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ELECTRIC FUSE ELEMENTS FOR RETARDED OR RAPID RESPONSE

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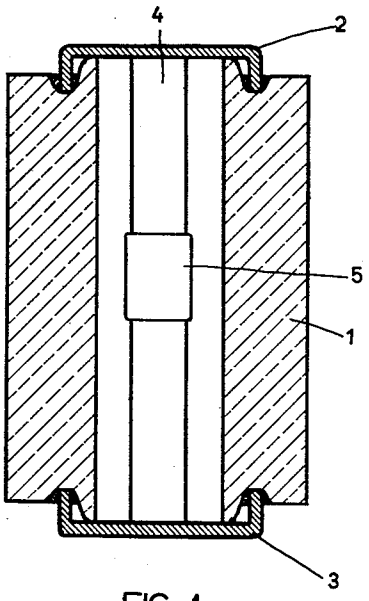


FIG. 1

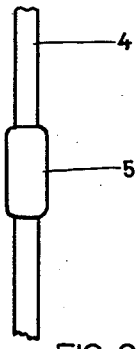


FIG. 2

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ELECTRIC FUSE ELEMENTS FOR RETARDED OR RAPID RESPONSE

Georg Iwantscheff, Nurnberg, and Walter Rauch, Regensburg, Germany, assignors to Siemens-Schuckertwerke Aktiengesellschaft, Berlin-Siemensstadt and Erlangen, Germany, a German corporation

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9 Claims. (Cl. 200—135)

Our invention relates to fuses for the protection of electric circuits and apparatus, and more particularly to fuses whose fuse element comprises an overdimensioned conductor and an activating substance joined with the conductor to form therewith an alloy or compound when sufficiently heated. Upon occurrence of a given temperature or current condition, the activating substance produces in the conductor a spot of increased electric resistance and reduced melting temperature, thus causing the fuse to blow in premature relation to the loading that would otherwise be sustainable by the conductor.

For retarded fuses, it is desired to have the effect of the added activator substance occur only after the fuse has been subjected to moderate overload for a relatively long period of time. In rapid-action fuses, the effect of the activator substance is desired to reach beyond a multiple of the rated current. The activator substance is further required to initiate its effect at a temperature that is sufficiently high to prevent changes in ambient room temperature from appreciably affecting the time characteristic of the fuse element, but is still low enough to rupture the element at a thermally favorable point and to maintain its steady-state conductance temperature at a low value.

Important also are the requirements that, as long as thermal conditions are not reached, the activator substance have no aging effect upon the conductor, and that the interval of time from initiation to completion of the activating and blowing performance be very short to minimize the possibility of maintaining an already weakened fuse element in operation when, after initiation of the activator action, the load current returns to below activating conditions. It is also desired to have the activating action commence not within an appreciable temperature interval but rather, as exactly as possible, at a given temperature point to minimize stray in the time characteristic of the fuse.

It has heretofore been infeasible to simultaneously meet these various requirements, as all activator substances thus far employed in fuses are incompatible with one or the other requirement.

It is an object of the invention, therefore, to devise a fuse element that, in these respects, is superior to those heretofore available and conjointly satisfies the above-mentioned desiderata.

To this end, and in accordance with our invention, we provide the conductor of a fuse element with an activator substance consisting substantially of selenium. That is, the activator substance is either entirely of selenium or it contains a minor addition, preferably sulphur, for modifying the activator melting point. The fuse conductor to which the selenium activator is applied, consists of conventional fuse metal, preferably silver or copper.

The invention is applicable with time-lag or rapid-action fuses of the open type as well as of the enclosed type, an example of an enclosed cartridge being shown on the drawing in which Fig. 1 shows the fuse in cross

section, and Fig. 2 is a partial side view of the fuse element.

The illustrated fuse has a cylindrical housing 1, for instance of ceramic material, closed at both ends by ferrule-type terminals 2, 3. A fuse conductor 4 extends within the housing 1 from one ferrule to the other. The conductor 4 carries a small activator body 5 of selenium. It will be understood that the fuse conductor and activator body may be given other shapes than illustrated, that several conductor strips or wires may be arranged in parallel, and that in fuse cartridges the enclosed space around the fuse element proper may contain granular or other arc-quenching material.

During normal loading of a fuse element according to the invention, the selenium has no activating effect upon the fuse conductor as long as its temperature remains below the selenium melting point of 220° C. The reaction occurs only when this melting point is reached and then commences like a sudden impact, as molten selenium acts upon the conductor metal with extreme aggressiveness. With a fuse conductor of copper, copper selenide is formed. With a conductor of silver, there results the formation of silver selenide. Both compounds are virtually non-conducting. Hence the very first attack of the fused selenium upon the conductor results in constricting the conductive cross section, thus immediately and considerably increasing the temperature at the point of attack so that the fuse element will blow within an extremely short interval of time. Once the phenomenon has commenced by the selenium reaching its melting temperature, it cannot virtually be stopped but proceeds to the complete interruption of the fuse conductor. The fuse element according to the invention, therefore, is distinguished by the fact that its original melting characteristic does not change during long periods of time or under the effect of preceding current loadings that do not cause the fuse element to blow. That is, such a fuse element is not subjected to appreciable aging. Due to the great aggressiveness of selenium relative to the material of the fuse conductor, an always reliable triggering and interrupting operation of the fuse element is secured. Since the melting point of selenium is at 220° C., the normal operating temperature of a fuse element according to the invention is low, this being desirable for most applications of such elements; but the operating temperature is still high enough to prevent changes in ambient room temperature from affecting the protection characteristic of the fuse. For reducing the melting point of the treated substance, an amount of sulphur may be admixed to the selenium so that the trigger substance is formed by the selenium-sulphur mixture, the preponderant portion of the mixture being preferably the selenium. By virtue of the low melting point of the trigger substance or mixture, it is possible to make the fuse conductor of a base metal, particularly copper, without the danger of aging.

The invention can be used to advantage in conjunction with enclosed or cartridge type fuses as exemplified by the illustrated embodiment described in the foregoing. In such fuses the fuse conductor, as a rule, is overdimensioned; and, by employing correspondingly different designs of the fuse element, the effect of the selenium or of the selenium mixture upon the fuse conductor is varied to adapt it to either retarded or rapid-action. In both kinds of fuses, one and the same activating substance may be used, and both have a low rated-current temperature.

The selenium or selenium-sulphur mixture can be joined with the fuse conductor in different ways. The activating substance in solid form may be disposed directly upon the fuse conductor while the conductor is heated. However, the fuse conductor may also be coated with the activating substance by submerging it in liquid

substance at the locality to be coated. Another method is to apply the activating substance in liquid form to the cold or heated fuse conductor by dripping or spreading the substance onto the conductor. When applying the substance onto a heated conductor, the conductor may be kept at a temperature between its rated-current temperature and the melting point of the activating substance. When spreading the activating substance onto the conductor, this should be done as rapidly as feasible for minimizing detrimental effects of the liquid substance upon the material of the fuse conductor. However, the selenium or selenium mixture may also be joined with an additional, auxiliary body, such as a rivet, which is subsequently attached to the fuse conductor so that the activating substance can act upon the conductor material. Still another possibility is to join the activating substance as a solid body with the fuse conductor by means of an adhesive or other cementing agent.

We claim:

1. In an electric power system subject to overload, which includes a fuse conductor of electrically good conductive metal connected into the electric power supply, the improvement comprising a trigger substance for said conductor essentially of elemental selenium for initiating destruction of the conductor when said substance is heated to melting temperature, to interrupt the power supply, the heat produced upon overload of the fuse conductor initially acting upon and melting the elemental selenium.

2. In an electric power system subject to overload, which includes a fuse conductor of electrically good conductive metal connected into the electric power supply, the improvement comprising a trigger substance for said conductor essentially of selenium in elemental form for initiating destruction of the conductor when said substance is heated to melting temperature, to interrupt the power supply, the trigger substance being carried on the conductor and being localized to a limited portion of the length of the conductor.

3. In an electric power system subject to line overload, which includes a fuse conductor of electrically good conductive metal connected into the electric power supply, the improvement comprising a trigger substance for said conductor of elemental selenium for initiating destruction of the conductor when said substance is heated to melting temperature, to interrupt the power supply, the trigger substance being carried on the conductor and being localized to a limited portion of the length of the conductor, the conductive metal being taken from the group consisting of copper and silver.

4. In an electric power system subject to line overload, which includes a fuse conductor of electrically good conductive metal connected into the electric power supply, the improvement comprising a trigger substance for said conductor initially of free selenium for initiating destruction of the conductor when said substance is heated to melting temperature, to interrupt the power supply, the trigger substance being carried on the conductor and being localized to a limited portion of the length of the conductor, the conductive metal being taken from the group consisting of copper and silver, the fuse conductor comprising a rod-shaped element, a ceramic housing for said element open at opposite ends, ferrule-type terminals covering the respective open ends and serving to support, and being in electro-conductive connection with, opposite ends of the rod, the heat produced upon the overload of the fuse conductor initially acting upon and melting the free selenium.

5. In an electric power system subject to line overload, which includes a fuse conductor of electrically good conductive metal connected into the electric power supply, the improvement comprising a trigger substance for said conductor essentially of uncombined selenium for initiating destruction of the conductor when said substance is heated to melting temperature, to interrupt the power supply, the fuse conductor comprising a rod-shaped element, a ceramic housing for said element open at opposite ends, ferrule-type terminals covering the respective open ends and serving to support, and being in electro-conductive connection with, opposite ends of the rod.

6. A fuse element for electric fuses, comprising a fuse conductor, and an activator substance mounted on said conductor consisting substantially of selenium having an admixture of sulphur for reducing the melting temperature of the activator substance.

7. In a fuse element according to claim 6, said fuse conductor being a conductive metal taken from the group consisting of copper and silver.

8. A fuse system in an electric circuit subject to overload, comprising a fuse, the fuse including a fuse conductor element electrically connected in said circuit, means on the conductor element for initiating destruction of at least a portion of the conductor element to interrupt the circuit, said means comprising selenium initially present in chemically uncombined form, the heat produced by the overload of the conductor element directly and initially acting upon and melting the elemental selenium.

9. A fuse system in an electric circuit subject to overload, comprising a fuse, the fuse including a fuse conductor element electrically connected in said circuit, means on the conductor element for initiating destruction of at least a portion of the conductor element to interrupt the circuit, said means comprising selenium initially present in chemically uncombined form, the heat produced by the overload of the conductor element directly and initially acting upon and melting the elemental selenium, the fuse conductor element comprising a material taken from the group consisting of copper and silver.

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