

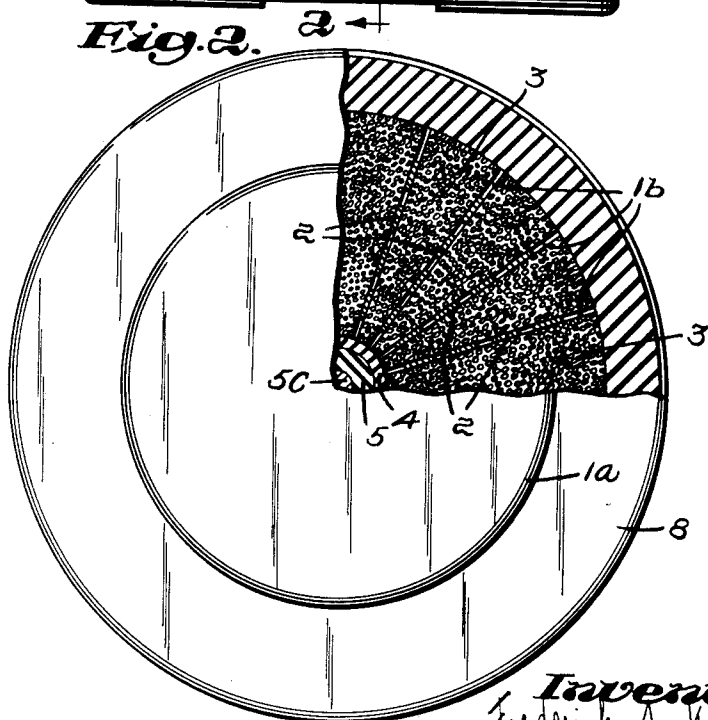
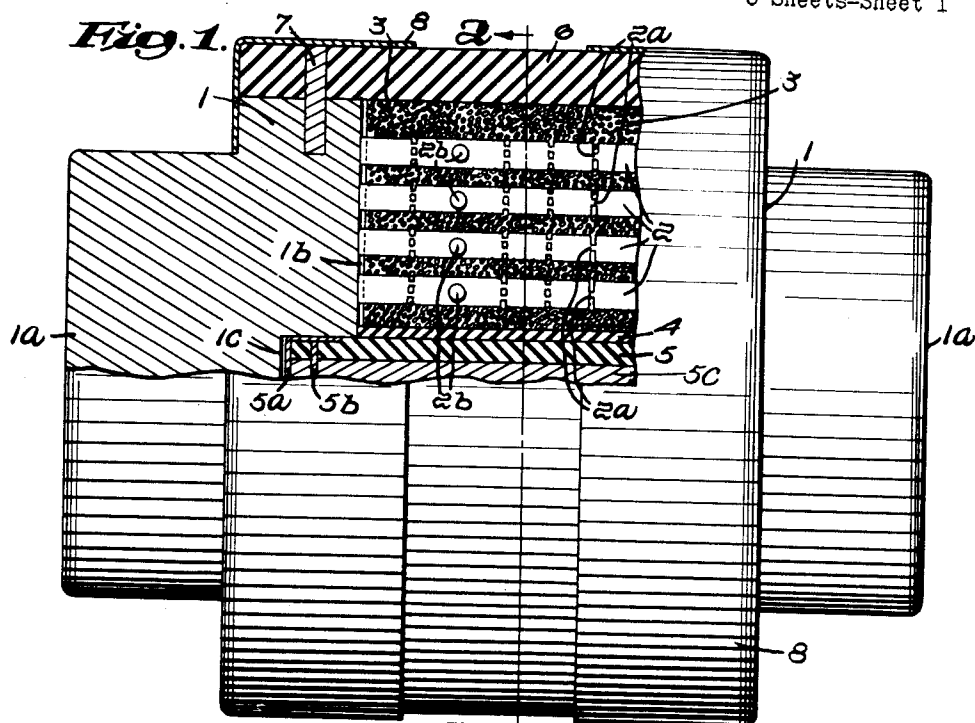
Feb. 23, 1954

F. J. KOZACKA
FUSE AND FUSE HOLDER

2,670,418

Filed Oct. 9, 1952

3 Sheets-Sheet 1



by

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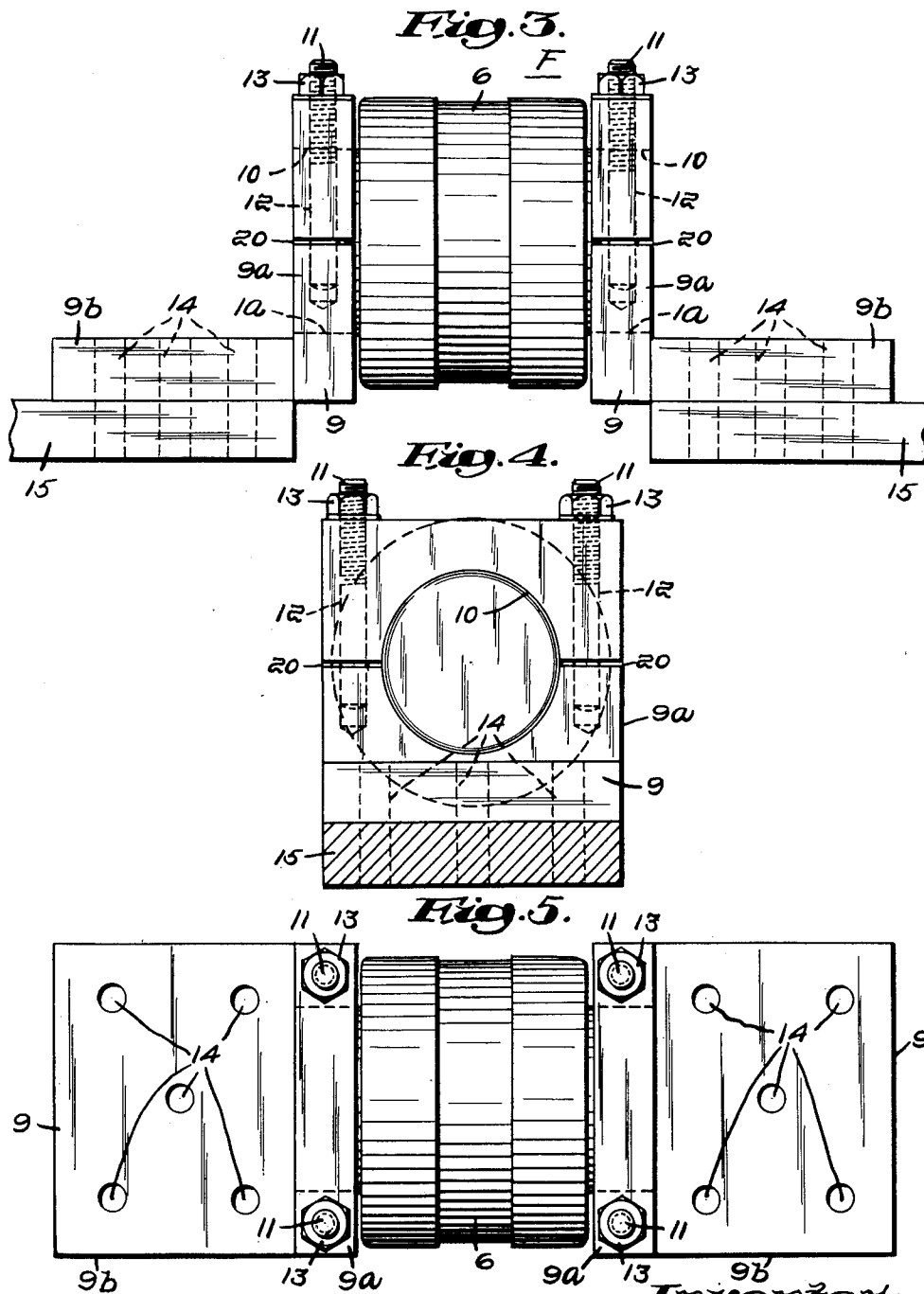
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Fig. 6.

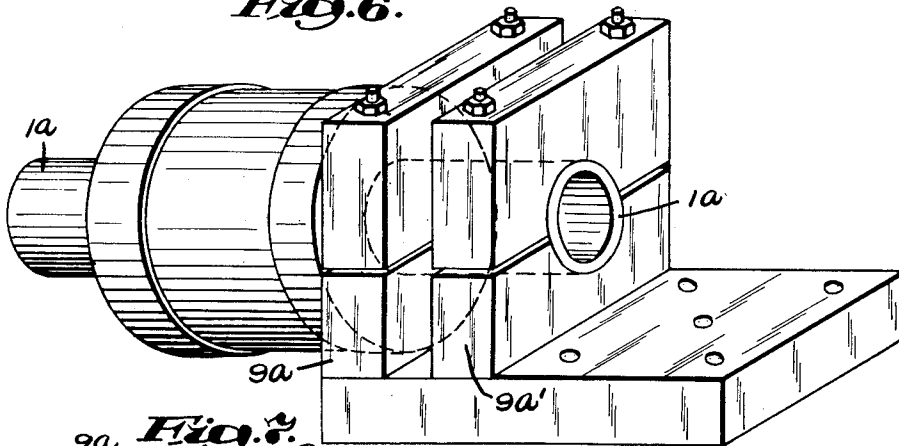


Fig. 7.

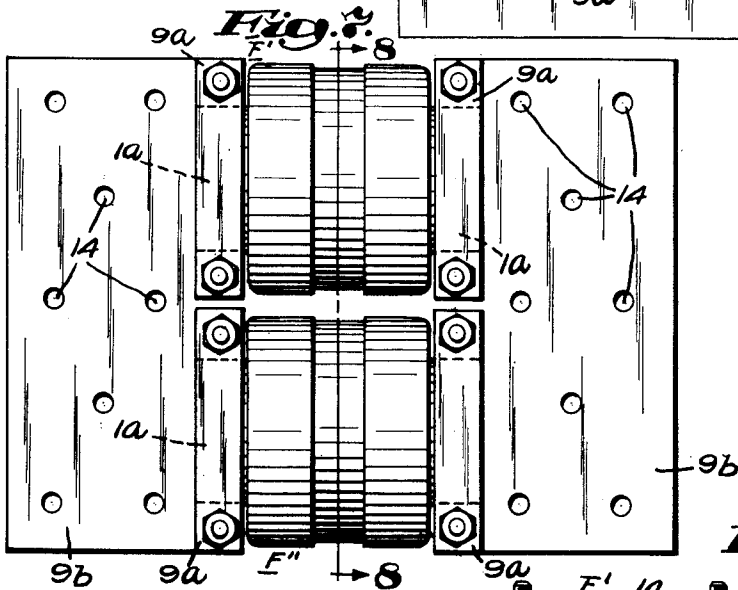


Fig. 8.

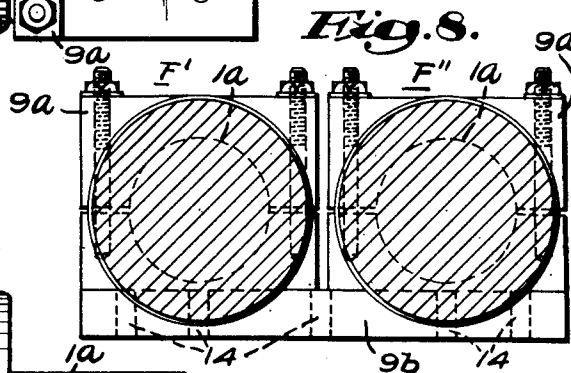
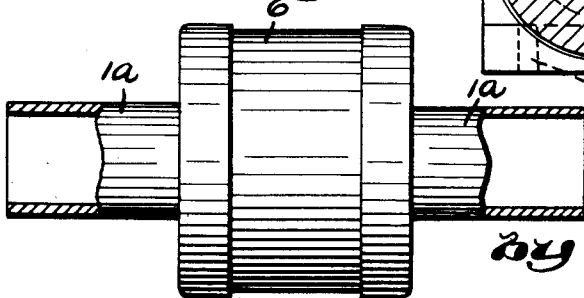


Fig. 9.



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FUSE AND FUSE HOLDER

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This invention relates to electric fuses and fuse holders therefor, and more particularly to a combination of fuses and fuse holders adapted to carry very high currents, i. e. currents in the order of several thousand amperes.

It is desirable to design high current-carrying capacity fuses in such a way as to preclude the short-circuit current from reaching the highest possible value which it might reach at the point of the system where the fuse is installed. The highest possible value which a short-circuit current might reach at a given point in an electric system is generally referred to as the available short-circuit current and the smaller current which a high current-carrying capacity current-limiting fuse permits to flow in a faulted system is generally referred to as the let-through current of that particular fuse. To preclude danger to electric systems and to apparatus connected into them by the electromagnetic stresses and strains and the thermal effects inherent in short-circuit currents, the peak of the let-through current ought to be substantially less than the peak of the available short-circuit current. This can be achieved by means of short multiple fuse links which are provided with one or more portions of restricted cross-section designed in such a way as to melt and to initiate the interrupting process while the short-circuit current is still well below the peak of the available short-circuit current. By adhering to this design principle it is possible to design fuses which, though having a very high current-carrying and current interrupting capacity, yet are very compact on account of the drastic way in which the current and the arc energy are being limited by their mode of operation. If such fuses are provided with the conventional blade contacts, the size of the blade contacts tends to be incongruous and their width may well exceed the diameter of the casing of the fuse.

It is, therefore, one object of the invention to provide a high current-carrying capacity current-limiting fuse of the aforementioned compact type having equally compact connector means of sufficient current-carrying capacity.

The prior art current-limiting fuses designed to have a current-carrying capacity in the order of several thousand amperes cannot be inserted into any known fuse holder but must be attached by means of their blade contact and by means of screws and nuts to the system of bus bars which they are supposed to protect. This makes any renewal of blown fuses a cumbersome and time consuming procedure.

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It is, therefore, another object of this invention to provide a fuse holder for fuses having a current-carrying capacity in the order of several thousand amperes, which fuse holder, while capable of exerting high positive contact pressures, permits a relatively rapid renewal of blown fuses.

Still another object of this invention is to provide a simple rugged structure in the nature of a pair of brackets of which one portion is adapted as a fuse holder proper and another portion is adapted to be attached to a system of spaced bus bars by means of screws and nuts.

In applications involving high current-carrying capacity current-limiting fuses it is desirable or necessary to provide some means precluding interchangeability of such fuses with other fuses, particularly fuses of the standard type.

It is, therefore, a further object of this invention to provide a contact system which precludes interchangeability of standard type fuses and current-limiting fuses designed to have a current-carrying capacity in the order of several thousand amperes and which contact system is capable of carrying currents of this order.

A still further object of this invention is to provide a fuse structure and a fuse holder structure which have cooperating contact means of the butt-type, as distinguished from the blade-and-multifinger type, which contact means have a current-carrying ability and heat-absorbing capacity which compares favorably with the more complex blade-and-multifinger type contacts.

A further special object of this invention is to provide a fuse structure and a fuse holder structure which have cooperating contact means of the butt-type designed, when engaging under pressure, to undergo a deformation tending to increase the number of points of contact engagement and thus to minimize contact resistance.

Another object of this invention is to provide a fuse structure having connectors which have a high ratio of surface to cross-sectional area to increase the rate of heat dissipation and to take account of the skin effect in A. C. circuit applications.

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

Fig. 1 is a longitudinal section of a fuse embodying the present invention;

Fig. 2 is in part a cross-section along 2—2 of Fig. 1 and in part a side elevation of the structure shown in Fig. 1;

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Fig. 3 is a side elevation of a fuse according to Figs. 1 and 2 inserted into a fuse holder embodying this invention;

Fig. 4 is a side elevation of the structure shown in Fig. 3;

Fig. 5 is a top plan view of the structure shown in Fig. 3;

Fig. 6 is a perspective illustration of a fuse and of the right hand portion of a fuse holder for extremely high currents, the identical left hand portion of the fuse holder being omitted;

Fig. 7 is a top plan view of another combination of fuses and of a fuse holder embodying this invention;

Fig. 8 is a cross-section along 8—8 of Fig. 7, and

Fig. 9 is partly a side elevation and partly a longitudinal section of a fuse embodying the present invention.

Referring now to Figs. 1 and 2, the fuse shown therein comprises a pair of cylindrical terminal elements 1 preferably made of solid copper and arranged in spaced relation. Each of terminal elements 1 is provided with a coaxial cylindrical projection 1a forming an integral part thereof. Projections 1a form connectors or connector studs for inserting the fuse into a fuse holder of the type shown in Figs. 3 to 9, inclusive. A plurality of slots 1b are milled into each terminal element 1 at juxtaposed surfaces thereof. The depth of slots 1b may be in the order of $\frac{1}{16}$ " and the angular displacement thereof in the order of 20 degrees. Each slot or groove 1b is adapted to receive a plurality of fuse links 2. Each of said plurality of fuse links 2 consists of a ribbon of silver or copper and each such ribbon is provided with a plurality of points of reduced cross-section. The points 2a of minimum cross-section of each link 2 limit the peak of the let-through current to a relatively low value, far below the peak of the available short-circuit current of the circuit into which the fuse is inserted. The large mass of copper of the terminal elements 1 (see Fig. 1) normally absorbs and dissipates the heat generated at the points of links 2 of reduced cross-sectional area. Fusion of the links 2 at the points 2a of minimum cross-sectional area occurs upon occurrence of a current of short-circuit current proportions. If it is desired to use the fuse for overload protection each of the links 2 may be provided with a tin rivet 2b. Tin rivets 2b fuse upon occurrence of relatively small protracted overloads and the metal of which links 2 are made diffuses into the melted tin, thus resulting in dispersal of links 2 and interruption of the circuit. The spaces between the fuse links 2 are filled with a pulverulent arc extinguishing substance 3, preferably pure quartz sand having a grain size in the order of 50-60 U. S. sieve number. Inasmuch as the let-through current and the arc energy of the structure of Figs. 1 and 2 are small, the quantity of filler 3 required is small and the volume occupied by the entire structure is correspondingly small.

Terminals 1 are securely held apart the required relatively limited distance by a central spacer structure. This structure includes a pair of concentric tubes 4, 5 of a material which combines high heat and heat shock resistance, mechanical strength and good insulating properties. The tubular elements 4, 5 are preferably made of a glass-cloth laminate impregnated with a suitable synthetic resin. The radially inner tubular element 5 is provided with a pair of metal caps 5a secured to it by steel pins 5b and may contain a filler rod 5c of insulating material.

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Caps 5a enter cylindrical recesses 1c in terminal elements 1. Only the left hand cap 5a, the left hand steel pin 5b and the left hand terminal recess 1c have been shown in Fig. 1. A large amount of pressure is applied for inserting the structure 5, 5a, 5b into the terminal elements 1, thus establishing the required high degree of dimensional stability. The links 2 and the granular arc-extinguishing filler 3 are enclosed in an insulating shell or casing 6 which is secured to terminals 1 by means of steel pins 7. Ferrules 8 of sheet metal are arranged at both ends of the fuse structure. It will be apparent that the cross-sectional area of connector studs 1a is considerably smaller than the cross-sectional area of casing 6.

Referring now to Figs. 3-5, it will be apparent from these figures that the pair of coaxial cylindrical connectors or connector studs 1a projecting from the fuse structure generally designated by the reference letter F, and more particularly from the cylindrical casing 6 of the fuse structure F, have been inserted into a fuse holder particularly designed to receive said cylindrical connectors or connector studs. The fuse holder comprises a pair of substantially L-shaped brackets 9 of solid copper arranged in spaced relation each with one shank 9a thereof in a pair of parallel planes and each with the other shank 9b thereof in a common plane. The shanks 9a are formed by substantially equilateral square blocks of copper substantially equal in length to the diameter of casing 6. Shanks 9a form a divided bearing substantially equal in diameter to the diameter of the connectors or connector studs 1a and in cooperative engagement therewith.

Reference numeral 10 has been applied to the cylindrical bearing surfaces which are in cooperative engagement with connector studs 1a. The clamping screws 11 are secured to the lower portions of the divided bearings and pass loosely through bores 12 provided in the upper portions or bearing caps thereof. Nuts 13 enable to clamp firmly the bearing surfaces 10 in the upper and lower portions of the divided bearings against the cylindrical connector studs 1a, thus ensuring the amount of contact pressure required to minimize $I^2 \cdot r$ losses at the contacts. A small gap 20 is always present between the upper portion or bearing cap and the lower portion of each contact bearing.

As nuts 13 are being tightened initially two opposite line contacts are established between the surface of each connector stud 1a and each bearing surface 10. Further tightening of nuts 13 increases the contact pressure prevailing at these two substantially linear contacts of each connector stud 1a but simultaneously each connector stud 1a is being deformed and engages the bearing surfaces 10 under pressure at progressively increasing areas. With further increase of contact pressure the deformation of the connector studs 1a progresses and the contact area changes accordingly from the above referred to initial pair of linear contacts to a surface type or butt contact, i. e. current is then transmitted along substantially the entire peripheral surface of studs 1a. Since the surface type or butt contacts involve a larger contact area and a higher contact pressure than the linear contacts formed during the initial stages of the tightening process of the contact bearing, it is readily apparent that the surface or butt contacts involve relatively less $I^2 \cdot r$ losses than the linear

contact arrangement of which they are an outgrowth.

It will also be readily apparent from Figs. 3-9 that the renewal of a new fuse for a blown fuse is a simple matter of loosening and tightening but a few screws. In prior art fuses and fuse holder structures having a comparable current rating, i. e. a current-carrying capacity in the order of several thousand amperes, the blade contacts of the fuse had to be secured directly to the bus bars. This involved loosening and tightening of a much larger number of screws. It takes therefore much more time and effort to renew prior art fuses than fuses according to this invention.

As shown in Figs. 3 to 5, inclusive, the shanks 9b of brackets 9 are each provided with a plurality of transverse bores or holes 14. These transverse bores or holes 14 are adapted for attachment of the fuse holder and the fuse F to a system of spaced bus bars shown at 15.

It will be apparent from Figs. 3 to 5, inclusive, that the shanks 9a of the two substantially L-shaped fuse holder brackets 9 which are arranged in a pair of parallel planes are spaced a distance slightly in excess of the length of the casing 6 of fuse F. Each bracket 9 is arranged with the other shank 9b thereof in a common plane at right angles to the above pair of parallel planes. The shanks 9a are formed by substantially equilateral square blocks substantially equal in length to the diameter of the casing 6 of fuse F. These square blocks are each subdivided into two parts to form a divided contact bearing having a cylindrical bearing surface 10 substantially equal in diameter to the diameter of connector studs 1a.

The structure shown in Fig. 6 is substantially the same as that shown in Figs. 3 to 5 except that the former is provided with two pairs of parallel shanks 9a, 9a' of which only one is shown in the drawing. Each pair of shanks 9a, 9a' is arranged in a separate pair of parallel planes and each pair of shanks 9a, 9a' forms a pair of divided bearings for the connector studs 1a.

The structure of Figs. 7 and 8 is adapted to accommodate a pair of high current-carrying capacity fuses F' and F'' instead of merely one such fuse. The four parallel shanks 9a are designed to form each a contact bearing. Each pair of four contact bearings formed by shanks 9a accommodates one pair of connector studs 1a. The right hand shank 9b and the left hand shank 9b each support one pair of shanks 9a, i. e. each shank 9b is common to a pair of shanks 9a. Shanks 9b are provided with a plurality of transverse bores 14 adapted to attach the fuse holder to a system of spaced bus bars (not shown).

Fig. 9 shows a high current-carrying and high interrupting capacity fuse similar to that shown in Figs. 1 and 2. The fuse comprises a casing 6 and a pair of coaxial cylindrical connector studs 1a projecting from opposite ends of casing 6. The connector studs 1a are hollow, at least in part, to increase the ratio of surface to cross-sectional area, thus tending to increase the rate at which watt-losses within the fuse are being dissipated. As clearly shown in Fig. 9 that portion of connector studs 1a which is situated at the ends thereof remote from casing 6 is hollow. The portions of the studs 1a immediately adjacent casing 6 are solid. It is apparent that hollow connector studs will not only be better heat exchangers or heat dissipaters than solid studs, but will tend to be more readily deformed by the clamping pressure and hence tend to establish a better contact with any of the fuse holders shown,

i. e. either that shown in Figs. 3-5, that shown in Fig. 6, or that shown in Figs. 7 and 8.

It will be understood that by illustrating herein several preferred forms of fuse structures and fuse holder structures, I do not intend to limit my invention thereto. It will further be understood that while the arrangements described and illustrated herein are the preferred embodiments of my invention, the same may take forms other than specifically shown and described herein. It will be apparent for those skilled in the art that various changes and modifications may be made without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A structure including a cartridge type high current-carrying capacity fuse comprising a casing having a relatively large cross-sectional area and a pair of coaxial cylindrical connector studs having a relatively small cross-sectional area projecting from opposite ends of said casing, and a fuse holder adapted to support said fuse and to receive said pair of connector studs of said fuse, said fuse holder comprising a pair of supports spaced a distance substantially equal to the length of said casing of said fuse, each of said pair of supports forming a divided bearing having a cylindrical bearing surface engaging one of said pair of connector studs of said fuse and having clamping means for exerting clamping pressure in a direction transversely of said casing and said pair of connector studs for firmly clamping said bearing surface against said one of said pair of connector studs of said fuse.

2. A structure according to claim 1 wherein each of said pair of cylindrical connector studs is hollow at the portion thereof remote from said casing of said fuse.

3. A structure including a cartridge type high current-carrying capacity fuse comprising a cylindrical casing having a relatively large cross-sectional area and a pair of cylindrical connector studs having a relatively small cross-sectional area arranged coaxially with respect to said casing and projecting from opposite ends thereof, and a fuse holder comprising a pair of fuse supports consisting of a pair of substantially L-shaped brackets spaced a distance slightly in excess of the length of said casing, said pair of brackets forming a pair of divided bearings having substantially cylindrical bearing surfaces, said bearing surfaces having an internal diameter substantially equal to the diameter of said pair of connector studs, and each of said pair of connector studs being conductively engaged under pressure by one of said bearing surfaces.

4. A structure including a cartridge type high current-carrying capacity fuse comprising a cylindrical casing having a relatively large cross-sectional area and a pair of cylindrical connector studs having a relatively small cross-sectional area arranged coaxially with respect to said casing and projecting from opposite ends thereof, and a fuse holder comprising a pair of substantially L-shaped brackets, each of said pair of brackets being arranged with one shank thereof in a pair of parallel planes spaced a distance slightly in excess of the length of said casing of said fuse, and each of said pair of brackets being arranged with another shank thereof in a common plane, each shank of said pair of brackets arranged in said pair of parallel planes forming a divided bearing including a bearing cap and cap screws and having a cylindrical bearing surface

cooperating with one of said pair of connector studs, and each shank of said pair of brackets arranged in said common plane being provided with means for attachment to a system of spaced bus bars.

5. A structure including a cartridge type high current-carrying capacity fuse comprising a cylindrical casing having a relatively large cross-sectional area and a pair of cylindrical connector studs having a relatively small cross-sectional area arranged coaxially with respect to said casing and projecting from opposite ends thereof and a fuse holder comprising a pair of substantially L-shaped brackets, each of said pair of brackets being arranged with one shank thereof in a pair of parallel planes spaced a distance slightly in excess of the length of said casing of said fuse, and each of said pair of brackets being arranged with another shank thereof in a common plane, each shank of said pair of brackets arranged in said pair of parallel planes being formed by a substantially equilateral substantially square block substantially equal in length to the diameter of said casing of said fuse, said block forming a divided bearing substantially equal in diameter to the diameter of one of said pair of connector studs of said fuse and in cooperative engagement with said one of said pair of connector studs, each shank of said pair of brackets arranged in said common plane being provided with a plurality of transverse bores adapted for attachment thereof to a system of spaced bus bars.

6. A structure including a cartridge type high current-carrying capacity fuse comprising a casing having a relatively large cross-sectional area and a pair of coaxial cylindrical connector studs having a relatively small cross-sectional area projecting from opposite ends of said casing, said pair of connector studs being hollow at least in part to increase the ratio of surface to cross-sectional area thereof, and a fuse holder adapted to receive said pair of connector studs, said fuse holder comprising two spaced fuse supports each forming a divided bearing having a cylindrical bearing surface in cooperative engagement with one of said pair of connector studs and each having clamping screws for firmly clamping said bearing surface against one of said pair of connector studs in a direction transversely of said pair of connector studs.

7. A structure including a cartridge type high current-carrying capacity fuse comprising a cy-

lindrical casing having a relatively large cross-sectional area and a pair of cylindrical connector studs having a relatively small cross-sectional area arranged coaxially with respect to said casing and projecting from opposite ends thereof, said pair of connector studs being hollow at least in part to increase the ratio of surface to cross-sectional area thereof, and a fuse holder comprising a pair of substantially L-shaped brackets, each of said pair of brackets being arranged with one shank thereof in a pair of parallel planes spaced a distance slightly in excess of the length of said spaced casing of said fuse, each of said pair of brackets being arranged with another shank thereof in a common plane, each shank of said pair of brackets arranged in said pair of parallel planes being formed by a substantially equilateral square block substantially equal in length to the diameter of said casing of said fuse, said block forming a divided bearing substantially equal in diameter to the diameter of one of said pair of connector studs and in cooperative engagement with said one of said pair of connector studs, each shank of said pair of brackets arranged in said common plane being provided with a plurality of transverse bores adapted for attachment thereof to a system of spaced bus bars.

8. A structure including a cartridge type high current-carrying capacity fuse comprising a casing having a relatively large cross-sectional area and a pair of coaxial cylindrical connector studs having a relatively small cross-sectional area projecting from opposite ends of said casing, and a pair of solid metal blocks each defining a sleeve for receiving one of said pair of connector studs, each of said pair of metal blocks being divided by a slit extending radially with respect to said pair of connector studs and each said pair of metal blocks being provided with a pair of clamping screws arranged symmetrically with respect to the common axis of said pair of connector studs and at right angles with respect to said slit in each of said pair of metal blocks to press each of said pair of metal blocks against one of said pair of connector studs.

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