March 7, 1961 E. V. SUNDT 2,974,208

TIME DELAY FUSE

Filed Jan. 24, 1957

Fig. 1.

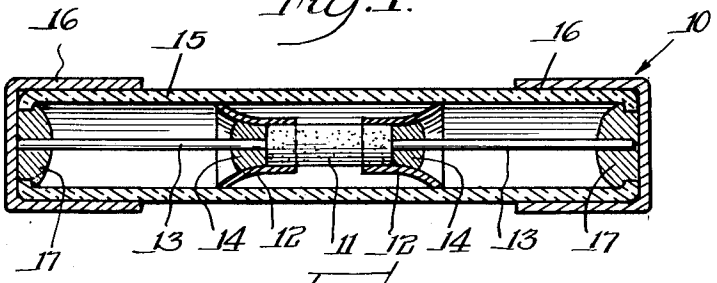


Fig. 2.

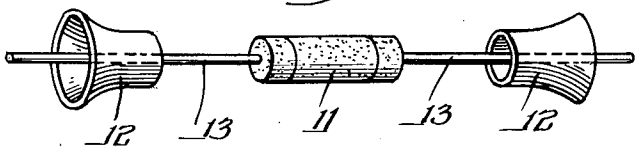


Fig. 3.

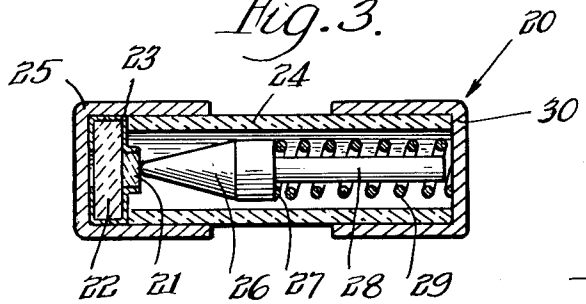
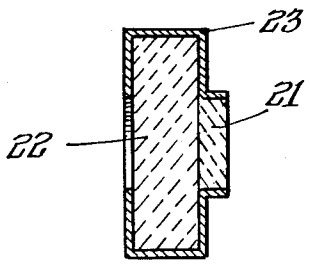


Fig. 5.



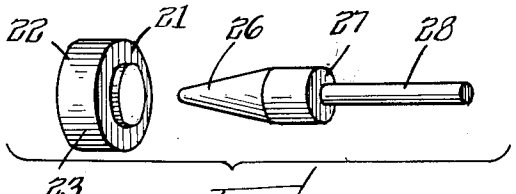


Fig. 4.

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United States Patent Office 2,974,208 Patented Mar. 7, 1961

2,974,208

TIME DELAY FUSE

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Filed Jan. 24, 1957, Ser. No. 636,080

11 Claims. (Cl. 200—131)

The principal object of this invention is to provide an improved time delay fuse wherein time delays of considerable length can be built into very small fuses so as to make them particularly useful in the electronic and automotive fields.

In accordance with this invention, the time delay fuse includes, as its fuse element, a pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, such as, for example, lead peroxide, bismuth dioxide, or the like. When heated by current flow therethrough, the normally electrically conductive metallic oxide of one form undergoes a chemical change to a lower oxide form to make it substantially non-conductive, this chemical change requiring time and producing the extremely favorable time delay characteristics of the fuse of this invention. By using such metallic oxide pellets, time lags, at, for example, 200 percent of rating, run three or four times as long as similar sized elements formed of conventional fuse metals.

In forming the metallic oxide pellets, the metallic oxide is finely powdered, as for example, so as to pass through about a 100 mesh sieve, or closer, and is then compressed, into the pellets under high pressure, as for example, 100,000 pounds per square inch, or more, by a suitable press, so as to provide a uniform and strong pellet. Control of the uniformity and resistance of the pellet may be obtained by the addition of powdered metals and this also results in a still stronger pellet. For example, the addition of powdered solder, up to about 50 percent by weight produces considerably more uniformity and weight but yet increases the current rating but slightly.

The metallic oxide pellets may be made in various sizes and shapes depending upon the load conditions to be protected and they may be mounted into fuse structures in various ways, two forms of the invention being disclosed herein by way of example.

Further objects of this invention reside in the details of construction of the time delay fuse and in the cooperative relationships between the component parts thereof.

Other objects and advantages of this invention will become apparent to those skilled in the art upon reference to the accompanying specification, claims and drawing in which:

Fig. 1 is a sectional view through one form of the time delay fuse of this invention;

Fig. 2 is an exploded perspective view of the elements within the time delay fuse;

Fig. 3 is a sectional view through another form of the time delay fuse of this invention;

Fig. 4 is an exploded perspective view of the elements within the time delay fuse of Fig. 4;

Fig. 5 is an enlarged sectional view of one of the elements utilized in Fig. 3.

One form of the time delay fuse of this invention is

illustrated in Figs. 1 and 2 and it is generally designated at **10**. It includes as its fuse element a pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, such as, for example, lead peroxide, bismuth dioxide, or the like. Where, for example, the pellet **11** is formed from lead peroxide, the lead peroxide is finely powdered and screened through at least a 100 mesh sieve or closer and then it is compressed into pellets of the required size for the amperage to be carried, and this is done in a press which is capable of applying a very high pressure as, for example, 100,000 pounds per square inch, or more. This provides a uniform and relatively strong pellet. Control of the uniformity and resistance of the pellet **11** may be obtained by the addition of finely powered metals and this also results in a still stronger pellet. For example, the addition of powdered lead or solder, which is also passed through a 100 mesh sieve or closer, up to about 50 percent by weight, produces considerably more uniformity and weight, but yet increases the current rating but slightly. Various powdered metals may be utilized for this purpose, but particularly good results have been obtained by using powdered lead or powdered solder.

Electrical contact is made to the ends of the pellet **11**, which is cylindrical in configuration, by means of metal eyelets **12**, these metal eyelets **12** closely gripping the pellet **11**. Preferably, the metallic eyelets **12** are applied to the pellet **11** at the time that the pellet **11** is being formed. In this connection a suitable die or mold is utilized in which the eyelets **12** are placed and in which the powdered metal oxide and powdered metal is also placed. The high pressure is then applied by a press to this assembly to form the pellet **11** and to firmly anchor the metal eyelets **12** to the pellet **11**.

Conductors in the form of wires **13** are electrically connected to the ends of the pellet **11**, this being accomplished by soldering the ends of the wires **13** to the metal eyelets **12** by means of pools of solder **14**. The fuse element so formed may be encased in an insulating tube **15** formed of glass or the like. The eyelets **12**, in addition to forming electrical connections to the pellet **11**, also operate in conjunction with the tube **15** to center the pellet **11** within the tube. The tube **15** is provided with metal end caps **16** which, in turn, are soldered to the other ends of the wires **13** by means of pools of solder indicated at **17**. The cartridge type fuse thus formed may be suitably connected into the electric circuit to be protected by the end caps **16** in the conventional manner.

The cartridge type fuse **10** and the metallic oxide pellet **11** may be made in various sizes depending upon the various load conditions which are to be protected thereby. In accordance with one example of this invention, the overall length of the cartridge type fuse may be one and one-quarter inches and the outside diameter of the tube **15** may be nine-thirty-seconds inch. Here, also, the pellet **11** may be one-quarter inch long and five-sixty-fourths inch wide. Such a fuse has a three ampere rating and at 200 percent of rating it has a time lag in the neighborhood of fifty to sixty seconds. When this time lag is compared with time lags of approximately fifteen seconds for conventional fuses of the same size and ampere ratings, it is seen that the time lag of the fuse of this invention is approximately three or four times greater than that of conventional fuses. When the pellet **11** is heated by current flow therethrough, the lead peroxide undergoes a chemical change to a lower oxide form, first turning to red litharge and then to lead oxide. The lead peroxide reduces at about 300 degrees centigrade, first to the red litharge and if the heat is continued

reduces further to lead oxide, both of which are excellent insulators. It is this chemical change and the time involved for completing the same that produces the extremely favorable time delay characteristics. The same general results are obtained by utilizing bismuth oxide as the powdered metallic oxide in the pellet.

Referring now to the other form of the invention illustrated in Figs. 3, 4, and 5, a sub-miniature cartridge type time delay fuse is generally designated at 20. It includes a thin metallic oxide disc-shaped pellet 21, also consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive, but which becomes substantially non-conductive when heated above a predetermined temperature value, such, as, for example, lead peroxide, bismuth dioxide, or the like. This metallic oxide disc-shaped pellet 21 is suitably adhered to a ceramic disc 22, and the ceramic disc 22 is provided with a metal film 23 which extends from the marginal edges of the pellet 21 over and around the edges of the ceramic disc 22. This metallic film 23 may be formed in any suitable manner such as by applying a silver paint. This metal film 23 operates as a conductor for connecting the marginal edges of the pellet 21 to the electric circuit being protected. The pellet 21 is contained within an insulating tube 24 formed of glass, ceramic or the like, and the supporting ceramic disc 22 may abut against one end of the tube 24. A metallic cap 25 is applied to one end of the tube 24 over the ceramic disc 25 for holding the ceramic disc in place. It also makes electrical connection with the pellet 21 through the metallic film 23.

A metallic pin 26 engages one face of the pellet 21 at a point adjacent the center thereof, this pin being provided with a shoulder 27 and an extension 28. The pin 26 is held in engagement with the pellet 21 by a spring 29 which is interposed between the shoulder 27 and a metallic end cap 30, also secured to the tube 24. The spring 29 also forms an electrically conductive path from the pin 26 to the end cap 30. The end caps 25 and 30 operate to electrically connect the fuse into the circuit to be protected in the conventional manner. Here the sub-miniature fuse may have an overall length of about three-eighths inch and the tube 24 may have an outside diameter of approximately seven sixty-fourths of an inch. The ceramic disc 22 has a diameter of approximately three thirty-seconds of an inch and is about one thirty-second of an inch thick. The pellet 21 has a diameter of approximately three sixty-fourths of an inch and a thickness of approximately one one-hundred and twenty-eighth of an inch. In the sub-miniature fuse 20 the rating of the fuse is determined by the diameter and thickness of the pellet 21 and this fuse may be utilized for protecting sensitive low amperage circuits. Here, as in the form of the invention illustrated in Figs. 1 and 2, when the pellet 21 is heated by current flow therethrough, the normally electrically conductive metallic oxide of one form undergoes a chemical change to a lower oxide form to make it substantially non-conductive and interrupt the current flow in the electric circuit. Here, also, extended time delay is obtained.

While for purposes of illustration, two forms of this invention have been disclosed, other forms thereof may become apparent to those skilled in the art upon reference to this disclosure and, therefore, this invention is to be limited only by the scope of the appended claims.

I claim as my invention:

1. A time delay fuse for protecting an electric circuit against overload conditions comprising, a pellet consisting essentially of a compressed mixture of powdered metallic oxide and less than 50% powdered metallic filler which are uniformly dispersed in the compressed mixture throughout the entire pellet, and which pellet is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, and means for electrically connecting the pellet in series in the electric circuit to be protected so as to be heated by the current flow in the electric circuit and to interrupt the current flow upon overload conditions in the circuit.

2. A time delay fuse for protecting an electric circuit against overload conditions comprising, a pellet consisting essentially of a compressed mixture of powdered lead peroxide and less than 50% powdered metallic filler which are uniformly dispersed in the compressed mixture throughout the entire pellet, and which pellet is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, and means for electrically connecting the pellet in series in the electric circuit to be protected so as to be heated by the current flow in the electric circuit and to interrupt the current flow upon overload conditions in the circuit.

3. A time delay fuse for protecting an electric circuit against overload conditions comprising a pellet consisting essentially of a compressed mixture of powdered bismuth dioxide and less than 50% powdered metallic filler which are uniformly dispersed in the compressed mixture throughout the entire pellet, and which pellet is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, and means for electrically connecting the pellet in series in the electric circuit to be protected so as to be heated by the current flow in the electric circuit and to interrupt the current flow upon overload conditions in the circuit.

4. A cartridge type time delay fuse for protecting an electric circuit against overload conditions comprising, a pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, an insulating tube, means for mounting the pellet in the tube in spaced relation thereto, electrically conducting end caps carried by the tube, and means including electrical conductors connecting the end caps in series with the pellet for connecting the pellet in the electric circuit to be protected so as to be heated by the current flow in the electric circuit and to interrupt the current flow upon overload conditions in the electric circuit.

5. A cartridge type time delay fuse for protecting an electric circuit against overload conditions comprising, a cylindrical pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, a metallic eyelet secured to each end of the pellet, a conductor soldered to each eyelet, an insulating tube receiving the pellet, eyelets and conductors with the pellet being centered therein by the eyelets, and electrically conductive end caps carried by the tube and soldered to the conductors for connecting the pellet in the electric circuit to be protected so as to be heated by the current flow in the electric circuit and to interrupt the current flow upon overload conditions in the electric circuit.

6. A time delay fuse for protecting an electric circuit against overload conditions comprising, a thin disc-shaped pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially non-conductive when heated above a predetermined temperature value, means for supporting the pellet, a metallic pin engaging one face of the thin disc-shaped pellet adjacent the center thereof, and means for connecting the pin and the marginal edges of the thin disc-shaped pellet to the electric circuit to be protected for connecting the pellet in series in the electric circuit so as to be heated by the current flow in the electric circuit and to interrupt the current flow upon overload conditions in the circuit.

7. A cartridge type time delay fuse for protecting an electric circuit against overload conditions comprising, a thin disc-shaped pellet consisting essentially of a com-

pressed powdered metallic oxide which is normally electrically conductive when heated above a predetermined temperature value, a ceramic disc carrying the pellet, an insulating tube receiving the pellet, a metallic pin in the insulating tube engaging a face of the pellet adjacent the center thereof, metallic end caps carried by the ends to the tube, means for electrically connecting the pin to one of the end caps, and means for electrically connecting the marginal edges of the pellet to the other end cap, said end caps connecting the pellet in series with the electric circuit to be protected so that the pellet will be heated by the current flow in the electric circuit and interrupt the current flow upon overload conditions in the circuit.

8. A cartridge type time delay fuse for protecting an electric circuit against overload conditions comprising, a thin disc-shaped pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially nonconductive when heated above a predetermined temperature value, a ceramic disc carrying the pellet, an insulating tube receiving the pellet, a metallic pin in the insulating tube engaging a face of the pellet adjacent the center thereof, metallic end caps carried by the ends to the tube, means for electrically connecting the pin to one of the end caps, and means including a metallic film on the marginal edges of the pellet and on the ceramic disc for electrically connecting the marginal edges of the pellet to the other end cap, said end caps connecting the pellet in series with the electric circuit to be protected so that the pellet will be heated by the current flow in the electric circuit and interrupt the current flow upon overload conditions in the circuit.

9. A cartridge type time delay fuse for protecting an electric circuit against overload conditions comprising, a thin disc-shaped pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially nonconductive when heated above a predetermined temperature value, a ceramic disc carrying the pellet, an insulating tube receiving the pellet, a metallic pin in the insulating tube engaging a face of the pellet adjacent the center thereof, metallic end caps carried by the ends to the tube, a spring engaging one end cap and the pin for pressing the pin against the pellet and for electrically connecting the pin to said end cap, and means for electrically connecting the marginal edges of the pellet to

the other end cap, said end caps connecting the pellet in series with the electric circuit to be protected so that the pellet will be heated by the current flow in the electric circuit and interrupt the current flow upon overload conditions in the circuit.

10. A cartridge type time delay fuse for protecting an electric circuit against overload conditions comprising, a thin disc-shaped pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive but which becomes substantially nonconductive when heated above a predetermined temperature value, a ceramic disc carrying the pellet, an insulating tube receiving the pellet, a metallic pin in the insulating tube engaging a face of the pellet adjacent the center thereof, metallic end caps carried by the ends to the tube, a spring engaging one end cap and the pin for pressing the pin against the pellet and for electrically connecting the pin to said end cap, and means including a metallic film on the marginal edges of the pellet and on the ceramic disc for electrically connecting the marginal edges of the pellet to the other end cap, said end caps connecting the pellet in series with the electric circuit to be protected so that the pellet will be heated by the current flow in the electric circuit and interrupt the current flow upon overload conditions in the circuit.

11. A cartridge type time delay fuse for protecting an electric circuit against overload conditions comprising, a cylindrical pellet consisting essentially of a compressed powdered metallic oxide which is normally electrically conductive, but which becomes substantially non-conductive when heated above a predetermined temperature value, an insulating tube, means for mounting the pellet in the tube in spaced apart relation thereto, metallic end caps carried by the tube, and means including electrical conductors for connecting the ends of the cylindrical pellet to the end caps for connecting the pellet in the electric circuit to be protected so as to be heated by the current flow in the electric circuit and to interrupt the current flow upon overload conditions in the electric circuit.

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