fuse having a tubular insulating casing and a pair of metallic end caps closing the opposite ends of the casing, and each said fuse having a fuse link extending within its casing and secured to the opposite end caps thereon, with pulverulent arc-extinguishing material surrounding the fuse link within the casing, said end caps having strong mechanical connections to the casings and being capable of successfully resisting high internal pressures tending to displace the end caps axially along the casings, said terminal members having aligned recesses in the opposed faces thereof for reception of the end caps of said fuses, and the opposite end caps of each fuse being seated in aligned recesses of said pair of terminal members and strongly held therein by friction between the walls of said end caps and the walls of said recesses, said fuses having their said casings exposed in spaced general parallelism between the terminal members, and the friction between said end caps and the walls of said recesses in the terminal members constituting the only means maintaining the fuses and terminal members in their assembled relationship.

2. A current limiting fusible protective device comprising two relatively massive spaced terminal members having relatively large heat absorbing capacity, each having a generally flat terminal element projecting therefrom, and each having a plurality of recesses therein at its surface which faces the other terminal member, the locations of said recesses in the respective terminal members being such that when said terminal elements are aligned in a common plane, each said recess in one terminal member is aligned with a said recess in the other terminal member, a plurality of individually enclosed current-limiting fuses arranged in spaced general parallelism between said terminal members, each said fuse comprising a tubular insulating casing, metallic end caps strongly secured on the opposite ends of the casing, a fuse link within the casing connected to the opposite end caps thereof, and arc-extinguishing filler material surrounding the fuse link within the casing, each said individually enclosed current-limiting fuse having its said opposite end caps seated within and individually subjected to compression by walls of aligned recesses of the two said terminal members, whereby said recess walls tend to enhance the said securement of the end caps on the ends of said casings with friction between said recess walls and said end caps strongly maintaining each end cap within the recess in which it is seated, said fuses constituting the only means maintaining said terminal elements of the spaced terminal members in their said alignment in a common plane.

3. A current-limiting fusible protective device comprising two relatively massive spaced terminal members having relatively large heat absorbing capacity, each having a generally flat terminal element projecting therefrom, and each having a plurality of recesses therein at its surface which faces the other terminal member, the locations of said recesses in the respective terminal members being such that when said terminal elements are aligned in a common plane, each said recess in one terminal member is aligned with a said recess in the other terminal member, a plurality of rigid current-limiting fuses arranged in spaced general parallelism between said terminal members, each said rigid fuse comprising a tubular insulating casing having metallic end caps

strongly secured on its opposite ends whereby said caps resist appreciable displacement axially of the casing when relatively high pressures develop within the casing, each said rigid fuse having one of its end caps seated within and frictionally gripped by walls of a said recess of one terminal member and having its other end cap seated within and frictionally gripped by walls of a said aligned recess of the other terminal member, whereby said recess walls tend to enhance the said securement of the end caps on the ends of said casings with friction between said recess walls and said end caps strongly maintaining the end caps within said recesses, said rigid fuses with their frictionally maintained end caps constituting the only mechanical connection between the terminal members.

4. A current-limiting fusible protective device comprising two relatively large heat-absorbing terminal members arranged in opposed spaced relation and having opposed generally plane parallel faces, means defining a plurality of pairs of aligned recesses in said opposed faces of the terminal members, a rigid current-limiting fuse extending between the recesses of each said pair of aligned recesses and constituting a rigid mechanical connection between said terminal members, each said fuse comprising a tubular insulating casing having metallic end caps closing its opposite ends, and said end caps being strongly secured on said casings and seated within said recesses, and there being friction between said end caps and the recess walls, whereby said end caps strongly resist axial displacement on said casings when subjected to relatively high pressures within the casings, said rigid fuses constituting the only connections between said terminal members maintaining said members and fuses in their assembled relationships.

5. A current-limiting fusible protective device comprising two relatively large heat-absorbing terminal members arranged in opposed spaced relation and having opposed generally plane parallel faces, means defining a plurality of pairs of aligned recesses in said opposed faces of the terminal members, a plurality of current-limiting fuses arranged between said terminal members, each said current-limiting fues comprising a tubular insulating casing made of a glass-cloth-resin laminate of substantial thickness having an exterior annular groove therein inward from each end of the casing, a metallic end cap arranged over each end of the casing with the flange material of each end cap displaced into a said annular groove in the casing, whereby said end caps are strongly secured on said casing against axial displacement by substantial pressures developed within the casing, each said current-limiting fuse having its opposite end caps seated within a said pair of aligned recesses of the terminal members with friction between the end caps and the walls of the recesses strongly maintaining the end caps seated, whereby said plurality of current-limiting fuses constitute rigid connections between the terminal members maintaining them in a predetermined spaced relation.

6. A composite high interrupting-capacity fuse of the type comprising a plurality of spaced current-limiting fuse units arranged in the gap formed between a pair of spaced terminal elements common to said plurality of fuse units, each of said plurality of fuse units including a casing of a glass-cloth-synthetic-resin laminate having an annular recess and a terminal cap adjacent each end thereof, said cap projecting radially inwardly into said recess to equally distribute the pressure generated within said casing incident upon blowing of each of said plurality of fuses along the entire circumference of said casing, said pair of spaced terminal elements having pairs

of aligned cavities each accommodating one said terminal cap of each of said plurality of fuse units and retaining said terminal cap by pressed fit means only, said casing of each said plurality of fuse units receiving the entire thrust incident upon blowing thereof and the spaces formed between said plurality of fuse units being laterally open to permit lateral access of the ambient atmosphere to each of said plurality of fuse units.

7. A composite high interrupting capacity fuse comprising a plurality of current-limiting fuse units arranged in parallel spaced relation, the spaces between said plurality of fuse units being laterally open to permit lateral access of the ambient atmosphere to each of said plurality of fuse units, a pair of spaced terminal elements common to said plurality of fuse units, said plurality of fuse units being accommodated within the gap formed between said pair of spaced terminal elements, each of said plurality of fuse units comprising a casing of glass-cloth-synthetic-resin laminate having annular outside recesses one adjacent each end thereof, a fuse link and a pulverulent arc-quenching filler within said casing, and a pair of terminal caps conductively interconnected by said link mounted on opposite ends of said casing, the end surface of each of said caps being conductively connected to one of said terminal elements and the lateral surface of each of said caps having an annular projection protruding radially inwardly into one of said annular recesses of said casing.

8. A current-limiting fusible protective device adapted to be frictionally held between a pair of mounting elements having a predetermined fixed spaced relation, said device comprising two terminal members, each having a relatively long knife blade terminal element projecting therefrom and said terminal elements being aligned axially of the protective device and adapted to be slidably inserted in and frictionally held by the mounting elements, a plurality of individually enclosed current-limiting fuses mounted in spaced general parallelism between and electrically connected in parallel to said terminal members, said terminal members and fuses having overall extent substantially less than the distance between said mounting elements whereby said knife blade terminal elements have substantial extent, axially of the protective device, between said terminal members and said mounting elements when said terminal members are positioned substantially centrally between the mounting elements, and a fixed abutment on each said knife blade terminal element spaced a substantial distance from the adjacent terminal member, said fixed abutments being spaced apart a distance substantially equal to the distance between said mounting elements for guiding a generally central positioning of said terminal members between the mounting elements when the device is being mounted, and for coaction with the mounting elements to maintain the mounted device against appreciable axial displacement relative to the mounting elements due to vibrations and shocks in service.

References Cited in the file of this patent

UNITED STATES PATENTS

2,157,906	Lohausen	May 9, 1939
2,309,013	Rawlins et al.	Jan. 19, 1943
2,546,074	Lindell	Mar. 20, 1951
2,577,531	Laing	Dec. 4, 1951

FOREIGN PATENTS

28,872	Great Britain	1911
508,077	Great Britain	June 23, 1939
675,932	France	Nov. 18, 1929