June 15, 1954 F. J. KOZACKA ET AL 2,681,398

FLUID-TIGHT FUSE STRUCTURE

Filed March 27, 1953

Fig. 1.

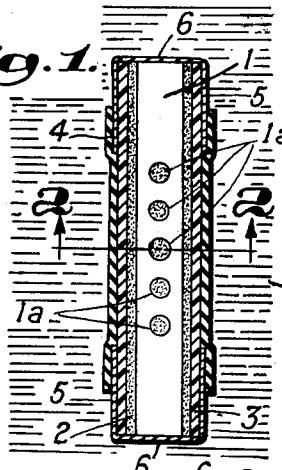


Fig. 2.

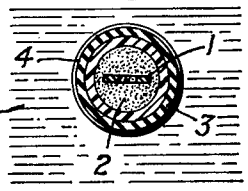


Fig. 4.

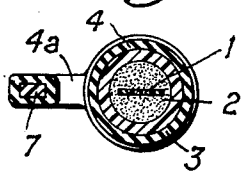


Fig. 3.

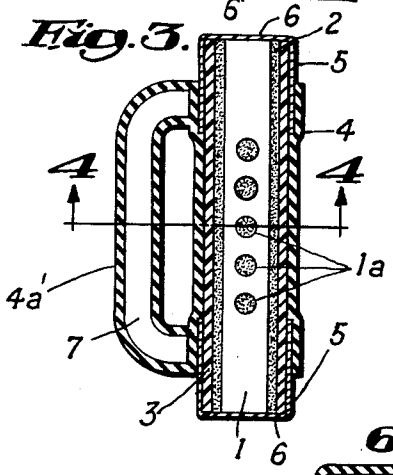


Fig. 6.

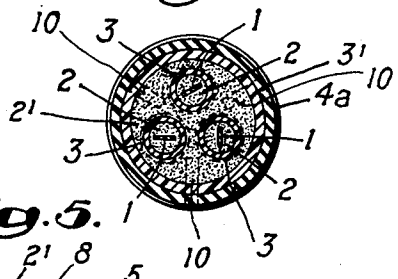


Fig. 5.

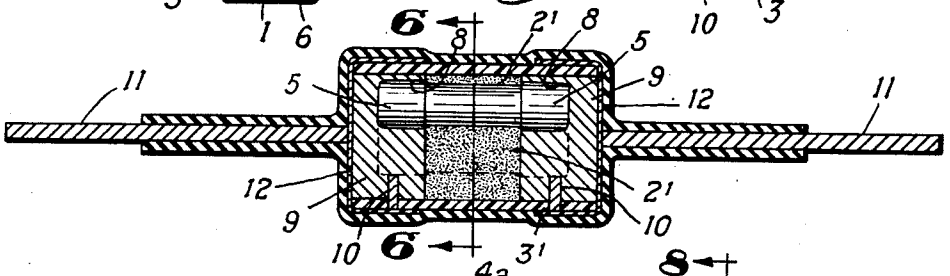


Fig. 7.

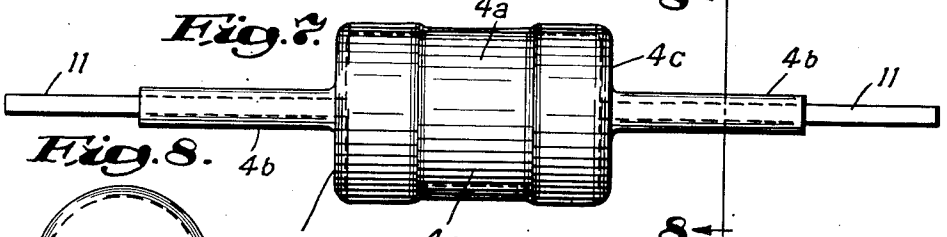
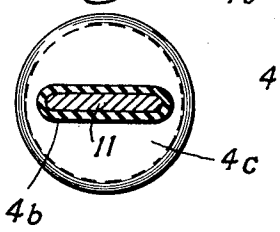


Fig. 8.



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FLUID-TIGHT FUSE STRUCTURE

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6 Claims. (Cl. 200—120)

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This invention relates to fluid-tight protective devices for interrupting electric circuits on the occurrence of excessive electric currents, and more particularly to power-filled cartridge fuses for continuous oil immersion in service.

It is sometimes necessary to provide fluid seals on thermally responsive devices for circuit protection such as, for instance, fuses to preclude fluid diffusion or fluid leakage into the casing of the device. Fluid seals are particularly important where the protective device under consideration is a fuse whose casing is filled with an arc-extinguishing pulverulent substance as, for instance, quartz sand, and where the fuse is intended for continuous oil immersion in service. If a power-filled fuse immersed in oil is not absolutely oil-tight, the pressure head in relation to the casing of the fuse will result in penetration of oil into the pulverulent arc-extinguishing filler. A power-filled fuse into which but a small amount of oil has penetrated is likely to cause a highly destructive explosion upon blowing thereof, because the semi-instantaneous release of large amounts of heat results in a semi-instantaneous gasification of the oil and a concomitant semi-instantaneous build-up of pressure within the casing of the fuse.

In order to avoid this serious explosion danger fuses have been developed which comprise absolutely fluid tight casings made of a suitable glazed ceramic material and relatively complex fluid tight seals arranged at the axially outer ends of the casings. United States Patent 2,333,354 to Reginald Charles Anderson and Kurt Dannenberg, Electric Fuse of the Cartridge Type, issued November 2, 1943 refers to a fuse of this nature.

Though it is possible to produce ceramic casings for fuses which are absolutely fluid tight, the application of ceramic materials for casings for oil immersed fuses involves serious dangers because of the limited mechanical strength of ceramic materials. It is, therefore, one object of the invention to provide fluid-tight overload protective devices, and more particularly fluid tight fuses having a pulverulent or granular arc-extinguishing filler, which devices or fuses have a considerable amount of mechanical strength and do not become potential sources of failure when subjected to rough handling, and like conditions.

In the past, designers of fuses have evolved two methods for achieving fluid-tightness without sacrificing mechanical strength requirements. One of these methods consists in surrounding

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the fuse with an air-filled bell precluding access of oil to the casing of the fuse. The other method consists in providing the fuse with a pair of flexible leads projecting from opposite ends thereof for connecting the fuse into an electric circuit and in enclosing the entire fuse structure, including its casing and one of the terminals of the flexible leads, in a fluid tight casting.

The first mentioned method involves provision of additional relatively bulky and expensive parts, while the second mentioned method precludes insertion of the fuse in any standard fuse holder and gives rise to difficulties if the curing temperature of the material of which the casting is to be made exceeds the temperature to which any constituent part of the fuse may safely be subjected, particularly if the curing temperature of the material of which the casting is to be made exceeds the gassing point of an organic insulating material of which the casing of the fuse is to be made.

It is, therefore, another object of the invention to provide a fluid-tight protective device for interrupting electric circuits on the occurrence of excessive electric currents which is free from the limitations and/or drawbacks of the aforementioned prior art devices.

Still another object of this invention is to provide a fluid-tight fuse adapted to be summersed under oil, the fuse having a safety feature precluding decomposition of the surrounding oil by the arc and the hot arc products formed upon blowing of the fuse in case that the casing of the fuse should break during the process of interrupting a faulted circuit.

Further objects and advantages of this invention will become apparent as the following description proceeds and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

For a better understanding of this invention reference may be had to the accompanying drawing which illustrates several embodiments of the invention.

Fig. 1 is a longitudinal section of a first embodiment;

Fig. 2 is a section along 2—2 of Fig. 1;

Fig. 3 is a longitudinal section of a second embodiment;

Fig. 4 is a section along 4—4 of Fig. 3;

Fig. 5 is substantially a longitudinal section of still another embodiment;

Fig. 6 is a section along 6—6 of Fig. 5;

Fig. 7 is a top plan view of the structure shown in Figs. 5 and 6; and

Fig. 8 is a section along 8—8 of Fig. 7.

Referring now to Figs. 1 and 2, reference numeral 1 indicates a fusible link preferably of silver or copper which is provided with a plurality of circular perforations 1a to form a plurality of breaks in series on interrupting currents of short-circuit current proportions. Link 1 is surrounded by a pulverulent arc-extinguishing filler 2, preferably chemically pure quartz sand. The body of quartz sand is enclosed in a tubular casing 3 of a thermosetting synthetic-resin-glass-cloth-laminate. A tubular material of this kind can readily be produced by a process well known in the art comprising the step of winding on a mandrel glass-cloth in sheet form. The ends of casing 3 are closed by a pair of metallic terminal caps 5 which are conductively interconnected by the fusible link 1. The latter may be soldered to caps 5 and since producing such a solder joint is a conventional process, no details of the solder joint have been shown in the drawing. The sleeve 4 covers the outer surface of casing 3 and extends in axial direction thereof over a limited portion only of the outer surfaces of terminal caps 5. The axially outer portions 6 of the outer surfaces of the terminal caps 5 are left bare to enable convenient insertion of terminal caps 5 into a fuse holder or cut-out (not shown). Sleeve 4 consists of a polysulfide type synthetic rubber and is bonded to casing 3 as well as to the axially inner portions of the outer surfaces of terminal caps 5. Caps 5 closely fit casing 3 and are pressed upon the axially outer ends thereof with considerable force. In spite of the tight fit of caps 5, very fine gaps are generally formed at some points between the outer surface of casing 3 and the inner surfaces of caps 5. Such gaps are potential passages for the egress of hot products of arcing out of the casing 3, or the diffusion of gases and the leakage liquids from the space outside of casing 3 into the inside of casing 3. However, the presence of sleeve 4 firmly bonded to both casing 3 and caps 5 precludes any undesired flow of fluid from the outside of casing 3 to the inside thereof, or vice versa.

In Figs. 1 and 2 reference letter O has been applied to indicate a body of oil in which the entire fuse structure is submerged. The structures of Figs. 3 to 8 may be submerged under oil in a similar fashion.

Thermosetting synthetic - resin - glass - cloth-laminates have a high degree of dimensional stability combined with considerable mechanical strength and heat-shock resistance. Their gassing point may be low, i. e., but slightly above the temperature which a cool running fuse may reach when continuously carrying a current slightly less than the minimum fusing current. This temperature may be in the order of 130 deg. C. Polysulfide type synthetic rubbers have a low curing point—in the order of 130 deg. C.—are fluid-tight and oil-proof and can be vulcanized and thus bonded to synthetic-resin-glass-cloth-laminates as well as to copper, brass and silver. Thus synthetic-resin-glass-cloth-laminates and polysulfide type synthetic rubbers form a completely matching pair of materials for making fluid-tight, and particularly oil-tight, fuses adapted for continuous oil submersion in service.

Vulcanized polysulfide type synthetic rubbers are no longer thermoplastic and their percentage volume swell in oil is in the order of a few percent. Therefore no noticeable change in the geometry of the polysulfide type synthetic rubber protector of the fuse takes place upon submersion of the fuse under oil and this enables insertion of the fuse into, and removal of the fuse from, the clips of a fuse holder, or cut-out, without interference of an out-of-shape rubber part.

The characteristics of the vulcanized polysulfide synthetic rubber protector are of particular importance in case that the thermosetting synthetic-resin-glass-cloth-laminate casing of the fuse should break during the process of circuit interruption. If the casing 3 should break, the flexible bag formed by sleeve 4 precludes interaction of the hot products of arcing formed within casing 3 and the body of oil O outside of casing 3. The resiliency of sleeve 4 permits a sudden expansion of the hot products of arcing formed within casing 3, and the concomitant adiabatic cooling of these hot products of arcing is conducive to immediate interruption of the circuit of the faulted fuse.

Under normal operating conditions sleeve 4 increases the dielectric strength of the fuse structure and provides a flexible cushion-like protector for the casing 3 thereof.

To provide the fuse structure with the polysulfide synthetic rubber sleeve 4 the fuse is placed in a mould tightly surrounding the axially outer ends of terminal caps or ferrules 5. A space is left between all of the external surface of the fuse structure and the internal surface of the mould, except for the axially outer ends of the terminal caps or ferrules 5 where the fuse is tightly clamped in the mould. The space left between the external surface of the fuse structure and the mould is filled with a suitable polysulfide synthetic rubber to which a suitable vulcanizer has been added. As is well known in the art, polysulfide synthetic rubber may be vulcanized by using a combination of zinc oxide and p-quinone dioxime as vulcanizing agent. .5 part of zinc oxide and 1.5 part of p-quinone dioxime may be added to 100 parts of polymer.

Other ingredients may be added to the mix as is well known in the art as, for instance, softeners, reinforcing pigments, etc.

The vulcanization of the synthetic rubber occurs through an oxidation condensation involving the conversion of —S—H— terminals to —S—S— linkages with elimination of H_2O. This reaction increases the molecular weight of the polymer and effects cross-linking.

The structure shown in Figs. 3 and 4 is basically the same as that shown in Figs. 1 and 2, except that a handle has been added to the structure shown in the first mentioned figures. The handle comprises a substantially U-shaped flat piece 7 of insulating material arranged in a radial plane of casing 3. The two ends of handle member 7 are located immediately adjacent ferrules 5 but a gap is left between parts 5 and 7. The polysulfide synthetic rubber sleeve 4 has a lateral projection, or extension, 4a' which covers all of piece 7 and integrates piece 7 and casing 3 into a unitary structure.

Referring now to Figs. 5 to 8, the structure shown therein comprises three fuse units of which each includes a fuse link 1, a casing 3, a body of pulverulent arc-extinguishing filler 2 within casing 3 surrounding link 1, and a pair of terminal caps 5. The terminal caps 5 of each fuse unit are arranged in recesses 8 of a pair of terminal blocks 9. An insulating shell or casing 3' made of a thermosetting synthetic resin-glass-cloth-laminate encloses both the three fuse units

as well as both terminal blocks 9. Casing 3' is filled with a pulverulent cooling substance, e. g. quartz sand 2'. The body of quartz sand 2' is a highly effective coolant for the products of arcing permitted to escape from casings 3 through the fine gaps formed between casings 3 and terminal caps or ferrules 5. Casing or shell 3' is secured to terminal blocks 9 by a plurality of transverse pins 10 of which two have been indicated in Fig. 5 and three have been shown in Fig. 6. A pair of blade contacts 11 having a considerably smaller cross-sectional area than terminal blocks 9 and casing 3' is secured to blocks 9 in any appropriate fashion, for instance, by brazing. The terminal blocks 9 are covered by sheet metal caps 12 having apertures (not shown) through which the blade contacts 11 project.

The fuse structure shown in Figs. 5 to 8 comprises a protective shell which consists of a unitary casting made of a polysulfide type synthetic rubber. This protective shell comprises a sleeve *4a* covering the outer surface of casting 3' and bonded to that surface and a pair of additional sleeves *4b* covering and bonded to the axially inner ends of blade contacts 11. The axially outer ends of contacts 11 are bare to enable making of direct current-carrying connections with adjacent circuit-elements (not shown) as, for instance, the finger contacts of a fuse holder adapted to receive contacts 11 shown in Figs. 5 to 8. Sleeve *4a* and the additional sleeves *4b* are connected by intermediate portions *4c* of the protective polysulfide type synthetic rubber shell and parts *4a*, *4b*, *4c* form a unitary protector.

It will be apparent to any one skilled in the art that the protective polysulfide synthetic rubber coverings with which our thermosetting synthetic-resin-glass-cloth-laminate fuse structures are provided is not only of value where it is intended to submerse the fuse structures under oil, but may be applied to advantage in any instance where it is desired to provide fuse structures of the aforementioned type with fluid-tight or/and oil-proof seals.

Having disclosed several preferred embodiments of our invention, it is desired that the same be not limited to the particular structures disclosed. It will be obvious to any person skilled in the art that many modifications and changes may be made without departing from the broad spirit and scope of our invention. Therefore it is desired that the invention be interpreted as broadly as possible and that it be limited only as required by the prior state of the art.

We claim as our invention:

1. A fluid-tight protective device for interrupting electric circuits on the occurrence of excessive electric currents comprising a tubular casing of a thermosetting synthetic-resin-glass-cloth-laminate, circuit interrupting means predicated upon fushion of a metal by heat generated by the flow of an excessive electric current arranged within said casing, a pair of metallic terminal structures including means for closing said casing at the axially outer ends thereof supported by said casing and conductively connected to said interrupting means, and a sleeve covering the outer surface of said casing and extending in axial direction thereof over a limited portion only of the surface of said pair of terminal structures leaving bare another portion of the surface of said pair of terminal structures to enable convenient insertion of said pair of terminal structures into a pair of cooperating contacts, said sleeve consisting of a polysulfide type synthetic rubber bonded to said casing as well as to said limited portion of the surface of said pair of terminal structures.

2. A fluid-tight fuse comprising a tubular casing of a thermosetting synthetic-resin-glass-cloth-laminate, a pulverulent arc-quenching filler within said casing, a fuse link within said filler, a pair of terminal caps conductively interconnected by said link closing the axially outer ends of said casing, and a sleeve covering the outer surface of said casing and extending in axial direction thereof beyond the axially inner edges of said pair of terminal caps but exposing the bare axially outer ends of said pair of terminal caps to permit cooperative engagement thereof with the contacts of a fuse holder, said sleeve consisting of a polysulfide type synthetic rubber bonded to said casing as well as to the axially inner portions of said pair of terminal caps.

3. A fluid-tight protective device for interrupting electric circuits on the occurrence of excessive electric currents comprising a tubular casing of a thermosetting synthetic-resin-glass-cloth-laminate, circuit interrupting means predicated upon fusion of a metal by heat generated by the flow of an excessive electric current arranged within said casing, a pair of terminal plates conductively interconnected by said circuit interrupting means closing the axially outer ends of said casing, a pair of blade contacts each projecting in an opposite direction from one of said pair of terminal plates, and a sleeve covering the outer surface of said casing and extending in axial direction thereof over a limited portion only of the surface of said pair of blade contacts leaving bare another portion of the surface thereof to enable convenient insertion of said bare portion into a cooperating pair of contacts, said sleeve consisting of a polysulfide type synthetic rubber bonded to said casing as well as to said limited portion of the surface of said blade contacts.

4. A fluid-tight fuse for interrupting electric circuits on the occurrence of excessive electric currents comprising a tubular casing of a ther- a plurality of fuse links arranged within said casing and surrounded by a pulverulent arc-quenching filler, a pair of metal plates conductively interconnected by said plurality of fuse links closing the axially outer ends of said casing, a pair of substantially rigid contacts each forming an integral part of and projecting in an opposite direction from one of said pair of metal plates and having a smaller cross-sectional area than said one of said metal plates, and a sleeve covering the outer surface of said casing and extending at least over the radially outer portion of each of said pair of metal plates, the axially outer portion of each of said pair of contacts being bare to enable direct current carrying connection thereof with adjacent circuit elements, said sleeve consisting of a polysulfide type synthetic rubber bonded to the side of said casing as well as to said pair of metal plates.

5. A fluid-tight fuse for interrupting electric circuits on the occurrence of excessive electric currents comprising a tubular casing of a thermosetting synthetic-resin-glass-cloth-laminate, a fuse link arranged within said casing and surrounded by a pulverulent arc-quenching filler, a pair of metallic terminal elements for closing the axially outer ends of said casing and connecting said fuse link into an electric circuit, a substan-

tially U-shaped handle member arranged in a radial plane of said casing and radially projecting from said casing, and a unitary casting of a polysulfide type synthetic rubber forming a sleeve covering said casing and the axially inner ends of said terminal elements and leaving bare the axially outer ends of said terminal elements, said casting covering also said handle member and attaching said handle member to said casing and to said pair of terminal elements.

6. A fluid-tight fuse comprising a tubular casing of an insulating material, a pulverulent arc-quenching filler within said casing, a fuse link within said filler, a pair of terminal caps conductively interconnected by said link closing the axially outer ends of said casing, and a sleeve covering the outer surface of said casing and extending in axial direction thereof beyond the axially inner edges of said pair of terminal caps but exposing the bare axially outer ends of said pair of terminal caps, said sleeve consisting of a synthetic rubber bonded to said casing as well as to the axially inner portions of said pair of terminal caps.

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