

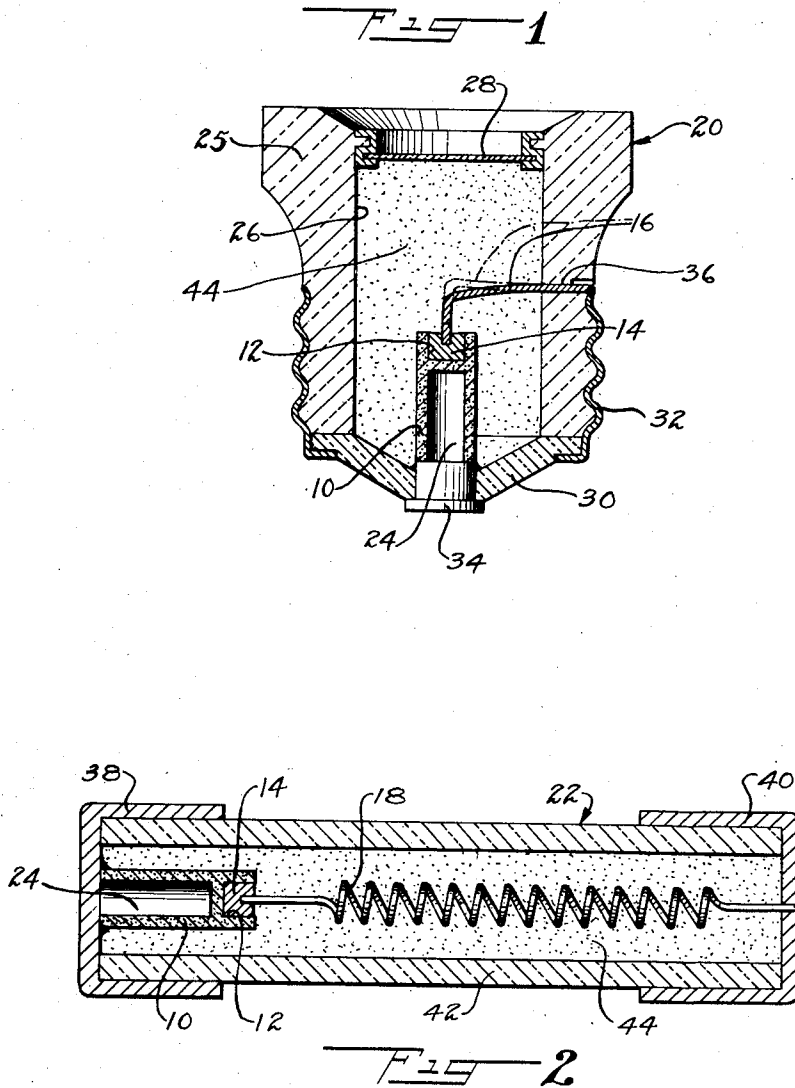
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DELAYED ACTION FUSE

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## DELAYED ACTION FUSE

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The invention relates to fuses such as those employed to open electric circuits when the current therein exceeds a predetermined value, and more particularly to fuses of the delayed action type which are adapted to carry a relatively large overload for a short period of time or carry a relatively small overload for a longer period of time.

Fuses of this type have been proposed in which the fusible element was surrounded by a heater element composed of a coil of relatively high resistance wire in series with the fusible element, but such fuses are usually adapted to carry only a small amount of current, and also, due to the oxide coating that forms on the fusible element, their characteristics change with age and they soon become unreliable.

Fuses of larger size have also been proposed in which two conductive elements were joined by a fusible element suitably alloyed thereto and the fusing heat was provided by the passage of current through adjacent granular carbon. However, due to the variation in resistance of such carbon under different degrees of compression it is extremely difficult to commercially manufacture fuses of this type that are uniform in action.

Fuses of this type have also been proposed in which one end of a fusible wire is soldered to one end of a graphite resistance element. In this construction, however, the solder and the fuse wire are both fusible and, due to the high conductivity of graphite, a relatively small cross-section must be used to provide the necessary resistance. As both the amount of solder used and the amount of fuse wire melted down during the soldering operation varies considerably, the amount of fusible metal in contact with the heater element likewise varies and this causes variations in the action of the fuses.

Therefore, the chief objects of this invention are to provide a fuse of the type described that is lower in cost, easier to manufacture, more simple in construction, better adapted to the various conditions of use, more accurate and uniform in operation, better adapted for installation in the various types of fuse containers, and subject to less change in operating characteristics with age. These, and any other new and novel features will be more fully described in the following specification and shown in the accompanying illustration, in which:

Fig. 1 is a sectional view of a fuse embodying the invention mounted in a plug type fuse container; and,

Fig. 2 is a sectional view of a similar fuse mounted in a cartridge type container.

The invention, as illustrated by the drawing, may be embodied in a fuse consisting of a suitable refractory conductive element 10 provided

with a suitable recess 12 having a fusible material 14 embedded therein in which one end of a suitably tensioned conductive spring such as 16 or 18 is embedded. This fuse may be mounted in any suitable or conventional holder or container such as a plug type holder 20 or a cartridge type holder 22. The heating element 10, the fusible material 14, and the spring such as 16 or 18 may be electrically connected in series so that the passage of more than a predetermined amount of current through the fuse will produce sufficient heat in the heating element to fuse or soften the fusible material and release the embedded end of the tensioned spring thereby breaking the circuit.

The heating element 10 may be of any suitable refractory conductive material such as carbon or the like that melts at a temperature above the fusing point of the fusible material 14, and has sufficient internal resistance to cause the generation of sufficient heat to melt the fusible material when a current above the carrying capacity of the fuse is passed therethrough. The size and shape of the heating element may vary according to the mounting space available and the operating characteristics desired, although a fuse suitable for protecting electric equipment and circuit conductors, such as those used at present, may be provided with a heating element of cylindrical contour having flat ends in which the length of the element is substantially twice as great as the diameter.

The carbon rod forming this heating element may be provided with a suitable recess such as 12 in which the fusible material may be embedded, and this recess may be located in any suitable portion such as one end. The size and relative proportion of this recess may vary according to operating requirements, but a suitable heating element may be provided with a flat bottomed cylindrical recess having a diameter and a depth substantially half the diameter of the rod. In general, however, the larger the recess with respect to the rod the lower the carrying capacity of the fuse due to the reduced sectional area of the carbon, and the greater the delay in opening the circuit on relatively small overloads due to the longer time required to melt or fuse the larger mass of fusible alloy.

In order to provide a heating element of sufficient size to hold a suitable mass of fusible alloy, and also of sufficient internal resistance to suitably fuse this mass, the carbon rod may be provided with a resistance increasing recess such as 24 in the end opposite recess 12. Although the relative size and proportion of this recess may vary with the operating characteristics, a suitable recess may be cylindrical in contour with a diameter substantially half that of the diameter of the rod and a depth somewhat greater than 60

the diameter of the rod so that a wall having a thickness substantially  $\frac{1}{4}$  the diameter of the element is provided between the recesses.

The fusible material 14 may be any suitable metal or alloy of metals such as those already well known in the arts, but a suitable alloy may consist of an intimate mixture of equal parts of lead and tin.

The separating springs 16 and 18 may be of any suitable conductive material such as steel or bronze and of any suitable size that will carry the current for which the fuse is intended. The outer contour of the material is not important and therefore the shape of the material may be of any form that facilitates manufacture although round is preferred. The size and shape of the formed springs may also vary according to the size and shape of the available space of the particular container or housing in which the fuse element is mounted. In general, a spring such as shown at 16 is suitable for elements mounted in a plug type container.

This improved fuse element may be mounted in any suitable holder or mounting such as a fuse plug 20 which in general may be of conventional design comprising a body 25 of dielectric material having a suitable axial opening 26 closed at one end by a suitable transparent member or window 28, and at the other by a dielectric support 30 which is secured to the body by a threaded conductive shell 32 forming one terminal of the fuse. A conductive member 34 forming the other terminal of the fuse is suitably mounted in the support 30 so that a portion thereof is exposed within the opening 26. The fuse element may be mounted within this container by any suitable means. For example, the open end of the heating element 10 may be secured to the inner end of central terminal 34 by suitable means such as a joint of solder, and body 25 may be provided with a lateral opening 36, adjacent the upper end of shell 32, through which spring 16 extends outward to this shell with which it is joined by a suitable joint such as solder. This opening 36 is preferably above the normal or free position of spring 16, a distance somewhat greater than that which the inner end of the spring is embedded in the fusible material 14 so that the embedded end of the spring will be separated from the fusible material when it fuses.

The improved fuse element may also be mounted in a suitable or conventional cartridge type holder comprising conductive end caps 38 and 40 on opposite ends of a dielectric cylinder or tube 42 by securing the open end of the heating element 10 to the inner surface of one cap, such as 38, by a suitable joint such as solder, and securing the outer end of spring 18 to the other cap, such as 40, by suitable means such as solder. For convenience in assembly cap 40 may be provided with an axial opening through which a relatively long end of spring 18 may project while this cap is being assembled to tube 42, after which the spring may be suitably tensioned, soldered to the cap, and the protruding end removed.

As an example of the operating characteristics of this improved fuse, a carbon heater element cylindrical in outline,  $\frac{1}{4}$  inch in diameter and  $\frac{1}{2}$  inch long, having a flat bottomed recess 12,  $\frac{1}{8}$  inch in diameter and  $\frac{1}{8}$  inch deep, substantially filled with fusible alloy, and a flat bottomed recess 24 of similar size with a wall  $\frac{1}{16}$  inch in thickness between the recesses, will carry 6½

amperes of current indefinitely and about 20 amperes for a short period of time, but a current of 7 amperes will cause the fuse to open the circuit after it has carried this current for about 6 minutes. Also, these fuse elements are relatively easy to manufacture at a comparatively low cost, they are uniform and reliable in action, and the operating characteristics do not change with age.

When desirable the operating characteristics of the fuse may be modified somewhat by surrounding the thermal element with a powdered, non-conductive filling material 44 which in general increases the delayed action of the fuse. However, a filling material having either a higher or a lower heat conducting capacity than that of air may be employed according to the result desired.

Examples of suitable filling materials are finely divided, fluffy, heat absorbing materials such as magnesium oxide and calcium hydrate. These materials absorb appreciable quantities of heat and thereby increase the delay action of the fuse without otherwise affecting its carrying capacity or other characteristics. Although these materials may be supported around the fuse element by any suitable means, the space within the fuse container around the fuse element is usually filled with a material of this type, and preferred results are obtained when the container exerts no compressive force on the filling material so that it is not compressed or compacted. In this condition the filling material absorbs sufficient heat for the purpose intended and at the same time offers no detrimental resistance to the action or movement of the separating spring.

The size, form, and relative location of the component elements of this improved fuse may be different from that shown, and various similar and equivalent materials may be employed in place of those defined without departing from the real invention or the desirable and useful results obtained.

#### I claim:

1. A delayed action fuse comprising a refractory conductive heating element provided with a recess therein; a fusible alloy secured directly to the wall of said recess; and a tensioned conductive spring having one end thereof embedded in said alloy.

2. A delayed action fuse comprising a suitable mass of fusible alloy; a support for said alloy comprising a heating element of conductive material having a melting point above that of said fusible alloy and a recess therein in which said fusible alloy is directly embedded; and a suitably tensioned spring of conductive material having one end thereof directly embedded in said mass.

3. A delayed action fuse comprising an elongated heating element having an alloy recess in one end thereof and a resistance increasing recess in the other end thereof; a suitable mass of fusible alloy embedded in said alloy recess; and a tensioned spring of conductive material having one end thereof embedded in said mass.

4. A delayed action fuse comprising an elongated carbon heating element having an alloy recess in one end thereof and a resistance increasing recess in the other end thereof with a separating wall therebetween; a suitable mass of fusible alloy embedded in said alloy recess; and a suitable conductive spring having one end thereof secured under tension to said mass.

5. A delayed action fuse comprising a cylin-

drical carbon heating element having a length substantially twice that of its diameter, and provided with a cylindrical recess in one end having a diameter and depth substantially half the diameter of said element; a fusible alloy directly secured to the wall of said recess; a tensioned spring having one end thereof directly secured to said alloy; and a suitable container for said element and spring.

6. A delayed action fuse comprising a cylindrical carbon heating element having a length substantially twice the diameter thereof, a cylindrical recess in one end thereof having a diameter and depth substantially half the diameter of said element, and a recess in the other end thereof having a diameter substantially half and a depth somewhat greater than the diameter of said element; a fusible alloy substantially filling the smaller of said recesses; a tensioned spring having one end thereof operatively secured to said alloy; and a suitable container for said heating element and spring.

7. A delayed action fuse comprising an elongated heating element provided with a recess therein and also with means for increasing the resistance thereof; a mass of fusible metal embedded in said heating element in direct contact with the wall of said recess; a container in which said heating element is rigidly secured in electrical contact with one terminal thereof; and a tensioned spring having one end thereof directly secured to said fusible metal and the other end thereof suitably secured to the other terminal of said container.

8. A delayed action fuse comprising an elongated cylindrical carbon heating element provided with a recess in each end thereof with a separating wall therebetween; a suitable mass of fusible alloy embedded in one of said recesses in direct contact with said carbon; a container in which said heating element is rigidly secured with the open end thereof in electrical contact with one terminal of said container; and a suitably tensioned metal spring having one end thereof embedded in said fusible alloy and the other end thereof operably secured to the other terminal of said container.

9. A delayed action fuse comprising an elongated carbon heating element having a recess therein; a suitable mass of fusible alloy directly embedded in said recess; a hollow container provided with a lateral opening and two circuit terminals in which said element is rigidly secured in electrical contact with one of said terminals; and a resilient conductive member having one end thereof in said opening in electrical contact with the other of said terminals and the other end thereof directly embedded under tension in said fusible alloy.

10. A delayed action fuse comprising an elongated carbon heating element having a recess therein; a suitable mass of fusible alloy directly embedded in said recess; a hollow container for said element having a lateral opening therein a suitable distance above said fusible alloy; and a resilient conductive member having one end thereof secured in said lateral opening and the other end thereof directly embedded in said fusible alloy in a position a greater distance from the free position of said spring than the distance said end is embedded.

11. A delayed action fuse comprising an elongated carbon heating element having a recess therein; a suitable mass of fusible alloy directly embedded in said recess; a hollow container for said element having a hollow cylindrical body of dielectric material with a conductive cap on each end thereof in which said element is rigidly secured in electrical contact with one of said caps; and a coiled spring within said container having one end thereof secured to the other of said caps and the other end thereof directly embedded in said alloy in a position a greater distance from the free position of said spring than the distance said end is embedded.

12. A delayed action fuse comprising a suitable container having an opening therein; a heating element mounted in said opening; a recess in said heating element; a delayed action fusible element suitably mounted within said recess; and means for increasing the delay action of said element comprising a filling of calcium hydrate within said opening around each of said elements.

13. A delayed action fuse comprising a suitable container having an opening therein; a fusible element suitably mounted within said opening and comprising an electrically conductive heating element having a recess therein, a mass of fusible material within said recess, and a tensioned conductive spring having a portion thereof embedded in said fusible material; and a non-conductive filling of magnesium oxide within said opening around said fusible element to increase the delay action of said fuse.

14. A delayed action fuse comprising a suitable container having an opening therein; a fusible element suitably mounted within said opening and comprising a heating element having a recess therein, a mass of fusible material directly embedded in said recess, and a tensioned conductive spring having a portion thereof embedded in said fusible material; and a non-conductive filling of finely divided fluffy material within said opening around said fusible element to increase the delay action of said fuse.

15. A delayed action fuse comprising a suitable container having an opening therein; an electrically conductive heating element suitably mounted within said opening and provided with a recess therein; a mass of fusible material embedded in said recess; a suitably tensioned conductive spring operably mounted within said opening with one end thereof embedded in said fusible material; and means for increasing the delaying action of said heating element comprising a suitable filling of non-conductive powdered material loosely filling the residual space in said opening.

16. A delayed action fuse comprising a container; a substantially hollow heating element rigidly secured within said container and provided with a recess, said heating element being provided with a relatively large outer surface exposed within said container; a fusible material secured in said recess; a resilient conductor under tension having one end thereof embedded in said fusible material; and means for increasing the delay action of said fuse comprising a filling of heat conducting material in contact with the outer surface of said heating element for dissipating part of the heat generated therein.

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