This invention relates to the art of fuses and pertains, more particularly, to a metallic fuse member that may be advantageously employed as an electrical fuse or as a thermal fuse, and to the method of making the same.

The fuse member of this invention is suitable for application. It is especially useful, for example, as a detonator fuse where extremely rapid firing is required and as a protective fuse for various items of electrical equipment, including delicate electrical instruments, where very rapid blowout is essential in order to prevent damage to the equipment.

The invention is predicated on my basic discovery that if a first metal, selected from the group consisting of palladium and platinum, is placed in intimate contact with a second metal, selected from the group consisting of aluminum and magnesium, and the resulting product is brought to a temperature approaching the melting point of the selected second metal, a very rapid exothermic alloying reaction occurs with the evolution of a considerable quantity of heat. The reaction is quite violent and is so rapid that it may be fairly considered as being substantially instantaneous.

A primary object of this invention is to produce an improved metallic fuse member for use as an element of an electrical fuse or a thermal fuse.

Another object of the invention is to provide a method of making a fuse member of the type indicated.

The invention has for a further object the provision of a quick-acting fuse member that may be made and used in a wide range of sizes, that is reasonable in manufacturing cost and that is capable of performing its intended functions in a dependable manner.

A preferred and recommended fuse member of this invention comprises first and second metallic materials that are in intimate contact with each other. At least 95% of the first material consists of a metal selected from the group consisting of palladium and platinum, while at least 95% of the second material consists of a metal selected from the group consisting of aluminum and magnesium. The remainder of each material, preferably from 1% to 5% thereof, consists of a metallic agent for changing its physical and electrical characteristics.

The enumerated objects and other objects, together with the advantages of the invention, will be readily understood by persons skilled in the art from the detailed description that follows taken in conjunction with the accompanying drawing.

In the drawing:

Fig. 1 is a greatly enlarged isometric view of a clad wire fuse member of this invention;

Fig. 2 is a greatly enlarged isometric view of a composite strip fuse member according to the invention and comprising relatively superfused strips of the selected metals; and

Fig. 3 is a greatly enlarged isometric view of another composite strip fuse member according to the invention and formed by an electro-plating procedure.

It is within the purview of this invention to make the fuse member in various forms, including (1) a clad wire 5 (Fig. 1) wherein one of the essential metals constitutes a solid core element 6 and the other metal constitutes a sheath 7 which encircles and is coextensive with the core element, (2) an elongated composite strip 8 (Fig. 2) wherein corresponding strips 9 and 10 of the essential metals are disposed along and against each other and are joined together by soldering, welding or in any other suitable manner known to the art, and (3) a composite strip 11 (Fig. 3) formed by an electro-plating procedure wherein a strip 12 of one of the selected metals serves as a base on which a layer 13 of the other selected metal is deposited.

As regards the clad wire form of fuse member, an entirely satisfactory product is obtained when either one of the selected metals is used as the sheath element and the other metal as the core element. Palladium or platinum is preferred as the metal of the sheath. In any case, I find it advantageous to facilitate drawing of the wire to use a sheath material that is slightly harder than the core material. To this end, the sheath material preferably contains from 1% to 5% of a suitable metallic agent for changing its physical and electrical characteristics. Very good results were obtained with a clad wire in which the sheath element was made of palladium containing approximately 2% ruthenium by weight as the metallic agent. Good results were also obtained when the core element consisted of at least 95% palladium and from 1% to 5% of magnesium as the metallic agent. Ruthenium and magnesium are illustrative of preferred agents for increasing the hardness and electrical resistivity and improving the ductility and tensile strength of the product.

For best results, it is recommended that the fuse member contain approximately equal volumes of the selected metals. In the case of a fuse member employing equal volumes of palladium and aluminum, the weight ratio of these metals is 85.5% palladium to 15.5% aluminum, which ratio is approximately the molecular proportions of these metals.

Entirely satisfactory results may be obtained, however, if the parts by volume of the selected metals vary within ranges of from 80 to 20 parts of one of the metals to from 20 to 80 parts of the other metal. In other words, the palladium or platinum component may consist of from 80 to 20 parts and the aluminum or magnesium component from 20 to 80 parts by volume.

The above-mentioned proportions of selected metals apply not only to the clad wire form of fuse member, but also to the other indicated forms.

A preferred example of clad wire fuse member of this invention and the method of making the same will now be briefly described. In this example, a tubular sheath element, consisting of 98% palladium and 2% ruthenium was fabricated to obtain an outside diameter of 0.143", a wall thickness of 0.021" and an inside diameter of 0.101". A solid wire of commercially pure aluminum, having a diameter of 0.092", was used as the core element. The aluminum core was inserted in the palladium-ruthenium sheath element and formed a slightly loose fit therewith, there being a play of 0.009" between the core and sheath elements. The composite unit so formed by the core and sheath elements contained substantially equal parts by volume of palladium and aluminum. This composite unit was drawn through conventional wire drawing equipment employing standard drawing procedures until the outside diameter of the composite unit was reduced to 0.130". At this point in the drawing operation, the opening defined by the sheath element was reduced to the diameter of the core element, causing intimate contact between the sheath and core elements.

The composite unit was then drawn to approximately one-half of its original diameter.
The product was then heat treated at a temperature of approximately 700° F. The product of the last-mentioned step was then drawn and heat treated at about 700° F. The drawing and heat treating steps were repeated, the product being reduced approximately one-half in diameter, as a result of each succeeding drawing step until a wire fuse member having a diameter of approximately 0.020" was obtained.

Separate lengths of the wire product were heated electrically by passing a current therethrough. Other lengths were heated by the direct application of heat. In each instance, the wire remained intact without any noticeable physical change until it reached a temperature approximately equal to the melting point of aluminum, at which time it burned instantaneously with the evolution of considerable heat at an estimated temperature in excess of 2000° C. This resulted in destruction of the wire and alloying of its metallic ingredients.

While what actually takes place at the instant of reaction is not fully understood, it is believed that palladium or platinum when alloyed with aluminum or magnesium liberates considerable amounts of heat in the formation of the corresponding alloy. It is also possible that the platinum or palladium contains quantities of occluded oxygen which combines with the aluminum or magnesium, thereby developing heat at the time of the alloying reaction. It has been ascertained that reaction is not dependent upon the presence of atmospheric oxygen as it also takes place in substantially the same manner in an atmosphere of hydrogen.

From the foregoing, it is believed that the objects and advantages of the herein described fuse member and of the method of making the same will be apparent to those skilled in the art, without further description. It is to be understood, however, that the invention may be embodied otherwise than as here described, and that various changes may be made without departing from the spirit or sacrificing any of the advantages of the invention.

I claim:

1. A member adapted to be used as an element of a fuse consisting of from 80 to 20 parts by volume of a first material and from 20 to 80 parts by volume of a second material that is in intimate contact with the first material, at least 95% of said first material consisting of a metal selected from the group consisting of palladium and platinum, at least 95% of said second material consisting of a metal selected from the group consisting of aluminum and magnesium.

2. A member adapted to be used as an element of a fuse, comprising a tubular sheath element and a solid core element within and substantially coextensive with the sheath element, said core element being in intimate contact with the sheath element, said elements consisting, respectively, of from 80 to 20 parts by volume of one material and from 20 to 80 parts by volume of another material, at least 95% of the material of one of the elements consisting of a metal selected from the group consisting of palladium and platinum, at least 95% of the material of the other element consisting of a metal selected from the group consisting of aluminum and magnesium.

3. A wire adapted to be used as an element of a fuse, comprising a tubular sheath element and a solid core element within and substantially coextensive with the sheath element, said core element being in intimate contact with the sheath element, said elements consisting of approximately equal parts by volume of corresponding materials, at least 95% of the material of one of the elements consisting of a metal selected from the group consisting of palladium and platinum, at least 95% of the material of the other element consisting of a metal selected from the group consisting of aluminum and magnesium.

4. A member adapted to be used as an element of a fuse comprising a pair of relatively superposed layers of first and second materials that are in intimate contact with each other, said layers consisting, respectively, of from 80 to 20 parts by volume of the first material and from 20 to 80 parts by volume of the second material, at least 95% of the material of one of the layers consisting of a metal selected from the group consisting of palladium and platinum, at least 95% of the material of the other layer consisting of a metal selected from the group consisting of aluminum and magnesium.

5. A member adapted to be used as an element of a fuse comprising a pair of relatively superposed layers of approximately equal parts by volume of corresponding materials, at least 95% of the material of one of the layers consisting of a metal selected from the group consisting of palladium and platinum, at least 95% of the material of the other layer consisting of a metal selected from the group consisting of aluminum and magnesium.

6. A method of forming a member which is adapted to be used as an element of a fuse, the steps of inserting a solid core element into a tubular sheath element to obtain a composite unit, at least 95% of one of the elements consisting of a metal selected from the group consisting of palladium and platinum, at least 95% of the other element comprising a metal selected from the group consisting of aluminum and magnesium, drawing the composite unit whereby to substantially reduce the outer diameter thereof and effect intimate contact between the sheath and core elements, and heat treating the product of the last preceding step at a temperature up to 700° F.

7. In a method of forming a member which is adapted to be used as an element of a fuse, the steps of inserting a solid core element into a tubular sheath element to obtain a composite unit, at least 95% of one of the elements consisting of a metal selected from the group consisting of palladium and platinum, at least 95% of the other element comprising a metal selected from the group consisting of aluminum and magnesium, drawing the composite unit whereby to substantially reduce the outer diameter thereof and effect intimate contact between the sheath and core elements, and heat treating the product of the last preceding step at a temperature up to 700° F., again drawing the composite unit to further substantially reduce the outer diameter thereof, and heat treating the product of the last-mentioned step at a temperature up to 700° F.

8. The method according to claim 9 wherein the diameter of the composite unit is reduced approximately one-half by each drawing step.

References Cited in the file of this patent

UNITED STATES PATENTS

550,705 Williams Dec. 3, 1895
620,309 Hadaway Feb. 28, 1899
1,246,694 Wood Nov. 13, 1917
1,653,378 Steel Dec. 20, 1927
2,173,200 Grunwald Sept. 19, 1939
344,670 France Sept. 12, 1904