Oct. 12, 1965 H. C. FOSTER 3,211,095

BLASTING CARTRIDGES

Original Filed Aug. 21, 1959 2 Sheets-Sheet 1

FIG. 1

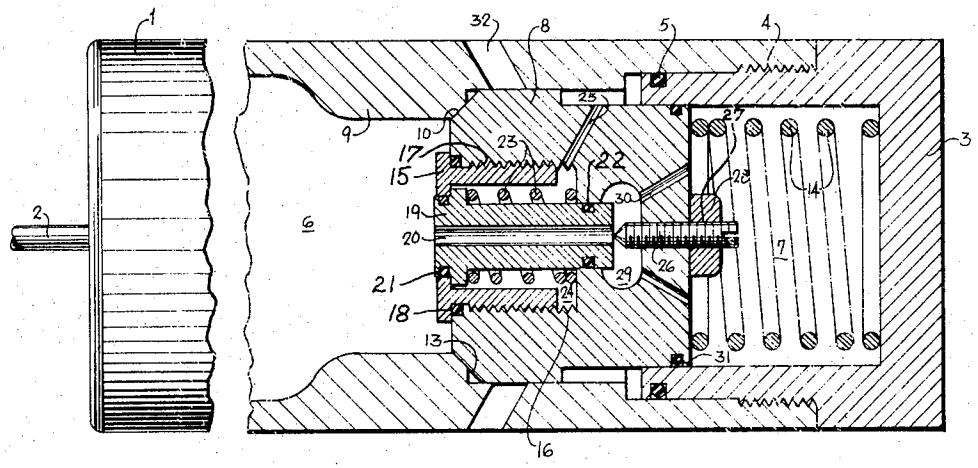
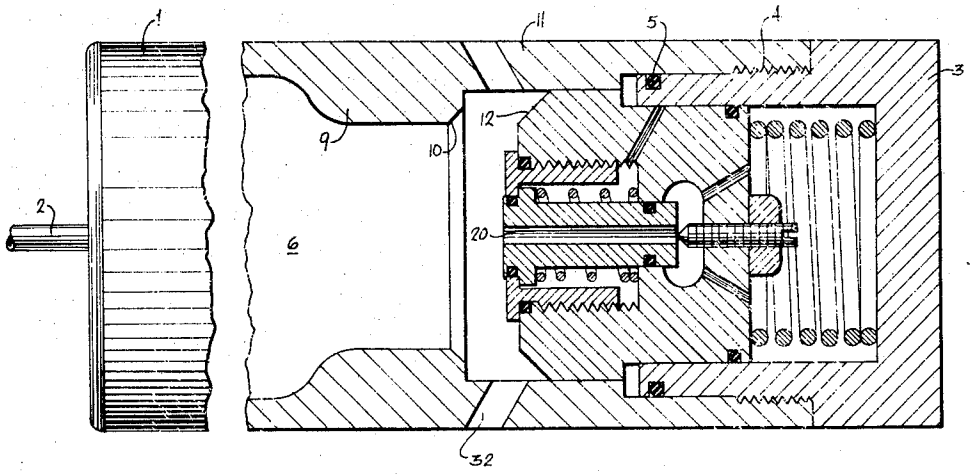


FIG. 2



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FIG. 3

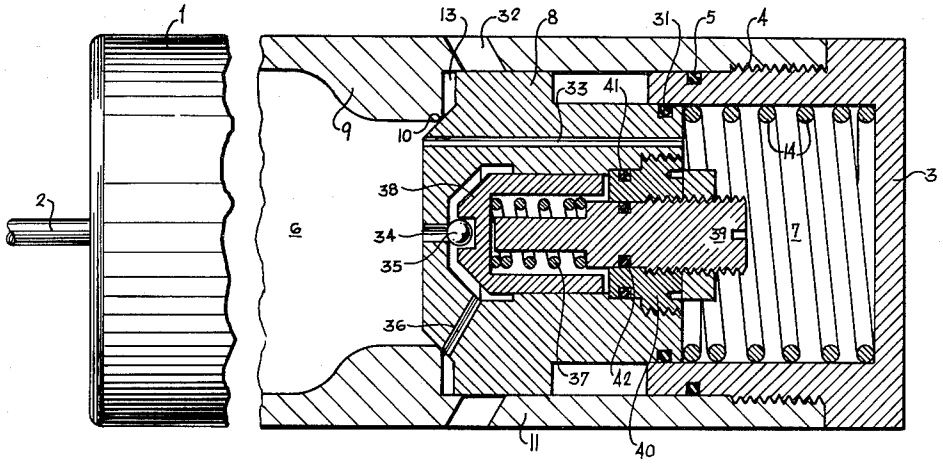
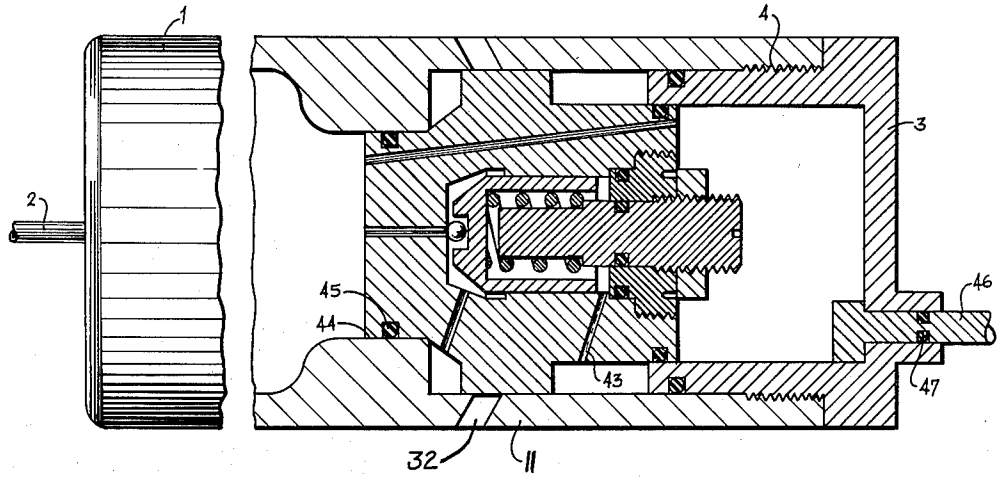


FIG. 4



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United States Patent Office 3,211,095 Patented Oct. 12, 1965

3,211,095

BLASTING CARTRIDGES

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Original application Aug. 21, 1959, Ser. No. 835,267. Divided and this application Nov. 13, 1962, Ser. No. 248,826

6 Claims. (Cl. 102—25)

This is a division of application Serial No. 835,267, now Patent No. 3,087,426.

This invention relates to blasting devices and more particularly to material breaking cartridges utilizing a gas under pressure as the work performing medium.

Material breaking cartridges using compressed gas to execute the required work are well known and widely used in the mining industry. Such cartridges or blasting devices are all reliant upon the sudden release of compressed gas to give a quasi explosive effect. The predecessors of this type of blasting cartridges consisted essentially of a cylindrical gas containing cartridge having venting means. The cartridges were charged with gas under considerable pressure, sealed and then conveyed to the face to be worked. The compressed gas within these cartridges was released by elaborate remote control means. More recently, the practice has been to place an uncharged cartridge in the bore hole and pump gas through a suitable conduit into the cartridge in situ. Conventionally, these cartridges are formed of high strength materials and are provided with a relatively weak member which shears or ruptures so as to liberate the gas from the cartridge body. Since the amount of pressure that can be built up in the cartridge body is dependent upon the strength of the expendable member, the quantity of energy developed by the liberation of the gas can be controlled within relatively close limits. Such cartridges are generally satisfactory but have one serious inherent drawback. After each shot, the discharge end of the cartridge must be dismantled to remove the expendable portion which has ruptured or sheared and to replace it with a new one.

This shortcoming has been well recognized and has led to a concerted effort for the development of automatic shells. While many so-called automatic shells have been presented, they have met with only a modicum of success. The previous types of automatic cartridges are operable, but they are very heavy, complex and unreliable. Although the expendable portions of the shell have been eliminated, this elimination has introduced new and more serious problems. Normally, the known automatic shells rely upon a series of two or more control or pilot valves to initiate the main release valve. Such complexity of design leads to cartridges that are difficult to control and exceedingly difficult to discharge at a desired predetermined pressure. In addition, the great number of moving parts in the automatic shells prior to the advent of the present invention has confronted the industry with a formidable sealing problem.

Therefore, it is an object of this invention to provide new and improved automatic or semi-automatic material breaking devices utilizing compressed gas. A further object is to provide a device of this character having novel gas release means. Another object of this invention is to provide a simplified automatic or semi-automatic shell overcoming the disadvantages of the prior art.

The manner in which these and other objects are achieved will be apparent from the following specification together with the drawing in which:

FIGURE 1 is a longitudinal sectional view of a device illustrating a preferred embodiment of the present invention;

FIGURE 2 is a longitudinal sectional view of the device of FIGURE 1 in an open position;

FIGURE 3 is a longitudinal sectional view of a device illustrating another embodiment of the present invention; and

FIGURE 4 is a longitudinal sectional view of a modification of the device shown in FIGURE 3.

The same numbers are used throughout the drawing to identify similar components.

Referring to FIGURE 1 which illustrates a preferred embodiment of the invention, an elongated tubular body formed of metal of a strength to contain gas under high pressures, for example, pressures from 6,000 to 20,000 pounds per square inch, is indicated generally at 1. Only a portion of this tubular body, which may be of the order of 50 inches or more in length, is shown. Suitable means, such as a compressed air line 2, are provided at one end of the cartridge body for introducing compressed gas into it. The outer diameter of the body is such that it may be set freely within a bore drilled in the face of the material, such as coal, to be mined and broken down. The end of the body remote from the gas inlet is closed with an end cap 3. The body and the end cap are screw threadedly attached as shown at 4. The seal between the tubular body and the end cap is completed by an annular resilient sealing means 5. The interior of the cylindrical body is divided into a main chamber 6 and a secondary chamber 7 by main valve 8, which is slidable therebetween.

That portion of the main chamber in proximity to the main valve 8 is of a slightly smaller diameter than the remainder of the main chamber due to the presence of constriction 9, one end of which forms a conical valve seat 10. As particularly well shown in FIGURE 2, that portion of the constriction between the valve seat 10 and the wall 11 is substantially perpendicular to the interior wall. This configuration of the face of the constriction and beveled surface 12 on the main valve cooperate to form an annular sealed chamber 13 between the valve and the constriction. The main valve 8 is normally urged into seating position with the valve seat 10 by helical spring 14 in secondary chamber 7. Any suitable means can be employed to replace or augment this action of the spring 14.

Main valve 8 carries tubular fixture 15 in a central bore 16. The fixture is screw threadedly attached to the main valve as indicated at 17 and the seal between these two members is completed by resilient sealing means such as an O-ring 18. A control piston 19 provided with an orifice 20 therethrough is slidable within fixture 15 and main valve 8. The piston is slidably sealed to these members by O-rings 21 and 22. Helical spring 23, positioned about the control piston, normally urges it in a direction toward the main chamber 6. The space 24 about the external periphery of the control piston 19 is vented to the atmosphere through passageway or vent 25. Valve member 26 is screw threadedly affixed to the main valve 8, as shown at 27, and secured in position by lock nut 28. It will be noted that orifice 20 in the control piston 19 provides a communication between main chambers 6 and secondary chamber 7 through area 29 at the base of the piston and a plurality of passageways 30. A sliding seal between end cap 3 and main valve 8 is provided by O-ring 31.

By reference to the drawing, it will be noted that the effective area of the main valve 8 defining one end of secondary chamber 7 is greater than the effective area of the main valve forming an end of main chamber 6. Thus, when the gas pressure is equal on both sides of the main valve, the valve is urged into sealing position with valve seat 10 and spans ports 32. Likewise, the effective area of control piston 19 subject to the gas pres-

sure in main chamber 6 is greater than the effective area of the control piston exposed to the gas pressure in secondary chamber 7. Thus, when the equalizing pressures in chambers 6 and 7 are increased, control piston 19 is urged toward seating arrangement with valve member 26, in opposition to the action of helical spring 23.

In operation, compressed air or other suitable gas is introduced into main chamber 6 through gas inlet 2. The air passes through orifice 20, area 29 and passageways 30 into the secondary chamber. Thus, the pressure on either side of the main valve 8 is substantially equalized. However, because of the greater effective cross sectional area of valve 8 in the secondary chamber than in the main chamber, the valve is urged into sealing relationship with valve seat 10 and maintains discharge ports 32 in a closed position. Since this action, due to the differential effective area of the valve increases with increased pressure, the seal between the main valve 8 and valve seat 10 increases progressively as pressure builds up within the cartridge.

As the gas pressure is increased within the cartridge, control piston 19 is forced toward valve member 26. This action continues until the orifice is completely closed at a pressure that can be predetermined by the ratio of the differential areas of piston 19 and also by the force exerted by helical spring 23. In this way, secondary chamber 7 is effectively sealed from main chamber 6 to a predetermined pressure less than the discharge pressure of the cartridge.

After the secondary chamber 7 is thus sealed by cooperation of control piston 19 and valve member 26, the pressure in the main chamber and on the smaller effective cross sectional area of the main valve increases until the force overcomes that of the lower pressure on the larger area of the control valve in the secondary chamber. At this point, the main valve is unseated. As soon as the main valve unseats slightly, the pressure in the main chamber is applied to that portion 12 of the valve in the annular sealed chamber 13. Thus, the effective cross-sectional area of the valve in the main chamber is suddenly increased and the main valve 8 is forced back exposing lateral ports 32. The charge of compressed gas in main chamber 6 is thus completely and instantaneously released to the surrounding work face which is to be broken down.

The control piston 19 opens practically simultaneously with any appreciable movement of the main valve 8. This opening is due in part to compression within secondary chamber 7 and also to a pressure drop in the main chamber 6. When the charge of air leaves main chamber 6 reducing the pressure therein, main valve 8 is returned to its original position by helical spring 14 or any other suitable means.

In the embodiments shown in FIGURES 3 and 4, the configuration of the chambers and the main valve member is substantially the same as that illustrated in FIGURE 1. These embodiments differ from that of FIGURE 1 only in the employment of a somewhat different type of control valve means carried by main valve 8. In these embodiments, permanent communication between main chamber 6 and secondary chamber 7 is provided by one or more passageways 33 through the main valve 8. Thus, the pressures in these chambers are maintained substantially equal throughout the operation of the cartridge. The main valve 8 is provided with an orifice 34 which communicates with the annular sealed chamber 13 through one or more passageways 36. The orifice 34 is normally closed by a self-centering ball type valve 35 which is urged into sealing position with the orifice by helical spring 37 transmitting its force through valve seat member 38. The control valve members are adjustably maintained in position by set screw 39 and fixture 40 which are screw threadedly connected to the main valve and sealed thereto with O-rings 41 and 42. Any pressure build up in the area about the spring and under the valve seat member which would prevent proper functioning of the control valve is avoided by vent 43, shown in FIGURE 4, which communicates with the atmosphere through port 32.

In the operation of the embodiment of FIGURES 3 and 4, the pressure on both sides of the main valve 8 is maintained substantially equal because of passageways 33 therethrough. However, the force on the side of the valve facing the secondary chamber 7 is greater than that on the side facing the main chamber because the valve has a greater effective cross sectional area in the secondary chamber than in the main chamber. Thus, the seal between the valve and the valve seat 10 increases as pressure within the cartridge builds up. Thus, the escape of gas prior to reaching the discharge pressure of the cartridge is effectively eliminated. When the discharge pressure is approached, the pressure in the main chamber acting on ball valve 35 forces it downward toward the secondary chamber 7. In this way, the pressure in the main chamber is transmitted to the annular sealed chamber 13 through orifice 34 and passageways 36. Since the effective cross-sectional area of the main valve exposed to the pressure in the main chamber is thus abruptly increased to a value greater than the cross-sectional area of the valve in the secondary chamber, the main valve is suddenly forced away from the lateral ports 32 and the charge of compressed gas in the main chamber 6 is effectively and substantially instantaneously released to the surrounding work surface. After the cartridge has been discharged, the main valve is returned to its original position by helical spring 14 and the cartridge is again in condition for charging.

The embodiment shown in FIGURE 4 is substantially the same as that illustrated in FIGURE 3 but differs therefrom in two main respects. That portion of the main valve 8 in contact with the constriction 9 is extended so as to form a sliding fit, as indicated at 44 with the internal surface of the constriction. The seal between the main valve and the constriction in this embodiment is completed by an annular resilient sealing means, such as an O-ring 45. Also, helical spring 14 has been replaced with a manual reset plunger 46 slidable in the end cap 3 and sealed thereto by means of O-ring 47. Thus, in accordance with this embodiment, the cartridge is semi-automatic instead of automatic, and the seal between the main valve 8 and the main chamber 6 is of the sliding type rather than the conical seat type. While these modifications have been described with particular reference to FIGURES 3 and 4, it will be readily appreciated that they can be readily incorporated into the embodiment of FIGURE 1. Also, the helical spring and reset plunger can be employed in the same cartridge or can be replaced by other equivalent means which will return the main valve into a closed position.

Although the invention has been described in considerable detail in the foregoing for the purposes of illustration, it is to be understood that such detail is solely for that purpose and that many modifications can be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A reusable blasting cartridge comprising a substantially cylindrical housing having a main chamber for containing a charge of compressed gas, means at one end for introducing gas under pressure, an enclosed secondary chamber, a lateral outlet intermediate the ends of the housing, a pressure responsive main valve having a body slidable in said housing between the main chamber and the secondary chamber and normally positioned to span and seal said outlet, a passageway through the valve body interconnecting the chambers, an internal annular restriction in the housing adjacent the lateral outlet and positioned between the outlet and the gas inlet, said valve body having a greater diameter than the internal diameter of the constriction and a narrowed forward portion adapted for seating on the restriction in said main cham-

ber, said narrowed forward portion forming with said housing an annular obturated chamber between the restriction and the main valve body, the narrowed forward portion of the valve body facing the main chamber having an effective area less than the effective area of the valve body in the secondary chamber, while the sum of the effective areas of the narrowed portion of the valve body and that portion of the valve body within the obturated annular chamber is greater than the effective area of the valve body in the secondary chamber, a control valve within the main valve body, said control valve being solely responsive to pressure within the main chamber, a vent within the narrowed forward portion of said main valve body extending between the main chamber and the annular sealed chamber normally closed by the control valve and means in the secondary chamber for returning the main valve to a position spanning the lateral outlet.

2. A cartridge comprising a substantially cylindrical housing having a main chamber for containing a charge of compressed gas, inlet means at one end of said housing adapted to introduce gas under pressure to said main chamber, a lateral outlet intermediate the ends of said housing, an internal annular constriction in said housing adjacent the outlet and positioned between the outlet and the inlet means, a pressure responsive main valve slidably mounted in said housing and normally positioned to seat on said constriction and to seal said outlet, an enclosed secondary chamber in said housing, said main valve having a first end forming an end facing said main chamber including a first portion of said main chamber and a second end forming an end of said secondary chamber, a sealed annular chamber formed in said housing between said constriction and a second portion of said first end of the main valve, said second portion of the cross-sectional area of said first end being normally enclosed in said annular chamber so that it is not affected by the pressure in said housing during charging of said cartridge, said first portion of the cross-sectional area of said first end being exposed to the charging pressure in said housing, the total cross-sectional area at said first end of said valve being greater than the total cross-sectional area at said second end of said valve, said second end of said valve having a greater cross-sectional area exposed to the charging pressure in the housing than said first portion of the first end of said valve, a passageway in said main valve for equalizing the pressure in said main chamber and means including said secondary chamber, and control valve means mounted in said main valve operative to open said sealed annular chamber to the charging pressure in the main chamber at a predetermined discharge pressure and in said main chamber whereby to expose said second portion to the pressure in said main chamber and open said lateral outlet.

3. A cartridge comprising a substantially cylindrical housing having a main chamber for containing a charge of compressed gas, inlet means at one end of said housing adapted for the introduction of gas under pressure to said main chamber, a lateral outlet intermediate the ends of said housing, an internal annular constriction in said housing adjacent the outlet and positioned between the outlet and the inlet means, a pressure responsive main valve slidably mounted in said housing and normally positioned to seat on said constriction and to seal said outlet, an enclosed secondary chamber in said housing, said main valve having a first end forming an end of said main chamber and a second end forming an end of said secondary chamber, said first end including a narrowed forward portion having a cross-sectional area exposed to the pressure in said main chamber less than the cross sectional area of said second end, a sealed annular chamber formed in said housing by said constriction and said narrowed forward portion, said first end including a second portion normally enclosed in said annular chamber and not affected by the pressure in said housing during charging of said cartridge, the total cross-sectional area at said first end of said valve being greater than the total cross-sectional area at said second end of said valve, a first passageway in said main valve equalizing the pressure in said main chamber and said secondary chamber whereby said second end of said main valve has a greater cross-sectional area exposed to the pressure in the housing during charging of the cartridge than said first end of said valve, a second passageway in said narrowed forward portion of the main valve interconnecting said main chamber with said sealed annular chamber, spring biased control valve means mounted in said main valve and normally closing said second passageway, said control valve means being operative at a predetermined pressure within said main chamber to open said second passageway to allow the charging pressure of said main chamber to enter said sealed annular chamber thereby greatly increasing the area at said first end of said main valve exposed to the charging pressure in said housing.

4. The cartridge of claim 3 further including spring means in the secondary chamber for normally constantly biasing the main valve to a position spanning the lateral outlet, said spring means exerting less pressure on the main valve than is exerted on said control valve means.

5. The cartridge of claim 3 further including a manually slidable plunger arranged in said secondary chamber for returning the main valve to a position spanning the lateral outlet.

6. The cartridge of claim 3 wherein said main valve has a chamber therein for containing said spring biased control valve means and further including a third passageway in said main valve adapted to connect the portion of said last-mentioned chamber on the side of said control valve means opposite said second passageway with the atmosphere.

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