April 26, 1932. D. FERRELL 1,855,740

PROGRESSIVE HEATING CARTRIDGE

Filed Jan. 18, 1929

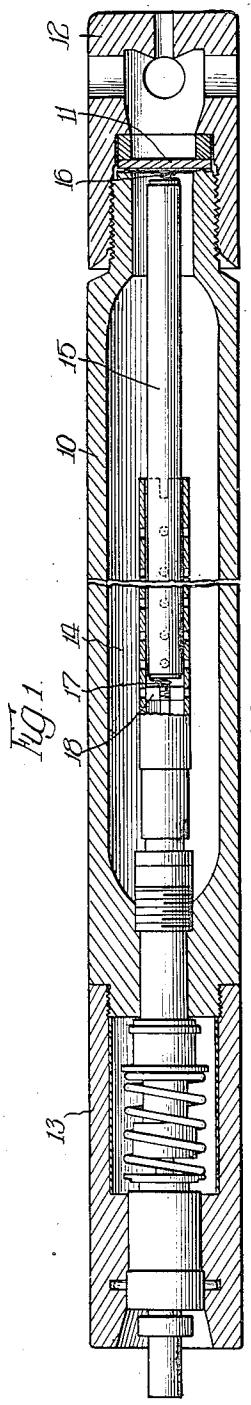

Fig. 1.

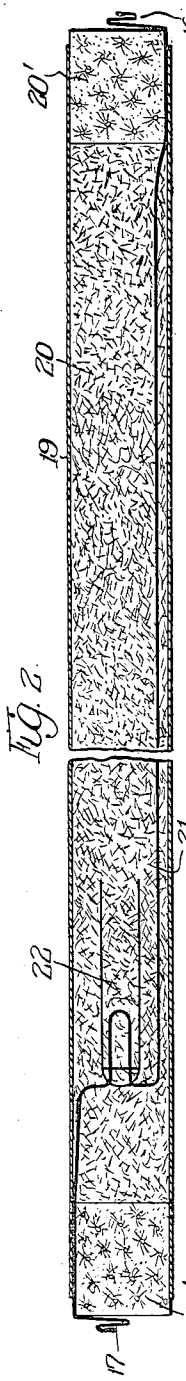

Fig. 2.

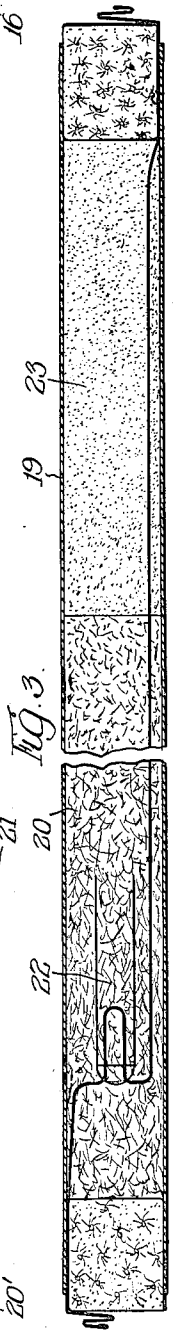

Fig. 3.

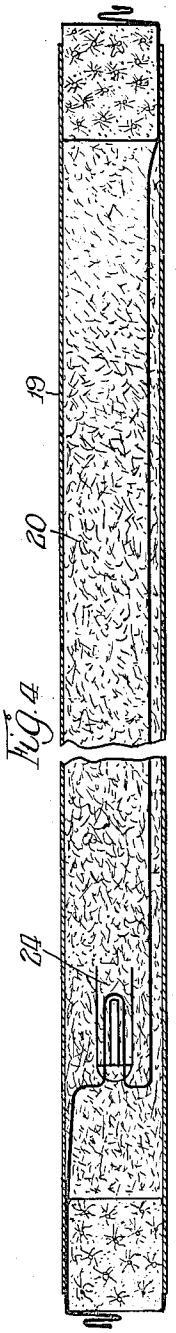

Fig. 4.

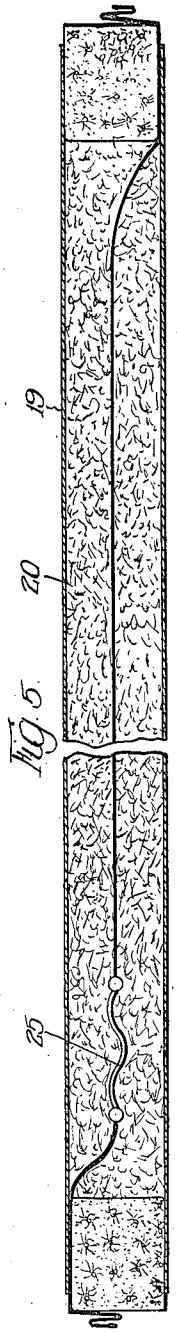

Fig. 5.

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UNITED STATES PATENT OFFICE

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PROGRESSIVE HEATING CARTRIDGE

Application filed January 18, 1929, Serial No. 333,400, and in Great Britain October 5, 1928.

This invention relates to improvements in the method of discharging cartridges, such as for example, blasting cartridges, and to means for practicing the improved discharging method.

The invention is herein illustrated as applied to blasting cartridges of the type comprising a casing having carbon dioxide contained therein under pressure together with suitable means for raising the temperature of the carbon dioxide to or slightly above its critical temperature, whereby the cartridge is discharged by rupturing one wall thereof giving vent to the expanding gas which acts to bring down a wall of coal, rock, or other material in accordance with the use to which the cartridge is put. This type of cartridge is fully described and claimed in the copending application, Serial No. 169,441, filed February 12, 1927, by the applicant and Arthur W. Helmholtz as joint inventors, and it represents the type of device to which the present invention relates and on which it is an improvement.

One danger which has been present in blasting operations, such as mine blasting operations, is that of explosions occurring in the rooms of the mines caused by explosive gases which sometimes accumulate in explosive volumes, being set off or ignited by sparks issuing from the cartridge during blasting discharge. This danger is for the most part entirely eliminated in blasting operations where carbon dioxide or similar blasting mediums are employed due to the inherent characteristics of this type of medium. The blasting force of carbon dioxide is derived from its power of vaporization and expansion upon being heated to or slightly above its critical temperature when in liquid form and under pressure, which action is entirely different from that of ordinary explosive substances, such as dynamite for instance. Dynamite or similar substances produce exothermic chemical reactions upon explosion which give off a tremendous amount of heat and the gases produced thereby are actually products of combustion. By the use of a gas, such as carbon dioxide, which is merely vaporized and expanded without chemical change, it becomes obvious that blasting operations practiced with carbon dioxide or similar substances are very much safer than those practiced with other blasting materials.

As above mentioned in carbon dioxide cartridges it is necessary to provide some means for raising the temperature of the carbon dioxide medium to or slightly above its critical temperature and it has been found convenient in practice to do this by igniting a substance which will evolve the proper amount of heat while maintaining the substance in proper heat transferring relationship relative to the carbon dioxide medium.

It, therefore, becomes desirable to provide a heating element which may be initially ignited by any suitable means such as by an electrical current, which means is the most convenient and thus the most preferable, which will develop exactly the amount of heat necessary for discharging the cartridge, but will not continue its igniting or burning action after the cartridge has been discharged. Also a heating element which is entirely free from all possibility of emitting sparks, or ignited or igniting material such as might be presented in contact with explosive gases in the mine resulting in an explosion in the mine room causing damage to property and injury to the workers.

It is, therefore, an object of this invention to provide a method and means for discharging cartridges of the type described in the copending application above referred to which will be entirely free of the foregoing dangers.

Other objections not enumerated will appear as the description proceeds.

The invention accordingly proceeds upon the principle of developing the heat necessary to raise the blasting medium to or above its critical temperature, progressively, that is to say, little at a time until the total required heat is reached. Although this involves some time element between the instant of initial ignition and resulting discharge, it must be borne in mind that the entire heating action is extremely rapid and in practice

is found to occur within the limits of approximately one-twentieth of a second. This progressive heating when employed with mediums, such as carbon dioxide, acts to assure a high degree of safety, as it is found that the cartridge will discharge immediately upon reaching the critical temperature with further ignition of the heating material automatically terminated by the extinguishing heat absorbing action of vaporization of the medium together with the violent agitation of the material during discharge.

The invention may be practiced by causing a relatively small volume of the heating material to be initially ignited and by causing a progressive ignition of the material in relatively small volumes at any one instant until the total necessary heat is developed. It is, of course, desirable if possible to gauge the amount of heating material that will be required, but due to slight variation this cannot always be done, and, therefore, a slight excess should be provided so as to assure discharge in every instance. As above explained, with the present progressive heating method the presence of such excess does not present any degree of danger, as continued ignition of this excess material is completely checked, the igniting action being extinguished and the particles of heating material violently discharged and agitated as minute particles suspended in the expanding heat absorbing medium.

The heating element may be actually constructed in shape relatively long with a relatively small cross-sectional area, and provided with means, such as a fusing element, match head, or squib, for initiating the igniting action, located in a predetermined local volume thereof, so that the igniting action will start from one predetermined point and continue of its own accord progressively throughout the entire length of the element. Due to the relatively small cross-sectional area of the element, the volume of heating material burning or undergoing ignition at any one instant, is relatively small and consequently the heat required for discharge is progressively developed as the heating element burns.

It is apparent that the advantages of this invention may be realized with elements having a single fusing element or squib located in one end thereof, or located at any other predetermined point throughout the length of the element provided only that there is sufficient of the heating material located remotely from the point of initiating the igniting action to give the progressive heat developing action. Thus, the fusing element or squib may be located centrally or any other desired point. It is also apparent that more than one fusing element or squib may be employed, as the progressive heating action can be produced even though the igniting action be initiated from a plurality of locations.

For the purpose of better understanding the present invention, the applicant has disclosed in the accompanying drawings and has hereinafter described in detail one specific embodiment thereof, which is given merely by way of example, and the present disclosure is not to be considered as limiting the invention in any particular. The scope of the invention will be determinable from an understanding of the present disclosure as one embodiment thereof, and with an appreciation of the advantages produced in the particular embodiment illustrated.

By referring to the drawings—

Figure 1 is a cross-sectional view in side elevation of a cartridge equipped with a heating element constructed in accordance with this invention;

Figure 2 is a cross-sectional view of a heating element constructed in accordance with this invention; and

Figures 3, 4 and 5 are modified types of heating elements shown in views similar to Figure 2.

Referring to the drawings, it will be noted that the present invention is disclosed as embodied in a cartridge comprising a casing 10 having a rupturable disk 11 and 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 cavity 14. The cartridge construction will not be described in detail as it is substantially the same as disclosed in the copending application referred to.

The heating element 15 is adapted to be inserted in the position shown in Figure 1 with its electrical connection 16 at one end in contact with the rupturable disk 11 and the electrical connection 17 at its opposite end in contact with the plate 18 constituting the other terminal for the electrical circuit.

Referring to Figures 2 to 5 inclusive, it will be noted that the heating element comprises a tube 19 which may be of any suitable material, such as for instance, wax paper, which is found to serve well in practice, having closing plugs 20′ at its two ends formed of any suitable material, such as for instance, cork. The heating mixture 20 is contained within the tube 19 and a conducting wire 21 terminating at one end as at 16, and at the other end as at 17 by passing between the corks 20′ and the tube 19 is also passed through the tube. The wire terminals are preferably in the form of a small coil spring so as to assure more perfect contact.

The mixture 20 may be of any suitable material, such as for instance, a mixture of sodium chlorate, aluminum, and wood charcoal, all mixed together in suitable portions,

such as the following, which are found to produce a good mixture in practice:

	Per cent
Sodium chlorate	81
Aluminum	13
Wood charcoal	6

The electrical connection 21 has connected in its length a match head or squib 22 embedded in the material so that upon the passage of electrical current through the match head or squib an ignition of the material is started locally in the area immediately surrounding the match head or squib. The conducting wire may be of any suitable material, such as of soft iron wire, copper, or nichrome. In the form shown in Figure 3, a diminished amount of ignition material is provided, the remaining portion of the tube being filled with a suitable inert material 23, such as fuller's earth, or like substance. In Figure 4, a slightly different form of match head or squib is shown as at 24 serving, however, to initiate the ignition in a local area the same as described above. In Figure 5, a fusible wire 25 made of copper or like suitable material is provided for initiating the ignition whereby the material is ignited throughout a local area immediately surrounding the wire 25. It is preferable to provide the tubes 19 of water proof paper or of any material which will contain the material and maintain a predetermined form according to the contour desired.

In operation, it will be appreciated that as an electrical current is passed through the heating element by means of the cartridge being properly connected to a suitable exploder, such as for example, a magneto or current and switch line, the material contained within the heating element is ignited throughout its area immediately around the match head or squib so that the material once ignited causes progressive ignition throughout the length of the heating element, further, that this ignition will continue until the proper heat is developed within the container for bringing the temperature of the medium to or slightly above its critical temperature or to the discharging temperature. Also at this time, further ignition is intermediately terminated as the discharging of the cartridge causes a large and rapid heat absorption due to the evaporation and gas liberation together with a violent agitation and division of the heating material into minute particles in which form continued ignition is immediately extinguished. With this understanding of the applicant's improved method and means, it will be appreciated that the present invention provides a means for producing exactly the required amount of heat for discharging the cartridge and for automatically terminating the heat generating ignition action at the moment the necessary heat is arrived at.

It will appear that the present invention eliminates all possibility of ignition after explosion and consequently elimination of all the dangers above referred to which are undesirable in mine blasting or other blasting operations.

The present disclosure and description is given merely by way of illustration as one form of the present invention and is obvious that various modifications may be resorted to without departing from the spirit of the invention, the scope of which is set forth in the appended claims.

I claim:

1. In a device of the character described, a relatively long container having a relatively small cross-sectional area, said container having a mixture therein of sodium chlorate, aluminum and carbon and means for initiating ignition thereof throughout a local area of its volume.

2. In a device of the character described, a relatively long container having a relatively small cross-sectional area, said container having a mixture therein of sodium chlorate, substantially 81%; aluminum, substantially 13%; and carbon, substantially 6%; and means for initiating ignition thereof throughout a local area of its volume.

3. The method of developing heat in gas charged blasting cartridges which consists in providing a quantity of combustible heat producing material, igniting the material at a given point and causing progressive combustion in relatively small increments until the amount of heat required for discharge of the cartridge has been thus progressively developed, whereupon combustion ceases.

4. The method of developing heat in blasting cartridges charged with highly compressed carbon dioxide and provided with pressure responsive discharge means, consisting in providing a combustible material proportional in quantity to the charge of carbon dioxide, igniting the material at a given point and causing progressive combustion of the material in relatively small increments until the amount of heat required for discharge has been thus progressively developed, whereupon the discharge causes the combustion to cease.

5. A heater unit for use in gas charged blasting cartridges, comprising a relatively long body of combustible material of relatively small cross sectional area and means for initiating ignition of said material throughout a small area, all for the purpose of developing the required amount of heat in a continuously progressive manner and avoiding an excess of heat by reason of the automatic extinguishment of the heater unit immediately upon discharge of the cartridge.

6. A heater unit for use in gas charged blasting cartridges, comprising an elongated tube of relatively small cross sectional area

containing a readily ignitible heat producing material, and means for initiating ignition of said material at a given point in the length of said tube, thus causing progressive ignition of said material lengthwise of said tube with consequent progressive heat development to the point at which discharge occurs.

Signed at Marion, Illinois, this 4th day of January, 1929.

DENT FERRELL.