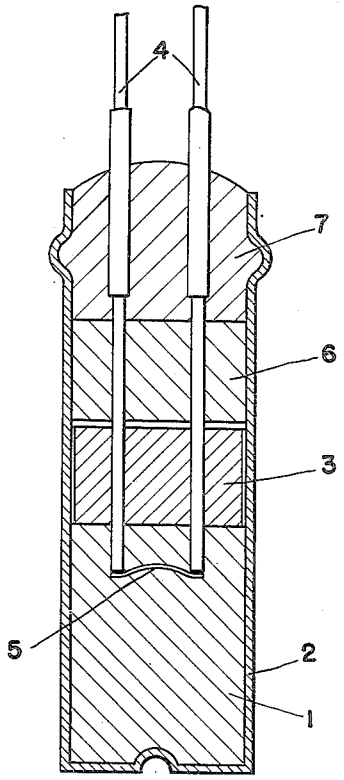
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BRIDGE PLUG ASSEMBLY

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BRIDGE PLUG ASSEMBLY

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This invention relates to an improvement in resistance wire for electric current and more particularly to resistance wire for use in electric firing devices, especially as the bridge wire in bridge plug assemblies used to initiate electric blasting caps, squibs, igniters and the like.

It is well known that electric firing devices include an initiating means normally comprising a bridge plug, cavity plug, or match head assembly which contains a high resistance bridge wire of platinum or platinum alloyed with iridium, rhodium, rubidium or similar metals to effect ignition of the device. Bridge wires of gold, gold alloys, such as white gold, nickel-copper alloys such as constantan and some iron alloys have also been used, but the platinum alloys are most generally used in the art as they exhibit marked resistance to corrosion.

The precious metal bridge wires are very expensive to use while the nickel-copper and iron alloys may not provide sufficient stability when in contact with the air and with certain explosive compounds used in electric firing devices.

Further, the thermic coefficient of the known bridge wire materials are not the most desirable, and also the action upon the application of a source of E. M. F. to these materials is not always predictable and constant. Thus, the bridge wire may, upon the application of E. M. F., fuse and break the circuit causing other devices in the series to fail, or it may not rise to a temperature sufficiently high to be effective in the ignition of the charge in the device.

The object of this invention is to provide a bridge wire for electric firing devices which will efficiently initiate the device.

A further object of this invention is to provide a bridge wire for electric blasting caps which will positively initiate the explosive charge thereof.

The further object of this invention is to provide a bridge wire for electric firing devices which does not depend entirely upon the heat generated due to the application of a source of E. M. F. to initiate the device.

A still further object of this invention is to provide a pyrophoric bridge wire for electric blasting caps.

Other and further objects will become apparent hereinafter.

The objects of this invention have been accomplished by providing bridge wire for electric firing devices comprising zirconium which is drawn into a high resistance wire of proper diameter to provide the electrical resistance per unit length desired for the particular use for which the bridge wire is intended.

As illustrative of the use of zirconium resistance wire embodying this invention, for example, as a bridge wire for electric blasting caps, the wire will be made of a good grade of ductile zirconium, and will be drawn to a diameter of between about .0010 inch and about .0020 inch as this diameter has an electrical resistance of between about 300 ohms and about 440 ohms per yard. The preferable diameter is about .0013 inch which gives a resistance of about 360 ohms per yard. The proper length of wire is secured to the usual leg wires of the bridge plug assembly of an electric blasting cap by welding, swaging, or in a similar manner, and the bridge wire terminals then slightly crimped towards each other to relieve the tension on the zirconium wire. The bridge plug assembly is inserted into contact with the charge within the device to be initiated, for example, into a priming charge of diazodinitrophenol in an electric blasting cap. The bridge plug assembly is sealed into the device and is then ready to effectively initiate the charge contained therein. Upon the application of a source of E. M. F. to the leg wire, the zirconium bridge wire becomes sufficiently hot to cause initiation of the charge contained in the electric firing device.

A preferred embodiment of my invention will be described with reference to the accompanying drawing in which the single figure represents an electric blasting cap.

The electric blasting cap shown in the figure comprises an explosive charge 1 in the closed end of a casing 2. The charge 1 has superimposed thereon an ignition means comprising a plug 3 having a pair of leg wires 4 extending therethru and a bridge wire 5 electrically connected across their terminals. This bridge wire 5 in accordance with this invention is composed of zirconium. The ignition device is maintained in position by a water-proofing materal 6 and a sealing compound 7.

The explosive charge 1 may be comprised of a single charge of primary explosive, for example, mercury fulminate, diazodinitro phenol, lead azide or the like, alone or in admixture with an oxidizing agent such as potassium chlorate, barium peroxide, lead dioxide or the like, or it may be comprised of base charge of tetryl, TNT, nitrostarch, pentaerythritol tetranitrate, or the like with a primary charge of the above mentioned types of explosives superimposed thereon.

While pure zirconium wire is much easier to

draw to the proper diameter to obtain the correct electrical properties, the use of those zirconium alloys which may be drawn to the desired form of wire and which retain their pyrophoric nature is contemplated by this invention.

The initiation of the electric firing device, discussed above, is aided by the pyrophoric nature of the zirconium bridge wire. Thus, the zirconium, upon arriving at a dull red heat, suddenly flashes with a very intense white light that is extremely hot. This pyrophoric phenomenon increases the efficiency of the firing device and also aids in firing or initiating the charge within the device. Thus, in accordance with this invention, a more efficient firing device, for example, electric blasting cap may be produced.

A further advantage of this invention is in firing a large number of caps. Thus, plurality of caps are commonly fired by connecting them in series to a source of power. Upon application of the power, the current passes through all the caps in the series, heating the bridge wire in each at about the same rate. The bridge wire reaches the ignition temperature of the surrounding explosive in perhaps .005 second, but it is usually necessary to rise considerably above the ignition temperature to surely effect ignition. Because of variations in the explosive and perhaps a slight non-uniformity in the manufacture of the cap, not all caps are equally sensitive and there is a tendency for some of the caps to fire before the others. It will be, of course, apparent that when the first cap fires, its bridge wire is destroyed and the circuit is opened, so that all heating of the remaining bridge wires ceases. They proceed to cool, transferring their heat to the explosive, which will generally enable these caps to likewise fire. However, it sometimes happens that the heat generated by the current is insufficient to fire a particularly insensitive cap. The result is a failure of the dynamite primed by this cap to explode, and the misfire may have very damaging consequences. This condition is aggravated by low currents.

When zirconium bridge wires are used, about the same sequence of events, up to the point of the firing of the sensitive caps and the cooling of the remaining bridge wire, takes place. These bridge wires, however, have reached the pyrophoric ignition temperature of the zirconium, and the zirconium proceeds to burn to zirconium oxide, raising the temperature and evolving considerable heat. It is calculated that under a normal set of conditions, the heat thus created may amount to over ten times the heat generated by the electric current. The danger of failure of an insensitive cap may thus be reduced or largely eliminated, and lower currents may be used to fire the caps without increasing the likelihood of misfires. Many more caps may be used in a series connection, and thus numerous improvements in field performance due to the improved reliability of caps containing zirconium bridge wires are obtained. The theory discussed above is believed to be correct, but this invention should not be construed as limited thereby.

Another advantage of this invention is the positiveness by which the zirconium bridge wire ignites ignition materials which are difficult to ignite with an electric bridge wire assembly which has a platinum bridge wire. For example, in using cavity plugs, only a small amount of ignition material is placed within the cavity around the bridge wire, and oftentimes the heat of the platinum bridge wire fails to ignite this small amount of material. However, when using zirconium bridge wires of this invention, the small amount of material is ignited by the flash produced when the zirconium is raised to its pyrophoric temperature.

The use of zirconium bridge wires of this invention in match head assemblies has been found to be highly desirable because the match head assemblies now known to the art are not regular in firing time. The zirconium bridge wire, due to the pyrophoric nature allows the production of more uniform match heads thereby giving more satisfactory firing devices.

The pyrophoric nature of the zirconium or zirconium alloy bridge wire of this invention has been found to be enhanced by coating the bridge wire with an oxidizing agent, for example, lead dioxide, barium peroxide, potassium chlorate, etc. The coating is aided by the use of a binder such as nitrostarch, nitrocotton, or the like in very small amounts. By the use of the oxidizing agent, a more brilliant flash is produced and better ignition of charges in the firing device is obtained. In some instances the inclusion of minor amounts of flame-producing materials in the coating has proved advantageous. Flame-producing materials of a carbonaceous nature such as, for example, charcoal or the like may be used.

It will be obvious to those skilled in the art that zirconium bridge wire alone or with oxidizing agents, binders, and flame producing agents surrounding it in accordance with the foregoing description of this invention may be used in bridge plug assemblies of various type firing devices such as, for example, electric blasting caps, delay electric blasting caps, squibs, igniters and other special caps, whether these caps contain a bridge plug assembly that has two terminal wires electrically connected by a zirconium bridge wire that is inserted directly into the explosive charge of a firing device as described hereinbefore with reference to the single figure; or whether the bridge plug assembly is of the cavity type having the terminals of the wires in a recess so positioned that an ignition compound is pasted into the recess and around the bridge wire; or whether the bridge plug assembly is a match head having a sensitive explosive pasted around the bridge wire. In each of the above type caps and bridge plug assemblies, the zirconium bridge wire of this invention provides an increased efficiency over the use of platinum bridge wires.

It will be understood that the details and examples given hereinbefore are illustrative only and in no way limiting on my invention as broadly described herein and in the appended claims.

What I claim and desire to protect by Letters Patent is:

1. An electric firing device of the character described, including, in combination, a casing, an explosive charge and a firing assembly adjacent said charge, said assembly comprising a pair of leg wires disposed in spaced relationship to each other, a bridge wire electrically connecting said leg wires, said bridge wire being made of zirconium and having a metallic oxide adhering to said wire whereby said bridge wire is caused to be pyrophorized under a relatively low electrical potential during a relatively short period of time.

2. An electric firing device of the character described, including, in combination, a casing, an explosive charge and a firing assembly adjacent said charge, said assembly comprising a pair of

leg wires disposed in spaced relationship to each other, a bridge wire electrically connecting said leg wires, said bridge wire being made of zirconium and having a metallic oxide secured directly to said wire by means of a binder whereby said bridge wire is caused to be pyrophorized under a relatively low electrical potential during a relatively short period of time.

3. An electric firing device of the character described, including, in combination, a casing, an explosive charge and a firing assembly adjacent said charge, said assembly comprising a pair of leg wires disposed in spaced relationship to each other, a bridge wire electrically connecting said leg wires, said bridge wire being made of zirconium and having a metallic oxide secured directly to said wire by means of a nitrostarch binder whereby said bridge wire is caused to be pyrophorized under a relatively low electrical potential during a relatively short period of time.

4. An electric firing device of the character described, including, in combination, a casing, an explosive charge and a firing assembly adjacent said charge, said assembly comprising a pair of leg wires disposed in spaced relationship to each other, a bridge wire electrically connecting said leg wires, said bridge wire being made of zirconium and having a metallic oxide secured directly to said wire by means of a nitrocotton binder whereby said bridge wire is caused to be pyrophorized under a relatively low electrical potential during a relatively short period of time.

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