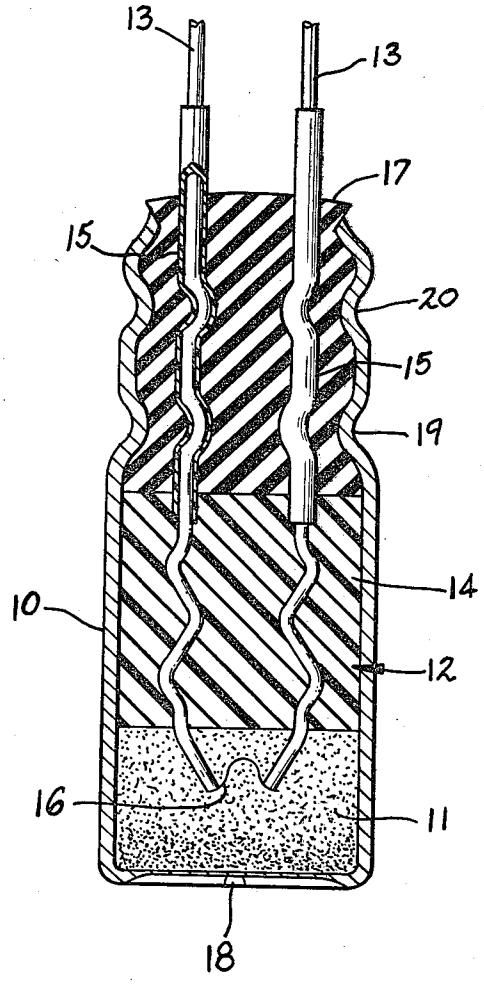
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IGNITION COMPOSITION AND ELECTRIC SQUIB CONTAINING IT

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1

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IGNITION COMPOSITION AND ELECTRIC SQUIB CONTAINING IT

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This invention relates to an improved ignition composition and to electrical ignition devices containing this improved ignition composition.

Electric ignition devices, which are generally referred to as electric squibs, are used extensively to fire or ignite charges of deflagrating materials or low explosives, such as, for example, granular black powder, pelleted black powder, rocket grains containing nitrocellulose, and the like. One problem encountered in the use of electric squibs is that moisture may penetrate the ignition composition and thereby cause misfiring. Heretofore, paper tubing has been used as a casing for electric squibs, but this material has not been completely satisfactory in sealing moisture from the ignition composition. In addition the paper tubing is not sufficiently strong to prevent crushing of the ignitor when subjected to a sharp impact. In order to overcome the disadvantages of the paper tubing, a later development involved the use of metal tubes or shells in which the lead wires, bridge wire, initiator and ignition composition and the like were sealed. While these latter electric ignitors were more effective in sealing out moisture and preventing collapse upon impact, one problem encountered in this type of electric ignitor was in obtaining a satisfactory ignition composition. Conventional ignition compositions such as a mixture of boron and barium chromate were unsuitable because they lacked sufficient power to rupture the metal case when ignited, and as a result the charge to be ignited by the electrical ignitor was not burned. On the other hand other ignition compositions such as a mixture of lead oxide and boron, when freshly mixed, were extremely violent when ignited, and the resulting explosive force frequently snuffed out the flame without igniting the charge. In addition when a mixture of lead oxide and boron was stored for extended periods before ignition, there was insufficient power generated to rupture the metal tube when the mixture was ignited.

It is a primary object of this invention to overcome the disadvantages inherent in ignition compositions used heretofore in electric ignitors.

Another object of the invention is to provide an improved ignition composition for electric ignitors.

Still another object of the invention is to provide an improved electric ignitor or squib.

These and other objects of the invention will be apparent from the following detailed description thereof.

A novel ignition composition comprised of a mixture of boron, barium chromate, and potassium perchlorate suitable for use in electric ignitors has now been discovered. In addition, the design of a novel electric squib containing this novel ignition mixture has also been discovered.

The proportions of ingredients which may be used and which are preferably used in the preparation of the novel

2

ignition composition, on a weight basis, are set forth below.

Component	Weight Percent Range	Preferred Weight Percent Range
Boron	10-30	18-22
Barium chromate	80-40	72-48
Potassium perchlorate	10-30	10-30

Mixing of the above-mentioned components in the above-mentioned proportions to form the novel ignition composition may be effected in any convenient manner. For example, the boron may be admixed with the barium chromate, and then the resulting mixture admixed with the potassium perchlorate until a substantially homogeneous mixture is formed, or the components may be mixed simultaneously or in any convenient order. The particles of the solid components of the ignition composition should be finely divided to obtain the desired rate of reaction.

The solid particles, prior to, during, and after mixing should be in a substantially anhydrous condition, and the components or mixtures thereof should not be subjected to humid conditions that would permit absorption of moisture by the solids.

The components are mixed for a sufficient length of time to permit the formation of a substantially homogeneous mixture, and the amount of time necessary to accomplish this will depend upon the type of solids-blending equipment employed, the particle size and the amount of components being mixed.

The novel ignition composition of this invention may be employed in conventional electric ignition devices by positioning the novel ignition composition around the bridge wire connected to the two lead wires. Energizing of the lead wires and bridge wire electrically is sufficient to ignite the ignition composition, which in turn supplies sufficient flame to ignite the charge. If desired auxiliary flash compositions may be employed with the novel ignition composition in the electric initiators.

The novel ignition composition does not lose any significant explosive power when stored for extended periods prior to ignition. In addition, when the novel ignition composition is ignited, there is sufficient gas to rupture conventional metal squib cases without snuffing out the flame. Furthermore, the flame resulting from ignition is extremely powerful.

The novel ignition composition is particularly suitable for use in the novel electric squib assembly of this invention, which is shown as a sectional elevation view in the drawing.

The novel electric squib has a case 10 containing the novel ignition composition 11 described above, and an ignitor plug 12 having two lead wires 13 in a plastic plug 14, lead wires 13 being partially coated with insulation 15, and a bridge wire 16 soldered to exposed ends of lead wires 13 positioned in the ignition composition 11. A rubber plug 17 seals ignitor plug 12 within case 10.

More in detail, case 10 is preferably in the shape of a cylindrical cup. Any ductile metal or material is suitable for constructing the cylindrical cup, but aluminum is preferably employed. A cross 18 is scored, stamped, or otherwise impressed into the outer base of the case 10.

The ignitor plug **12** is fabricated by first preparing two convenient lengths of lead wire **13** having insulation **15** such as polyvinyl chloride. A portion of the insulation **15** is removed from one end of each of the lead wires **13**, and the uninsulated portion as well as the adjacent insulated portion of each wire is then crimped. The lead wires thus prepared are then inserted, with suitable spacing, into an injection mold, and a plastic plug **14** is then formed about the spaced lead wires. The shape of plastic plug **14** should conform with that of case **10**, and is preferably cylindrical, the outer diameter being substantially the same as the inner diameter of case **10**. Polyethylene molding power is preferably employed in the preparation of plastic plug **14**, but other thermoplastic materials may also be employed. The length of the plastic plug **14** is sufficient to permit a part of the uninsulated portions of lead wires **13** to extend outside of the plug. These parts of the lead wires **13** are trimmed and a bridge wire **16** is then soldered to join each end of the lead wires **13**. The resulting ignitor plug **12** is then cleaned by dewhiskering all burrs, solder and the like from the lead wires and bridge wire junctures.

A rubber plug **17** having two holes spaced apart substantially the same distance as the space between the lead wires **13** is then placed on the lead wires **13** and slid down the wires until the rubber plug **17** is adjacent to the plastic plug **14**. The rubber plug **17** has an outer diameter substantially equal to the diameter of the plastic plug **14**, and is preferably constructed of neoprene rubber, but other suitable rubber such as natural rubber and the like may be employed.

In the preparation of the novel electric squibs of this invention, case **10** is loaded with the novel ignition mixture **11** in a proportion sufficient, when fired, to rupture case **10** at the cross **18**, and also to provide sufficient flame to ignite the charge. The proportion of ignition mixture **11** will vary with the size of the case as well as the type of charge to be ignited. Ignitor plug **12** having a rubber plug **17** covering the lead wires **13** is then inserted into the charged case **10**. Crimps **19** and **20** are then formed in the case to seal the ignitor plug **12** and rubber plug **17** within case **10**.

The bare portions of lead wires **13** extending outside of case **10**, are twisted together to provide a shunt, or a suitable aluminum shunt clip may be provided if desired to prevent unprogrammed ignition of the electric squib.

The following examples are presented to define the invention more fully without any intention of being limited thereby. All parts and percentages are by weight unless otherwise specified.

Example I

One hundred and fifty novel electric squibs containing a novel ignition mixture of this invention were prepared in the following manner. In each instance, an aluminum cylindrical cup having an outside diameter of about 0.233 inch and a wall thickness of between about 0.011 and about 0.019 was cut to a length of about 0.700 inch. The case, after cleaning to remove chips and other foreign material was placed mouth down on an anvil punch and the cross was then impressed on the outer base of the aluminum case to a depth sufficient to yield a web of metal varying from 0.002 inch to 0.005 inch.

The novel ignition composition or mixture was prepared by drying amorphorus boron containing about 93 percent boron, at a temperature of about 110° C. for about 1 hour, and the dried boron was then stored in a sealed glass container. Barium chromate, reagent grade, was heated in a thin layer for 1 hour at a temperature of 110° C., and then stored in a sealed glass container. Potassium perchlorate was heated at a temperature of about 100° C. for 3 hours in a thin layer. After drying the potassium perchlorate was screened through a U.S. standard 100 mesh screen, and —100 mesh particles were stored in a dry sealed container.

The dried barium chromate was screened through a 100 mesh screen to break up any lumps and remove foreign material, and 60 parts of the barium chromate was placed in a "Sweetie" barrel type blender. The dried boron was also passed through a 100 mesh screen and 20 parts of the —100 mesh fraction was placed in the blender. Twenty parts of the potassium perchlorate (—100 mesh fraction) was then placed in the blender, and the three components were mixed for about 20 minutes to yield a substantially homogeneous mixture.

Under dry conditions 150 of the cases prepared as described above were each loaded with about 110 (plus or minus ten) milligrams of the ignition mixture, and the loaded cases were then stored in a dry place.

The ignitor plugs were prepared by cutting two lengths of 22 gauge tinned copper wire coated with polyvinyl chloride insulation, each length being about 7 inches long. A ½ inch length of insulation at one end of each lead wire was stripped off, then the portion of the stripped wire adjacent to the insulation was crimped and the portion of the insulated wire adjacent to the stripped portion was also crimped. The wires were then placed in an injection mold spaced about 0.1 inch apart, and a polyethylene plug was then formed around the spaced wire. The plug was cylindrical in shape having a length of about 0.25 inch and a diameter of about 0.213 inch. The plug covered the insulated as well as a portion of the uninsulated parts of the lead wires. The uninsulated portions of the lead wires projecting from the plastic plug were trimmed to a projection of about 0.055 inch from the plastic plug.

Using a platinum alloy bridge wire, soldering flux and 50/50 solder, the bridge wire was soldered to the stripped portions of the lead wires projecting from the plastic plug. The lead wire tips were coned and bent in about 15°. All burrs, excessive solder, and the like were then removed, and the soldered and coned plugs were carefully washed.

A neoprene rubber plug was molded having an outside diameter of about 0.213 inch and then two holes spaced about 0.10 inch apart running the length of the plug were drilled therein. The rubber plug was then inserted over the insulated portions of the wires and slid down the wires until adjacent to the plastic plug portion of the ignitor plug. The resulting assembly was then inserted into one of the loaded aluminum cases. The aluminum case was then crimped in two places to form a tight seal between the rubber plug and the inner wall of the aluminum case. The insulated portions of the lead wires were trimmed to a length of about 6 inches. A portion of each exposed end was stripped and the stripped portions were twisted together to form a shunt until tested as described below.

All 150 squibs were X-rayed and the bridge wire resistances were measured. No defects were found in the X-ray films, and all but one of the squibs had a resistance of 1.15 plus or minus 0.15 ohm, the exception having a resistance of about 0.95 ohm.

Example II

Fifty of the squibs of Example I were subjected to a 1000 plus or minus 20 volts A.C. potential applied between the shunted leads and the case for a minimum of 1 second. All squibs had resistances in excess of 50 megohms, thus demonstrating resistance to unprogrammed ignitions due to extraneous electrical charges.

Example III

Fifteen of the squibs of Example I were subjected to a jolt test (Mil-Std-350) and then tested at ambient temperature in a bomb. No functional failures of the fifteen squibs occurred.

Example IV

Fifteen of the squibs of Example I were subjected to a vibration test as specified in Mil-Std-353 and then tested

at ambient temperature in a bomb. No functional failures occurred.

Example V

Fifteen of the squibs of Example I were subjected to a water-tightness test as specified in Mil-Std-314. Examination under a fluoroscope revealed no leakage and the squibs were then tested in a bomb without any functional failures occurring.

Example VI

The squibs of Example I functioned without failure when subjected to extreme variations in temperature conditions (from −65° F. to 160° F.). In addition when firing the squibs of Example I in the atmosphere, a flame which projected about 6 feet from the squib was obtained on firing, thus demonstrating the superior firing power of the novel squib and the novel ignition composition of this invention.

It will be recognized by those skilled in the art that various modifications of the invention, some of which have been referred to above, may be employed without departing from the spirit of the invention.

What is desired to be secured by Letters Patent is:

1. An ignition composition comprised of an intimate mixture of between about 10 and about 30 percent by weight of boron, between about 80 and about 40 percent by weight of barium chromate, and between about 10 and about 30 percent by weight of potassium perchlorate.

2. An ignition composition comprised of an intimate mixture of between about 18 and about 22 percent by weight of boron, between about 72 and about 48 percent by weight of barium chromate, and between about 10 and about 30 percent by weight of potassium perchlorate.

3. An ignition composition comprised of about 20 percent boron, about 60 percent barium chromate, and about 20 percent by weight of potassium perchlorate.

4. An electric squib device comprised of a cylindrical case having a cross scored in the outer base of said case, an ignition composition positioned in the inner base of said case, an ignitor plug comprised of two spaced apart lead wires embedded in a plastic plug, a bridge wire connecting the ends of the two lead wires, the opposite ends of the lead wires being embedded in a rubber plug, said ignitor plug positioned in said case adjacent to said ignition composition, said bridge wire being embedded in said ignition composition and said ignition composition is comprised of an intimate mixture of between about 10 and about 30 percent by weight of boron, between about 80 and about 40 percent by weight of barium chromate, and between about 10 and about 30 percent by weight of potassium perchlorate.

5. The device of claim 4 wherein said ignition composition is comprised of an intimate mixture of between about 18 and about 22 percent by weight of boron, between about 72 and about 48 percent by weight of barium chromate, and between about 10 and about 30 percent by weight of potassium perchlorate.

6. The device of claim 4 wherein said ignition composition is comprised of about 20 percent boron, about 60 percent barium chromate, and about 20 percent by weight of potassium perchlorate.

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