March 28, 1950 H. V. WILLIAMSON 2,502,193

SAFETY RELEASE FOR BLASTING SHELLS

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Fig. 1.

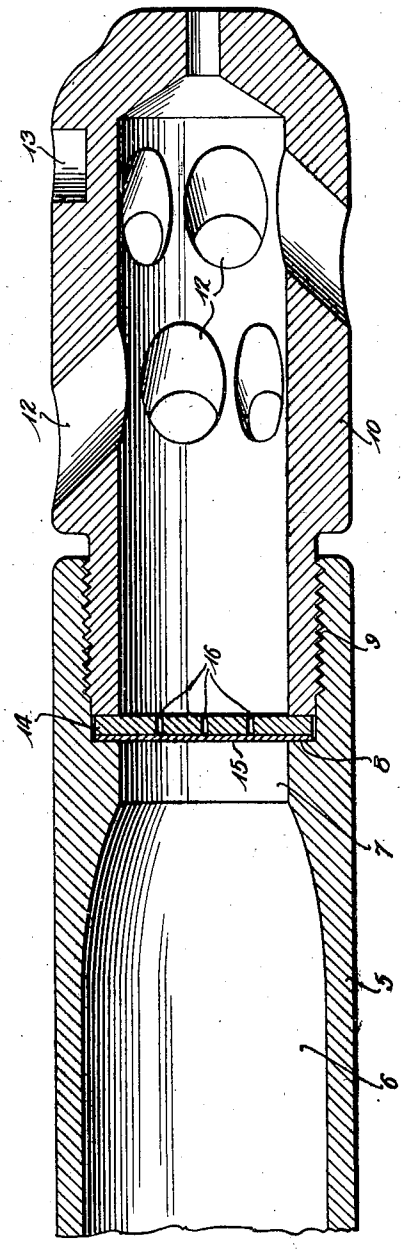
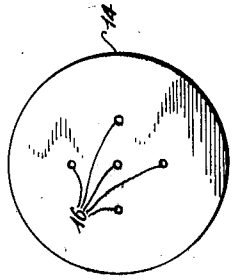


Fig. 2.



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SAFETY RELEASE FOR BLASTING SHELLS

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21 Claims. (Cl. 102—25)

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This invention relates to blasting cartridges or shells and more particularly to the provision of a safety pressure release means for such cartridges or shells.

The blasting cartridges with which the invention is concerned are of the type disclosed in Patent 2,207,191, issued to Eric Geertz on July 9, 1940. One use of these blasting cartridges is to break down material, such as coal which is being mined. Another use is to fracture slag which is formed in open-hearth furnaces, as is disclosed and claimed in Patent 2,151,264 to William C. Cavanagh, dated March 21, 1939.

These blasting cartridges in general consist of a thick walled body having a chamber in which liquid carbon dioxide is confined under high pressure. Located within the carbon dioxide chamber is a chemical heater unit for the generation of heat to convert the liquid carbon dioxide to vapor and greatly increase its pressure. The chemical heater unit is generally ignited by an electric match having circuit connections to the exterior of the cartridge. At one end of the cartridge is a replaceable wall section constituting a shear plate which ruptures when the pressure of the carbon dioxide vapor has reached a predetermined high value. This sudden rupture of the shear plate releases the confined pressure so that a material breaking effect is obtained.

Due to faulty operation of the cartridges in some instances, which may result from too small a charge of carbon dioxide or an imperfect chemical heater unit, they do not generate sufficient pressure to rupture their shear plates. When this occurs, it is necessary that the defective cartridge be removed from its drill-hole so that another can be substituted and so that the defective cartridge may be reconditioned for use. This handling of defective cartridges, however, is dangerous because the shearing action may be delayed and the shear plate may rupture while the cartridge is in the hands of or near an operator.

It is an object of the present invention to provide means in these blasting cartridges which will result in the gradual escape of the carbon dioxide vapor after the cartridge has been fired, to take care of a possible failure of the shear plate to rupture.

A further object of the invention is to provide a safety pressure release of this character which will not alter the construction or normal operation of the cartridges now being employed.

A further object of the invention is to provide a safety pressure release which will be very inexpensive and consequently may be applied to every cartridge without materially increasing its cost.

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A preferred embodiment of this invention is illustrated in the accompanying drawings in which:

Figure 1 is a longitudinal sectional view through the axis of a blasting cartridge to which the invention has been applied, and

Figure 2 is a plan view of the shear plate used with the invention.

The invention contemplates the provision of two general types of pressure safety release means, both of which have as their common purpose to cause a slow escape of carbon dioxide from a cartridge after it has been fired, so that the pressure will be bled off although the shear plate does not rupture. The first type of safety pressure release means serves to initiate the escape of pressure after the pressure has reached a relatively low value and this escape of pressure will continue while the pressure continues to build up to the high value required to rupture the shear plate. This action is not dependent upon an increase in temperature of the cartridge.

The second type of pressure release means with which the invention is concerned, functions to release the pressure as a result of a substantial rise in the temperature of the cartridge. This takes advantage of the fact that any cartridge which has been fired becomes heated due to the burning of the chemical heater unit. If insufficient pressure is developed in the cartridge to rupture the shear plate, sufficient heat nevertheless will be generated to elevate the temperature of the cartridge. This elevated temperature serves to weaken the safety release means of this second type contemplated by the invention, so that it will rupture or blow out and result in the escape of the pressure which is developed. This second type of safety pressure release means, preferably, has approximately the same rupturing strength under cold conditions as the main shear plate so that if the cartridge is a normal one and the shear plate ruptures, there will be no prior escape of gas due to rupture of the safety release means.

For a complete description of the entire cartridge, the aforementioned Patent 2,207,191 may be referred to. The accompanying drawings show only the discharge end of such a cartridge. In this drawing, the main body of the cartridge is indicated at 5 and this provides the chamber 6 to contain the liquid carbon dioxide, the chemical heater unit and the electrical match. An

orifice 7 is at the discharge end of the body 5 and within this opening is formed a recessed shoulder 8. Outwardly from the shoulder 8 are internal screw threads 9. Screwed into the threads 9 is a discharged cap 10 which is hollow but which has discharge ports 12 through the wall thereof. These discharge ports 12 preferably incline outwardly and rearwardly toward the main body 1 so that the escaping carbon dioxide vapor will be directed rearwardly and will tend to advance the cartridge into the drill-hole in which it is located. Notches 13 are formed in the cap 10 to enable it to be gripped by a wrench in assembling and disassembling this cap relative to the main body 5.

The cap 10 serves to hold in place against the shoulder 8 a wall section made up of a shear plate 14 and a pressure release disc 15. The disc 15 lies against the plate 14 in a face-to-face relationship and the disc 15 is located on the interior side of the plate 14 so that it is toward the pressure within the main body 5. The plate 14 should have a slightly lower rupture strength than the shear plates which have been employed in the cartridges heretofore used and which have not had the safety pressure release disc 15 of the invention. This is because the combined rupture strength of the shear plate 14 and safety disc 15 at the opening 7 should correspond to the pressure at which it is desired that they simultaneously shear. This pressure is generally on the order of 15,000 lbs. per square inch.

In accordance with the invention, openings 16 of small size are formed through the shear plate 14. The liquid carbon dioxide which is under its charging pressure within the main body 5 cannot, however, escape through these openings 16 because of the location of the disc 15 on the inner side of the plate 14. It is, therefore, apparent that the wall section made up of the main shear plate 14 and the safety pressure release disc 15 have their combined thickness reduced at very small isolated areas to provide portions of reduced rupture strength relative to the combined rupture strength of these two members.

It has been pointed out that one type of safety release means contemplated by the invention results in the initiation of the bleeding down of the carbon dioxide vapor after its pressure has reached a relatively low value. For example, it may be desired that this carbon dioxide vapor begin to escape after it has reached a pressure of 5,000 lbs. per square inch, as it is known that the pressure will always rise to this value if the chemical heater unit is ignited even though it may not rise to the higher pressure which is necessary to rupture the main shear plate 14. If this type of safety pressure release is desired, the disc 15 may be made of the same material of which the shear plate 14 is made and this generally will be steel, although it is possible to employ copper and other relatively strong metals for this purpose.

The safety disc 15 should be of such a thickness relative to the shear strength of this material that it will rupture at the openings 16 when the internal pressure is reached at which it is desired that the initiation of the vapor bleed-off will occur. For example, the thickness of this material may be such that it will rupture at the openings 16 at a pressure of 5,000 pounds per square inch and this will occur either upon the sudden generation of this pressure, or upon the gradual attainment of this pressure.

It is preferable that the openings 16 be of very small size so that the gas which they will permit to escape will be very small. This is important so that the increase in pressure to the high value necessary to rupture the main shear plate 14 will neither be prevented nor prolonged. It is apparent that if the openings 16 are too large or are too many in number, they might bleed off enough gas after the safety pressure disc 15 has ruptured so that the final bursting pressure could never be reached. It has been found that these openings may advantageously be one-sixteenth inch in diameter and may be four in number. It is preferable that there be more than one such opening 16 because if only one were present, it might become obstructed.

With a hole one-sixteenth inch in diameter and using a steel disc having a shear strength of 38,000 lbs. per square inch, a disc thickness of .002 inch will result in the rupture of this disc at the openings 16 at a pressure of about 5,000 lbs. per square inch. If sheet copper having a shear strength of 19,000 lbs. per square inch is used, and the holes 16 are of one-sixteenth inch diameter, a disc thickness of .004 inch will result in its rupture at 5,000 lbs. per square inch internal pressure.

If the pressure continues to rise within chamber 6 to the necessary high value, both the shear plate 14 and the safety disc 15 will shear at the opening 7. As has been noted, openings 16 should be so small that they will not prevent the attainment of this high pressure.

If it is desired to employ the second type of safety pressure release, set forth above, the disc 15 is merely made of a different material. This material should be one which has a reduced shear strength upon heating, or it may be one which, when heated, gradually flows and yields upon exposure to a prolonged pressure. Suitable materials for this purpose are lead and a rolled lead-antimony alloy consisting of lead with up to five percent antimony. The thickness of this material of which the disc 15 is made should be such that it will have a rupture strength at the relatively small openings 16 which is approximately equal to the combined rupture strength of the disc 15 and plate 14 at the relatively large opening 7. If this pressure is 15,000 lbs. per square inch, and if the main shear plate 14 has holes 16 therethrough which are of one-sixteenth inch diameter, a lead disc 15 may be employed which is one-thirty-second inch thick. If a pressure is suddenly applied to the interior of the main body 5, as would occur with a normal cartridge, this lead disc would shear at the openings 16 at about 15,000 lbs. per square inch and this is approximately the pressure at which both the main shear plate 14 and disc 15 shears at the opening 7.

If the internal pressure does not rise to a sufficiently high value to rupture both the safety disc 15 and the main shear plate 14, the temperature of the cartridge will nevertheless rise and at a temperature of 80° F. the safety pressure release disc 15 of this lead material will rupture at about 5,400 lbs. per square inch. Or, if the temperature should rise to 212° F., this lead disc will rupture at about 2,700 lbs. per square inch.

If the safety disc 15 is made of a relatively soft material as lead, it will serve as a gasket on the shoulder 8 to prevent the escape of carbon dioxide. If a hard material as steel is used for the disc 15, it will be necessary to employ a gasket between the disc 15 and shoulder 8.

This second type of safety pressure release

means has the advantage over the first type discussed above in that there will be no loss of internal pressure due to rupturing of the safety disc 15, inasmuch as with a normal cartridge the lead or like soft material disc will not rupture until approximately the rupture strength of the main shear plate.

The first type of safety pressure release which occurs in any event upon attainment of a relatively low pressure irrespective of the rise in temperature of the cartridge, nevertheless has the advantage that it is positive and rapid in its operation.

With both types of safety pressure release means, a cartridge which has been fired but which does not discharge in the normal manner, may be handled with complete safety as its pressure will have been bled off. There will consequently be no danger of the cartridge suddenly discharging when it is being handled. The defective cartridge can then be reconditioned and be put back in use.

Having thus described the invention, I claim:

1. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, a pair of members lying against each other in sealing relation with said orifice having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members supporting the inner member against the pressure in the hollow body and having a relatively small area of reduced support to provide a portion of reduced rupture strength relative to the combined rupture strength of said members, and means retaining said members in sealing relation with said orifice.

2. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, a pair of members lying against each other in sealing relation with said orifice having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members having an opening of relatively small area to provide a portion of reduced rupture strength relative to the combined rupture strength of said members when said members are subjected to an elevated temperature for a prolonged period of time, and means retaining said members in sealing relation with said orifice.

3. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, a pair of members lying against each other in sealing relation with said orifice having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members having an opening therethrough of relatively small area to provide a portion of reduced rupture strength relative to the combined rupture strength of said members, and means retaining said members in sealing relation with said orifice.

4. A blasting cartridge comprising a hollow cylindrical body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice at one end through which the vaporized charge is released, and providing a shoulder around said orifice, a pair of members lying against each other in sealing relation with said shoulder having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer member having an opening of relatively small area, and the rupture strength of the inner member at said opening being less than the combined rupture strength of said members when said members are subjected to an elevated temperature for a prolonged period of time, and means retaining said members in sealing relation with said shoulder.

5. A blasting cartridge comprising a hollow cylindrical body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice at one of its end portions through which the vaporized charge is released and providing a shoulder around said orifice, a pair of members lying against each other in sealing relation with said shoulder having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer member having an opening of relatively small area, and the rupture strength of the inner member at said opening being less than the combined rupture strength of said members when said members are subjected to an elevated temperature for a prolonged period of time, and means having a threaded engagement with the body and urging the members toward the shoulder to hold the inner member in sealing relation with said shoulder.

6. A blasting cartridge comprising a hollow cylindrical body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice at one of its end portions through which the vaporized charge is released and providing a shoulder around said orifice, a pair of members lying against each other in sealing relation with said shoulder having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pres-

sure in the hollow body, the outer member having an opening of relatively small area, and the rupture strength of the inner member at said opening being less than the combined rupture strength of said members, and means engaging said body and the peripheral portion of the outer member and urging the members toward the shoulder to hold the inner member in sealing relation with said shoulder.

7. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, a pair of members of larger size than said orifice lying against each other in sealing relation with said orifice having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members having a plurality of spaced openings, each of relatively small area, to provide portions of reduced rupture strength relative to the combined rupture strength of said members, and means retaining said members in sealing relation with said orifice.

8. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, a pair of members lying against each other and of larger size than said orifice, means retaining said members over said orifice in sealing relation therewith, the inner one of said members being of less structural strength than the outer member, and the combined thickness of said members being reduced at a materially small area to provide a portion of reduced rupture strength relative to the combined rupture strength of said members.

9. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, a pair of members of a larger size than said orifice lying against each other in sealing relation with said orifice having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the inner one of said members being thinner than the outer member, and the outer one of said members having an opening of relatively small area to provide a portion of reduced rupture strength relative to the combined rupture strength of said members, and means retaining said members in sealing relation with said orifice.

10. A blasting cartridge comprising a hollow cylindrical body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice at one of its end portions through which the vaporized charge is released and providing a shoulder around said orifice, a relatively thin member seated on said shoulder to close said orifice, and a relatively thick member overlying said thin member, said members having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer thick member having an opening of relatively small area to provide a portion of reduced rupture strength relative to the combined rupture strength of said members when said members are subjected to an elevated temperature for a prolonged period of time, and restraining means engaging said body in the peripheral portion of the thick member to urge the thick member toward the shou'der and thereby hold the thin member in sealing relation with said shoulder.

11. A blasting cartridge comprising a hollow cylindrical body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice at one of its end portions through which the vaporized charge is released and providing a shoulder around said orifice, a relatively thin member seated on said shoulder to close said orifice, and a relatively thick member overlying said thin member, said members having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer thick member having a plurality of spaced openings, each of relatively small area, to provide portions of reduced rupture strength relative to the combined rupture strength of said members, and restraining means engaging said body and the peripheral portion to urge the thick member toward the shoulder and thereby hold the thin member in sealing relation with said shoulder.

12. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, a plate disposed across said orifice having an opening of relatively small area, a disc on the interior side of the plate and of substantially the same peripheral shape as the plate, the rupture strength of said disc at the plate opening being less than the combined rupture strength of the plate and disc, said disk and said plate having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, and means for retaining the plate and the disk in sealing engagement with the body at said orifice to prevent leakage.

13. A blasting cartridge comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said

body having a discharge orifice through which the vaporized charge is released and presenting a shoulder around said opening, a disc seated on said shoulder, a plate bearing against said disc, said plate having an opening normally closed by said disc, the rupture strength of said disc at said opening being less than the combined rupture strength of the plate and disc when they are subjected to an elevated temperature for a prolonged period of time, said plate and said disk having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, and means engaging said body and the periphery of said plate to urge the plate toward the shoulder and thereby hold the disk in sealing relation to the shoulder.

14. A blasting cartridge comprising an elongated hollow cylindrical body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having one of its end portions open to provide a discharge orifice through which the vaporized charge is released, a plate disposed across said orifice, retaining means having a threaded engagement with the body and urging said plate against the body at its open end, and a disc between said open end of the body and said plate and held in sealing relation with the body by said plate and said retaining means, said plate having an opening and the rupture strength of the disc at said opening being less than the combined rupture strength of the plate and disc, said plate and said disk having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body.

15. In a blasting cartridge, the combination with a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, of means for closing said orifice, said orifice closing means comprising two members having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members supporting the inner member against the pressure in the hollow body and having a very restricted area of reduced support to provide a rupture strength substantially less than said combined overall rupture strength which will cause shearing to occur at said restricted area only to slowly bleed off the vaporized charge at a pressure below the intended work performing pressure.

16. In a blasting cartridge, the combination with a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, of means for closing said orifice, said orifice closing means comprising two members having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members supporting the inner member against the pressure in the hollow body and having a very restricted area of reduced support to provide a rupture strength substantially less than said combined overall rupture strength, when said members are subjected to an elevated temperature for a prolonged period, so that shearing will occur at said restricted area to slowly bleed off the vaporized charge if the intended work performing pressure is not developed.

17. In a blasting cartridge, the combination with a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, of means for closing said orifice, said orifice closing means comprising two members of the same diameter and having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members supporting the inner member against the pressure in the hollow body and having a very restricted area of reduced support to provide a rupture strength substantially less than said combined overall rupture strength which will cause shearing to occur at said restricted area only to slowly bleed off the vaporized charge at a pressure below the intended work performing pressure.

18. In a blasting cartridge, the combination with a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, of means for closing said orifice, said orifice closing means comprising two members of the same diameter and having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intented work performing pressure in the hollow body, the outer one of said members supporting the inner member against the pressure in the hollow body and having a very restricted area of reduced support to provide a rupture strength substantially less than said combined overall rupture strength, when said members are subjected to an elevated temperature for a prolonged period, so that shearing will occur at said restricted area to slowly bleed off the vaporized charge if the intended work performing pressure is not developed.

19. A blasting cartridge, comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the vaporized charge is released, and means for closing said orifice, said orifice closing means comprising two members having a combined overall rupture strength which will cause both

members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members having an opening of relatively small area, the inner member being of less structural strength than the outer member so that it will shear at the opening in said outer member to release the vaporized charge when said vaporized charge does not attain its intended work performing pressure.

20. A blasting cartridge, comprising a hollow body adapted to receive a charge of liquid carbon dioxide and a chemical heater unit that is burned to effect vaporization of said liquid charge and to raise its pressure to the value at which it is to be released to perform its intended work, said body having a discharge orifice through which the charge is released, and means for closing said orifice, said orifice closing means comprising two disk shaped members having a combined overall rupture strength which will cause both members to shear out of the orifice simultaneously upon the attainment of the intended work performing pressure in the hollow body, the outer one of said members being of greater thickness relative to the inner member and having a plurality of spaced openings of relatively small area, the inner member being of less structural strength than the outer member so that it will shear at the openings in said outer member to release the vaporized charge when said vaporized charge does not attain its intended work performing pressure.

21. In a device of the type described, a fluid charge containing body having a discharge orifice, a disk-shaped metal member closing the discharge orifice of said body, a perforated plate located outwardly of said disk-shaped member, means maintaining said plate and said disk in sealing relation with the discharge orifice, said plate and disk being adapted to shear simultaneously at the discharge orifice upon the attainment of a predetermined pressure in the charge containing body, and said disk being adapted to shear at the perforations of said plate at a pressure below the predetermined pressure.

HILDING V. WILLIAMSON.

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