Dec. 8, 1953 F. J. KOZACKA 2,662,140

SUPERCURRENT FUSE

Filed Aug. 15, 1952 3 Sheets-Sheet 1

Fig. 1. -PRIOR ART-

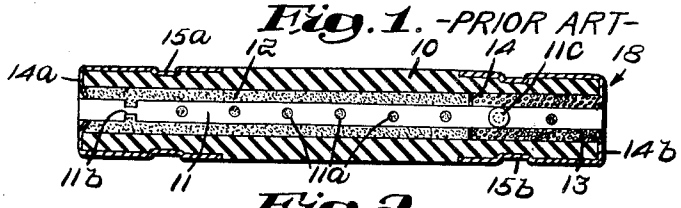


Fig. 2.

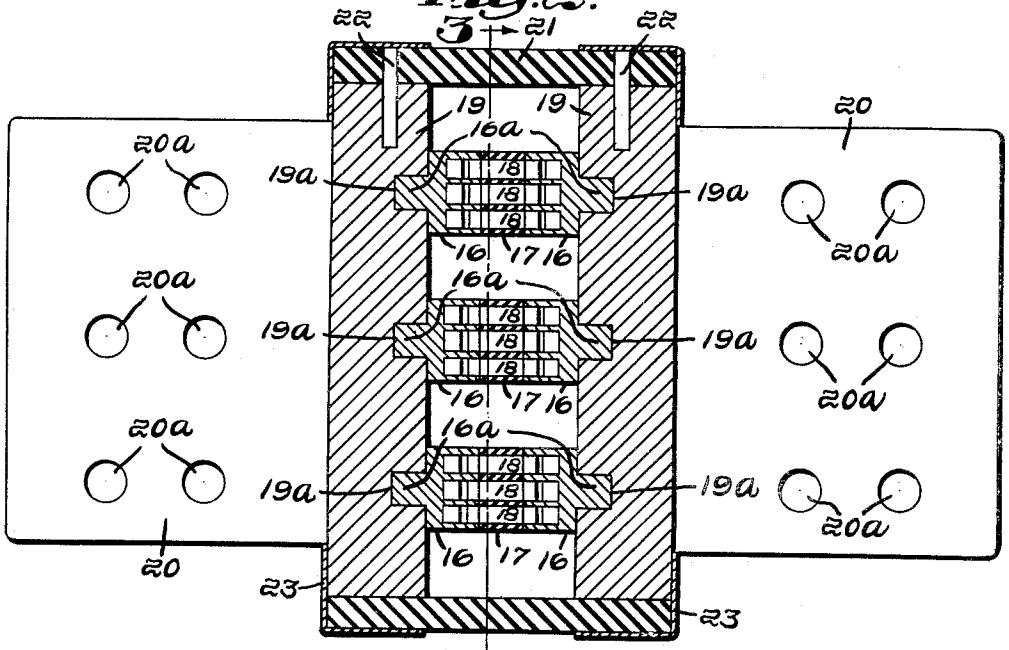
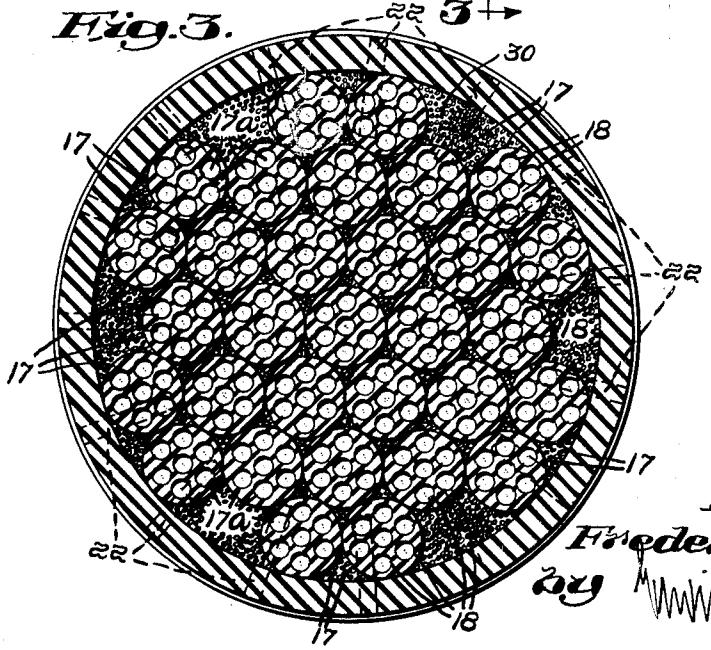


Fig. 3.



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Fig. 4.

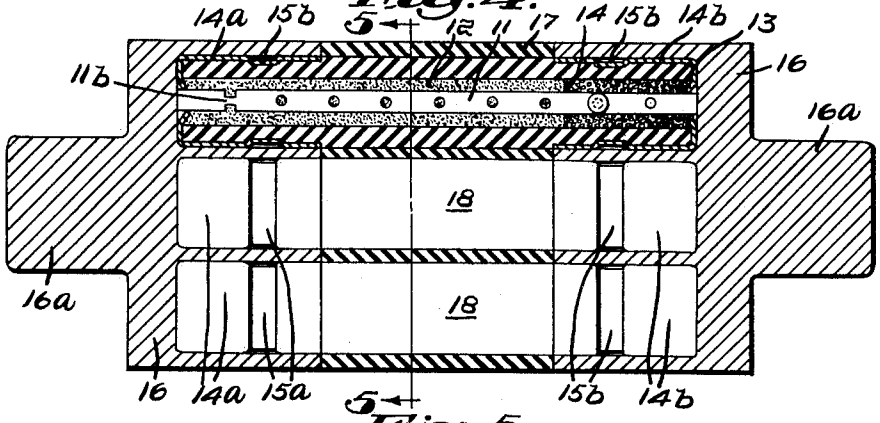


Fig. 5.

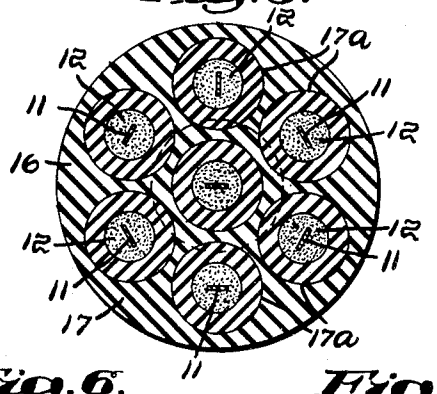


Fig. 6.

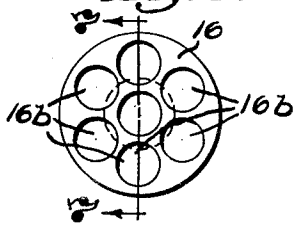


Fig. 7.

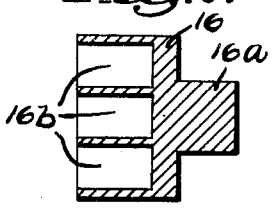


Fig. 8.

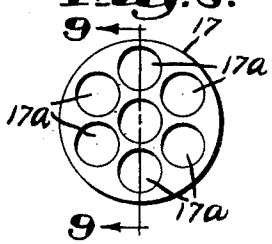
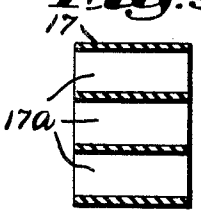


Fig. 9.



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SUPERCURRENT FUSE

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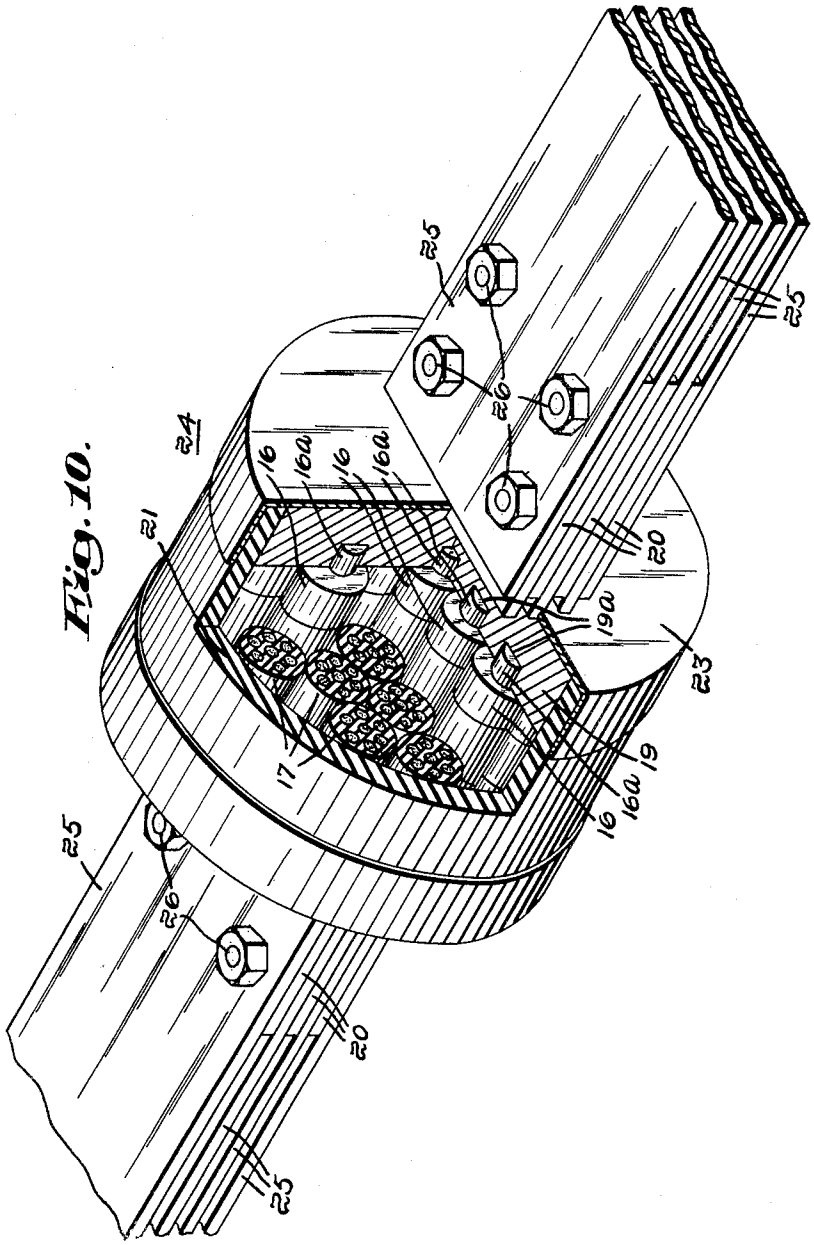


Fig. 10.

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SUPERCURRENT FUSE

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Application August 15, 1952, Serial No. 304,585

7 Claims. (Cl. 200—120)

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This invention relates to high capacity fuses, i. e. fuses which have a high current-carrying capacity, e. g. a current-carrying capacity in the order of several thousand amperes.

A general object of the invention is to provide a fuse having the aforementioned order of current-carrying capacity and capable of effecting interruption of short-circuit currents before the short-circuit currents reach the peak of the maximum available short-circuit current of the circuit which is to be protected.

Such current limiting action can be effectively achieved by composite fuse structure comprising a great number of integrated fuse units adapted to be arranged in parallel in the circuit to be protected. If a relatively high current-carrying capacity and a relatively low maximum let-through current are required, the number of fuse units which must be integrated into a composite fuse structure may be very large. It has been found desirable, for instance, to integrate between 200 and 300 single fuse units into a composite fuse structure designed for a current-carrying capacity of 5000 amperes at a circuit voltage in the order of 750 volts if the available short-circuit current is in the order of 100,000 R. M. S. amps. The composite fuse structures of the prior art do not lend themselves to integration into them of such large numbers of single fuse units.

It is therefore a special object of the invention to provide composite fuse structures which lend themselves to integration into them of considerably larger numbers of fuse units than could be integrated into composite fuse structures which were known heretofore.

Another special object of this invention is to provide a composite fuse structure enabling to readily assemble a very large number of fuse units by subdividing the total number of fuse units into groups of use units and integrating each group of fuse units into a subassembly unit.

Still another special object of the invention is to provide a composite fuse structure which is made up of a very large number of separate fuse units and wherein means having great mechanical strength are provided for the lateral support of the casing of each separate fuse unit to increase the ability of said casing to withstand the high pressures which may be generated therein.

Another object of the invention is to provide a composite fuse structure comprising a large number of single fuse units which are tied together by a common insulating support to form

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a self-sustained structural unit, the casings of said single fuse units being pressed into said common support with a press fit to greatly increase the mechanical strength of said casings.

Very high pressures must be applied when mounting on a composite fuse structure comprising a plurality of identical fuse units if the contacts of said fuse units and said common terminal elements are to be joined by pressure only, i. e. without solder or brazing joint or spot weld. While it is very desirable to join contact elements by pressure only, yet the application of very high pressures entails generally the danger of fracturing the casings of the fuse units when mounting common terminal elements or common terminal blocks thereon.

It is therefore another special object of the invention to provide a composite fuse structure comprising a plurality of identical fuse units which have common terminal elements applied under considerable pressure and wherein the casings of the fuse units are not subjected to the danger of fracture when the terminal elements are being secured in place by the action of pressure.

Another special object of the invention is to provide a composite fuse comprising a very large number of single fuse units which are combined in such a way as to limit space requirements and the peak of the let-through current but as to obtain an optimum of current carrying ability.

The foregoing and other general and special objects of the invention and advantages thereof will more clearly appear from the ensuing particular description of the invention, as illustrated in the accompanying drawings wherein:

Fig. 1 is substantially a longitudinal section of a single fuse unit;

Fig. 2 is substantially a longitudinal section of a composite fuse structure comprising a very large number of fuse units combined to form a plurality of smaller groups of which each group forms a self-sustained subassembly unit;

Fig. 3 is a cross-section along 3—3 of Fig. 2;

Fig. 4 is substantially a longitudinal section of one of the subassembly units of Fig. 2, shown on a larger scale;

Fig. 5 is a cross-section along 5—5 of Fig. 4;

Fig. 6 is an elevation of one of the terminal elements of the subassembly unit shown in Figs. 4 and 5;

Fig. 7 is a section along 7—7 of Fig. 6;

Fig. 8 is an elevation of the insulating structure used for tying together a plurality of fuse

units to form the subassembly unit of the kind shown in Figs. 4 and 5;

Fig. 9 is a section along 9—9 of Fig. 8, and

Fig. 10 is a perspective view of the structure shown in Figs. 2 and 3 associated with a system of bus bars.

Referring now to the drawing and more particularly to Fig. 1 thereof, showing one single fuse unit, reference numeral 10 has been applied to the casing of the fuse unit and reference numeral 11 to the fuse link thereof. Fuse link 11 consists preferably of silver or copper. The casing 10 is filled with an arc-quenching filler 12, such as clean quartz sand. If desired, an additional filler 13 may be provided in casing 10. The additional filler 13, may consist of a pulverulent substance which does not fuse under the action of the heat of the arc, forming an insulating barrier effective during the time the quartz sand filler 12 is fused and hot and forming a good conductor of electricity. Filler 13 may consist of chalk which evolves gases under the heat of the arc, thus requiring a casing of considerable mechanical strength. Casings 10 of glass-cloth laminates impregnated with suitable synthetic resins have sufficient mechanical strength to permit the use of limited quantities of gas evolving fillers therein. Where different kinds of fillers are provided within one casing the fillers should be separated by a washer 14 or like partition means. Fuse link 11 is provided with a plurality of substantially equidistant perforations 11*a* defining a plurality of restricted cross-section portions. An additional restricted cross-section portion is formed by a neck 11*b* having a smaller cross-sectional area than the cross-sectional area of link 11 at the points where the perforations 11*a* are situated. The purpose of neck 11*b* is to limit the let-through current which is allowed to flow through link 11 to a predetermined relatively small value without change in rating of the device. A rivet 11*c* of tin is inserted into one of the perforations 11*a*. The perforation 11*a* receiving tin rivet 11*c* is situated within the portion of the casing 10 accommodating the non-fusing gas-evolving filler 13. Rivet 11*c* fuses on the occurrence of small protracted overloads, thus initiating interruption of the circuit. At the occurrence of short-circuit currents, interruption of the circuit is initiated at the neck 11*b*. A pair of terminal caps 14*a*, 14*b* is arranged at the ends of casing 10 and conductively interconnected by link 11. Terminal caps 14*a*, 14*b* are mounted on casing 10 by application of considerable pressure to provide a structure capable of withstanding internal pressures of large magnitude. A circular pressed-in portion 15*a*, 15*b*, respectively, provided in each cap 14*a*, 14*b* and projecting into the casing 10 tends to greatly increase the mechanical strength of the fuse unit thus precluding destruction thereof by internal excess pressure. Fuse link 11 is conductively connected to the terminal caps 14*a*, 14*b* by appropriate solder joints as generally applied in the fuse art for this purpose.

The structure shown in Fig. 1 is substantially the same as that disclosed in United States Patent 2,592,399 to W. S. Edsall et al., Current-Limiting Fuse, issued April 8, 1952, and in United States patent application Ser. No. 208,548, Frederick J. Kozacka, Current-Limiting Fuses, filled January 30, 1951, both assigned to the assignee of the present invention.

The composite structure shown in Figs. 2 and 3 is designed to have a current-carrying capacity of 5000 amps. and a voltage rating of 750 volts. It comprises thirty-one subassembly units and each of these subassembly units comprises seven current-limiting fuse units of the type shown in Fig. 1. In other words, the composite fuse structure shown in Figs. 2 and 3 comprises thirty-one times seven fuse units, i. e. two-hundred-seventeen fuse units. In spite of this large number of fuse units integrated into one single high-capacity fuse structure the assembly of the fuse units does not involve particular difficulties. This is due to the formation of a number of subassembly units, as will be described below in greater detail.

The subassembly units comprised in the structure shown in Figs. 2 and 3 each include a pair of spaced subassembly terminals 16, an insulating structure 17 arranged in the space between the pair of subassembly terminals 16 and a plurality of fuse units 18 mechanically tied together by said insulating structure.

The insulating structures 17 are substantially in the shape of cylindrical bodies each having seven parallel passageways or bores 17*a* of which each is adapted to receive one fuse unit 18. The geometry of insulating structures 17 can best be seen from Figs. 8 and 9. Structures 17 consist preferably of a glass cloth laminate which is impregnated with a synthetic resin as, for instance, a melamine resin. The laminations of structures 17 and the fuse-unit-receiving cylindrical passageways or bores 17*a* provided therein are arranged at right angles, which makes for considerable mechanical strength in a direction radially of the cylindrical passageways or bores 17*a*.

As shown in Figs. 2 and 3, the composite fuse structure is provided with a pair of spaced main terminals 19, each having an electrical connector in the shape of a multiple blade contact 20. The main terminals consist each of a solid disc of copper and both main terminals are enclosed within a shell 21 of fiber-reinforced insulating material. Shell 21 encloses all the subassembly units by which the composite fuse structure is formed and is secured to the main terminals 19 by means of a plurality of substantially radially arranged steel pins 22. If desired a pulverulent filler 30, as, for instance, quartz sand may be arranged within shell 21 in the interstices formed between the subassembly units arranged therein. Each pair of subassembly terminals 16 is in immediate electrical contact with one of said pairs of main terminals 19. To this end each subassembly terminal is provided with a projection 16*a* engaging a juxtaposed recess 19*a* in the main terminals 19. The terminal caps 14*a*, 14*b* of each set of fuse units included in a subassembly unit are in immediate electrical contact with one pair of subassembly terminals 16. To this end subassembly terminals 16 are provided with a plurality of recesses 16*b* each adapted to receive one terminal cap 14*a* or 14*b* of one fuse unit. Caps 23 of thin sheet metal close the axially outer ends of the composite fuse structure.

As indicated in Figs. 1 and 2, blade contacts 20 are provided with transverse bores 20*a* for inserting the composite fuse structure according to this invention into an electrical circuit comprising a bus structure.

In Fig. 10 reference numeral 24 has been applied generally to the composite fuse structure according to this invention and reference numeral 25 indicates a bus bar system. The blade contacts 20 of the composite fuse structure are

arranged in interleaving relation with the bus bars of the bus bar system **25** and both are clamped together by means of screws **26**, providing the amount of contact pressure required to minimize I^2r losses.

In Fig. 10 some of the subassembly units **17** have been shown to be cut by a transversal plane which has been indicated in a general way by cross-hatching without illustrating the structural details of the different parts situated within this transversal plane.

Let n be the number of fuse units which are integrated into the composite fuse structure and p be the number of subassembly units which form integral parts of said structure. p is an integral number and n a multiple of p. The insulating block **17** forming part of each subassembly unit has n/p parallel passageways or bores **17***a*, each substantially equal in diameter to the outer diameter of the casing **10** of each said n fuse units. Each of the n fuse units accomodated in one passageway or bore **17***a* projects with its terminal caps **14***a*, **14***b* beyond the passageway in which its casing **10** is held.

As can best be seen in Fig. 4, the subassembly terminals **16** rest with their axially inner ends on the insulating block **17** which thus forms an abutment precluding terminals **16** to be pressed too far in a direction longitudinally of casing **10** when subassembly terminal elements **16** are being mounted on caps **14***a*, **14***b* or when the main terminal elements **19** are being mounted on subassembly terminal elements **16** under considerable pressure by means of a hydraulic press.

The number of pairs of subassembly terminal elements **16** is equal to the number of subassemblies, i. e. equal to p, and each subassembly terminal element **16** is common to n/p fuse units and in immediate contact with n/p terminal caps **14***a*, **14***b*. Each main terminal element **19** is common to p subassembly terminal elements and in immediate electrical contact therewith.

Both the subassembly terminal elements **16** and the main terminal elements **19** have a considerable heat absorbing and heat dissipating ability which is required for achieving a drastic limitation of fault currents, i. e. for maintaining the let-through currents well below the peaks of the available short-circuit currents.

A single composite fuse structure of the kind shown requires considerably less space than a number of non-integrated fuse structures arranged side by side and connected in parallel in the circuit to be protected and having a combined current carrying capacity equal to the current carrying capacity of the integrated fuse structure shown.

The lateral casing support provided by the insulating blocks **16** is stronger than the lateral casing support provided in any prior art composite fuse structure of which I am aware and enables therefore to admit higher internal gas pressures within the casings **10** than in any prior art composite fuse design.

Because the number of fuse units comprised in each subassembly unit is relatively limited, no mechanical difficulties are involved in assembling the parts which go into a subassembly unit. The limitations as to the number of subassemblies which go into a composite fuse structure tends to greatly reduce the mechanical difficulties involved in assembling all the parts which go into a complete composite fuse structure.

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

I claim:

1. In a high capacity fuse the combination of a pair of spaced main terminals each having an electrical connector, a plurality of subassembly units each including a pair of spaced subassembly terminals, an insulating structure arranged in the space between said pair of subassembly terminals, a plurality of fuse units, and joint tie means of insulating material for integrating said plurality of fuse units into a composite self-sustained structural unit, each of said pair of subassembly terminals being in immediate electrical contact with one of said pair of main terminal elements, each fuse unit of each said plurality of fuse units including a casing, a pulverulent arc-quenching filler within said casing, a fuse link within said filler, and a pair of terminal caps arranged at the ends of said casing and conductively interconnected by said link; each of the terminal caps of each said plurality of fuse units included in each said subassembly units being in immediate electrical contact with one said pair of subassembly terminals.

2. In a high capacity fuse the combination of a pair of spaced main terminal elements each having an electrical connector and each being provided with a plurality of main terminal recesses on juxtaposed surfaces thereof, a plurality of self-sustained subassembly units each including a pair of spaced subassembly terminals, each of said pair of subassembly terminals projecting into one of said pair of main terminal recesses and each of said pair of subassembly terminals being provided with a plurality of subassembly terminal recesses on juxtaposed surfaces thereof, each said subassembly units comprising a plurality of fuse units, each said plurality of fuse units including a casing, a pulverulent arc-quenching filler within said casing, a fuse link within said filler and a pair of terminal caps arranged at the ends of said casing and conductively interconnected by said link, said pair of terminal caps of each of said plurality of fuse units projecting into one juxtaposed pair of said subassembly terminal recesses.

3. A high capacity fuse comprising n fuse units each including a tubular casing, a pulverulent arc-extinguishing filler within said casing, a fuse link within said filler and a pair of terminal caps arranged at the ends of said casing and conductively interconnected by said link, p subassembly units each comprising a block of insulating material defining n/p parallel passageways each substantially equal in diameter to the outer diameter of said casing of each said n fuse units, each of said n fuse units being accommodated in one of said passageways and projecting with said pair of terminal caps thereof beyond said one of said passageways, p pairs of spaced subassembly terminal elements, each said subassembly terminal elements common to n/p said fuse units and each in immediate electrical contact with n/p of said terminal caps, and one pair of spaced main terminal elements, each of said pair of main terminal elements common to p said subassembly terminal elements and in immediate electrical contact therewith, p being an integral number and n a multiple of p.

4. A high capacity fuse comprising n fuse units each including a tubular casing, a pulverulent arc-quenching filler within said casing, a fuse

link within said filler and a pair of terminal caps arranged at the ends of said casing and conductively interconnected by said link, p subassembly units each comprising a cylindrical block made of a glass cloth base synthetic resin laminate having n/p parallel bores extending in a direction transversally of the laminations of said block, each said bores being substantially equal in diameter to the outer diameter of said casing of each said n fuse units, each of said n fuse units being accommodated in one of said bores and projecting with said pair of terminal caps thereof beyond said one of said bores, p pairs of spaced subassembly terminal elements, each of said pairs of subassembly terminal elements being common to n/p of said fuse units and each in immediate electrical contact with n/p of said terminal caps, and one pair of spaced main terminal elements, each of said pair of main terminal elements being common to p said subassembly terminal elements and each in immediate electrical contact therewith, p being an integral number and n a multiple of p.

5. A high capacity fuse comprising n fuse units each including a tubular casing, a pulverulent arc-extinguishing filler within said casing, a fuse link within said filler and a pair of terminal caps arranged at the ends of said casing and conductively interconnected by said link, p subassembly units each comprising a cylindrical block of solid insulating material defining n/p parallel passages each substantially equal in diameter to the external diameter of said casing of each said n fuse units, each of said n fuse units being accommodated in one of said passages and projecting with said pair of terminal caps thereof beyond said one of said passages, p pairs of spaced subassembly terminal elements, each of said pairs of subassembly terminals being provided on juxtaposed surfaces thereof with n/p subassembly terminal recesses and each said recesses being engaged by one of said terminal caps, and one pair of spaced main terminal elements, each of said pair of main terminal elements being provided on juxtaposed surfaces thereof with p main terminal recesses each being engaged by one of said subassembly terminal elements, p being an integral number and n a multiple of p.

6. A multiple fuse structure comprising m fuse units each including a tubular casing, a pulverulent arc-extinguishing filler within said casing, a fuse link within said filler and a pair of terminal caps arranged at the end of said casing and conductively interconnected by said link, a cylindrical block of solid insulating material defining m parallel passages each substantially equal in diameter to the external diameter of said casing of each said m fuse units, each of said m fuse units being accommodated in one of said passages and projecting with said pair of terminal caps thereof beyond said one of said passages, and a pair of spaced terminal elements, each of said pair of terminal elements being common to said m fuse units and each in immediate electrical contact with $m/2$ of said terminal caps, m being an integral number.

7. In a high capacity fuse the combination of a pair of spaced terminal elements each having an electrical connector and each being provided with a plurality of main terminal recesses on juxtaposed surfaces thereof, a plurality of subassembly units each including a pair of spaced subassembly terminals, an insulating structure arranged within the space between said subassembly terminals and defining a plurality of parallel passages and a plurality of fuse units each arranged in one of said passages and supported by said insulating structure, each of said subassembly terminals projecting into a juxtaposed pair of said main terminal recesses and each of said pair of subassembly terminals being provided with a plurality of subassembly recesses on juxtaposed surfaces thereof, each of said plurality of fuse units comprising a casing, a pulverulent arc-quenching filler within said casing, a fuse link within said filler and a pair of terminal caps arranged at the ends of said casing and conductively interconnected by said link, said pair of terminal caps of each of said plurality of fuse units projecting into one juxtaposed pair of said subassembly recesses.

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No references cited.