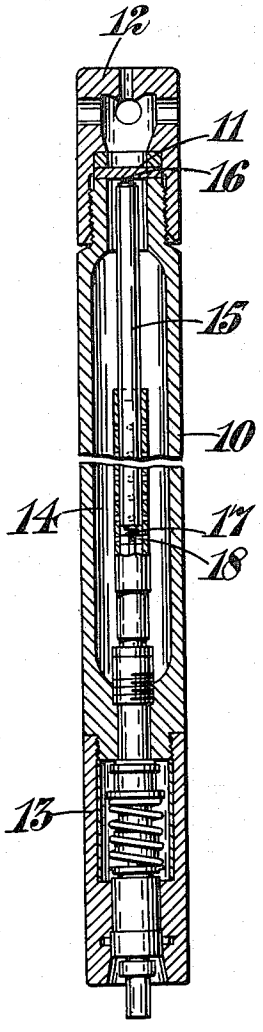
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EXPLOSIVE

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EXPLOSIVE

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This invention comprises improvements in or relating to explosives. It is known to provide explosive cartridges consisting of a strong metal container filled with carbon dioxide or like gas under pressure and a cartridge which can be ignited in the carbon dioxide or the like so as to raise its temperature to such a point that the pressure within the container is adequate to burst a retaining disc or other part of the container and so bring about an explosion of controlled force. Such cartridges have proved very valuable as mining explosives, but the provision of a suitable heating cartridge offers difficulties. The composition of the heating cartridge is usually that of some self-combustible explosive, such for example, as a perchlorate explosive containing a fuel and capable of being ignited by means of an electrically operated match. Ordinary fuels, used in such mixture, such as kerosene, however, prove to be soluble in liquid carbon dioxide and are, therefore, removed from the heated cartridge by the CO_2 in the surrounding container thus destroying the self-combustible properties of the heater. Attempts have been made to provide heating cartridges which are not subject to this disadvantage by encasing the cartridges in an impermeable envelope, for example, a lead tube, but this leads to crushing the cartridge by the external pressure and is not satisfactory.

According to the present invention a heating mixture for an explosive of the kind described is constituted by a mixture of an oxygen-carrying salt, for example potassium perchlorate, and a non-explosive or non-inflammable cellulose ester, for example cellulose acetate. The mixture of potassium perchlorate and cellulose acetate in finely powdered form is not, in itself, an explosive in the open air but burns very slowly, although it can be detonated if confined. Consequently the mixture has a high degree of safety during manufacture. Under the conditions of pressure obtaining within the gas filled container, however, combustion is found to be practically instantanecus, and as the cellulose ester is not soluble in the compressed gas, the mixture affords a satisfactory solution of the difficulty referred to.

In some cases it may be desirable to accelerate the rate of combustion of the heater and according to a further feature of the present invention there is incorporated in a heater composition comprising a mixture of an oxygen-carrying salt such as potassium perchlorate and a non-explosive or non-inflammable cellulose ester, such as cellulose acetate, a quantity of a resinous substance which is insoluble in liquid carbon dioxide.

The preferred resinous substance is a synthetic resin of the phenol-formaldehyde type. This may be admixed with the other ingredients in the form of a liquid, thinned with a solvent if required, but preferably in this case the solvent should be one which does not attack the cellulose ester. For example the solvent may consist of alcohol which comprises only a small proportion of acetone.

The composition is dried or warmed after the incorporation of the resin in order to solidify the resin.

Inert silicates or the like, for example, asbestos fibre, talc, mica, French chalk or fuller's earth may, if desired, be mixed into the heating mixture for the purpose of assisting uniformity of combustion.

One very advantageous use of the heating mixture of the present invention is in connection with blasting cartridges of the type shown in United States Patent No. 1,805,541, Dent Ferrell and Arthur W. Helmholtz and for the purpose of illustration the present invention is herein shown as applied to a cartridge of this general type.

The drawing is a view in longitudinal section of a blasting cartridge of the type referred to and showing the improved heating mixture of the present invention applied thereto.

Referring to the drawing it will be noted that the present invention is disclosed as embodied in a cartridge comprising a casing 10 having a rupturable disc 11 and a directing cap 12 at the discharge end, and means 13 for establishing an electrical connection for the heating element and for introducing the blasting medium into the interior 14 of the cartridge. The cartridge construction will not herein be described in detail inasmuch as it is substantially the same as that shown in the United States patent referred to above.

The tubular heat producing unit 15 containing the heating mixture is adapted to be inserted in the position shown in the drawing with its electrical contact 16 at one end thereof in contact with the rupturable disc 11 and the electrical connection 17 and at the opposite end thereof in contact with the plate 18 constituting the other terminal for the electrical circuit.

The following are examples of the preparation of mixtures according to the present invention.

Example 1

Finely powdered potassium perchlorate having a large proportion of particles less than 200 mesh is mixed with similarly powdered cellulose acetate and asbestos fibres in the following proportions:—

	Per cent
Potassium perchlorate	74
Cellulose acetate	24
Asbestos fibre	2

These ingredients are mixed in an ordinary kneading or mixing machine until they are thoroughly incorporated. They are then made up into paper cartridges containing a powder match capable of ignition by an electric fuse.

The terminals of the fuse are suitably connected to contact elements on the ends of the cartridge and the cartridges introduced in known manner into a carbon dioxide container of the kind hereinabove referred to. After the container has been charged with carbon dioxide it can be exploded by igniting the mixture through an electric current applied to the fuse.

Example 2

A similar mixture is prepared to that set forth in Example 1, but is moistened by acetone and rolled into sheets. Upon breaking up the sheets, a granulated heating mixture is obtained which can be used in a similar way to the powdered mixture.

Example 3

The following mixture is made up in the same manner as that of Example 1:—

	Per cent
Potassium chlorate $KClO_3$	77.0
Cellulose acetate	21.5
Mica powder	1.5

Example 4

There are mixed together:—

	Parts
Potassium perchlorate $KClO_4$ (finely powdered)	81
Cellulose acetate	10
"Elo" resin	9
	100

"Elo" resin which is a phenol formaldehyde condensation product in the soluble stage of condensation is thinned with a liquid consisting of ethyl alcohol containing a small quantity of acetone. The cellulose acetate and the potassium perchlorate are first mixed with one another and thereafter the liquid resin is added with stirring. The incorporation of the resin makes the compound somewhat granular, as some of the particles of the powdered constituents are caused to adhere together. After incorporation of the resin and stirring, the mixture is warmed and dried to remove the solvent and is then in granular condition, or if sufficient of the solvent is initially added with the resin the mixture makes a softish friable cake which is, after drying easily crushed to a fine-grained powder. The granular or powdered mixture is then filled into cartridges and utilized as heating elements in explosives of the known type containing carbon dioxide.

The following tests were carried out with the heating cartridge of Example 4 filled into carbon dioxide cylinders:—

40 grams of the mixture in a cylinder containing only five ounces of CO_2 failed to shear the steel sealing disc (7/64 of an inch thick) on the end of the cylinder. 40 grams, in a series of ten tests, sheared the disc twice when only 6 ounces of CO_2 were present. Thus about 7 ounces of CO_2 is the minimum for certainty of shearing when 40 grams of explosive are used. A charge of 40 grams is a normal one for this heater for a CO_2 container of the size employed in these tests and the normal quantity of carbon dioxide would be about 10 to 12 ounces. It will, therefore, be seen that the explosion is sufficiently violent when the resin is incorporated to ensure rupture of the disc, even when the carbon dioxide contained in the cylinder has fallen away, as sometimes happens through leakage, to a value as low as 7 ounces and thus failure to explode is very unlikely which is not the case when the resin is omitted. If it is desired to ensure explosion with still smaller quantities of CO_2 this can easily be arranged by increasing the charge. However, with the quantities stated, should all or nearly all the CO_2 have leaked away, there is fair certainty that the disc will not be sheared, and this is an advantage.

In this application, the term "gas" is intended to include vapors or gaseous substances which may pass into the liquid state under the conditions of temperature and pressure obtaining in everyday use.

I claim:

1. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of an oxygen-carrying salt and a non-explosive cellulose ester.

2. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of an oxygen-carrying salt and a non-inflammable cellulose ester.

3. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of potassium perchlorate and a non-explosive cellulose ester.

4. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of potassium perchlorate and cellulose acetate.

5. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of an oxygen-carrying salt, a non-explosive cellulose ester, and a resinous substance which is insoluble in carbon dioxide.

6. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of an oxygen-carrying salt, a non-explosive cellulose ester, and a synthetic resin of the phenol-formaldehye type.

7. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of an oxygen-carrying salt, cellulose acetate, and a resinous substance which is insoluble in carbon dioxide.

8. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas

therein, and a heating element therein comprising a mixture of an oxygen-carrying salt, cellulose acetate, and a synthetic resin of the phenol-formaldehyde type.

9. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of potassium perchlorate, a non-explosive cellulose ester, and a resinous substance which is insoluble in carbon dioxide.

10. In an explosive charge, the combination of a container adapted to withstand a high internal pressure, a relatively readily-rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein comprising a mixture of potassium perchlorate, a non-explosive cellulose ester and a synthetic resin of the phenol-formaldehyde type.

11. In an explosive charge, the combination of a container adapted to withstand high internal pressure, a relatively readily rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein consisting of granules, each granule comprising crystals of an oxygen-carrying salt and particles of a non-explosive cellulose ester bound together by a resinous binder.

12. In an explosive charge, the combination of a container adapted to withstand high internal pressure, a relatively readily rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein consisting of granules, each granule comprising crystals of potassium perchlorate and particles of a non-explosive cellulose ester bound together by a resinous binder.

13. In an explosive charge the combination of a container adapted to withstand high internal pressure, a relatively readily rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein consisting of granules, each granule comprising crystals of an oxygen-carrying salt and particles of cellulose acetate bound together by a resinous binder.

14. In an explosive charge, the combination of a container adapted to withstand high internal pressure, a relatively readily rupturable closure therefor, a compressed non-combustible gas therein, and a heating element therein consisting of granules, each granule comprising crystals of potassium perchlorate and particles of cellulose acetate bound together by a resinous binder.

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