

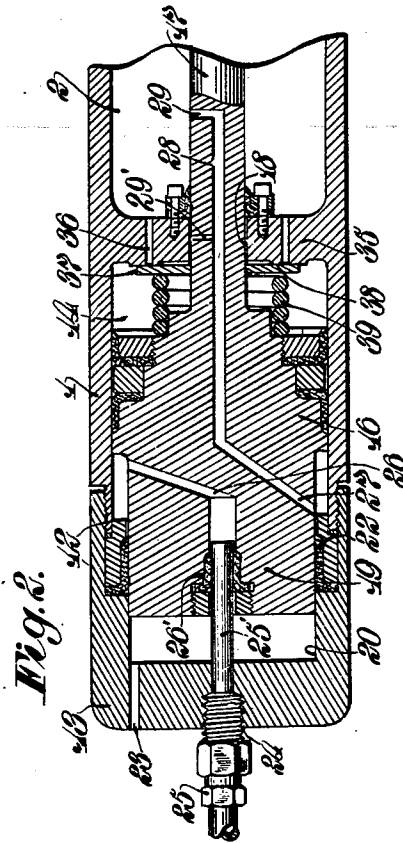
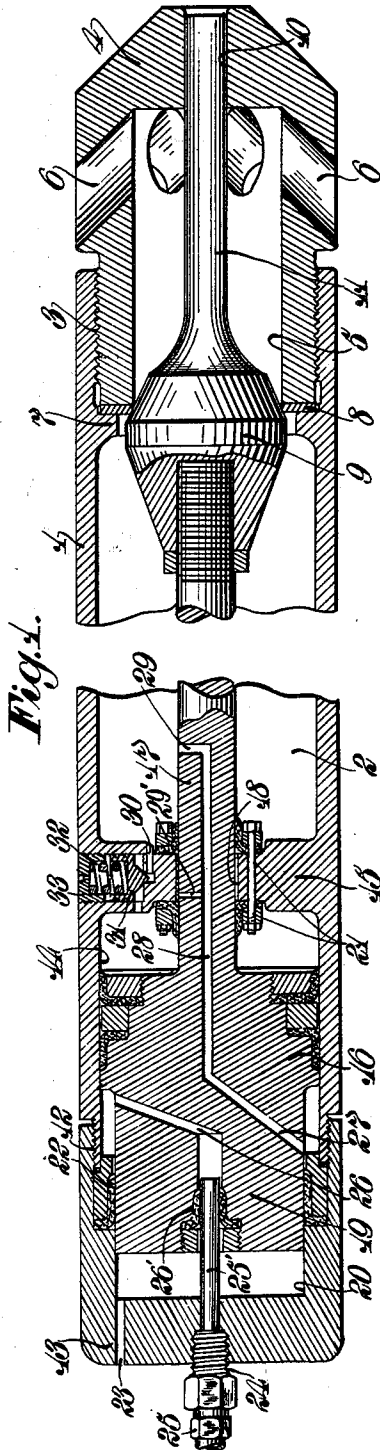
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MATERIAL BREAKING METHOD AND APPARATUS

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MATERIAL BREAKING METHOD AND APPARATUS

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This invention relates to material-breaking methods and apparatus, and more particularly to improvements in a material-breaking shell of the type wherein a highly compressed gas is employed as a blasting medium and to a method of air thereof.

From one aspect, my invention comprises an improved material breaking apparatus having provision for the storage of a relatively large quantity of highly compressed gaseous fluid, and upon the attainment of a predetermined pressure in the storage space providing for the passage of fluid at the high pressure into a space wherein it acts upon an area of such size that pressures theretofore acting to maintain a charge-release valve closed are overcome, and the charge release valve automatically moved to open position. To preclude a repetition of the cycle described, further flow of fluid to the apparatus may be interrupted by the attendant, or obviously, the apparatus may take such a form that by the movement of the valve to charge releasing position, communication between the source of high pressure and the working spaces of the shell may be interrupted. Again, automatic means for stopping the compressor and connecting the discharge line thereof to the atmosphere may be used and made responsive to the charging line pressure, which will build up when flow to the cartridge is interrupted as hereinafter described. From another aspect, the invention comprises an improved method of fracturing material including the steps of building up a charge of highly compressed gas in an appropriately positioned receptacle and in response to pressure conditions in the charge receiving receptacle automatically effecting a release of the stored charge to a desired point of use and substantially simultaneous cutting off of supply, without operator intervention. Other aspects of the invention will hereinafter appear from the specification, and as pointed out in the claims.

An object of this invention is to provide an improved material-breaking apparatus. Another object is to provide an improved material-breaking shell of the high pressure gas type having embodied therein improved release means for the charge of material-breaking pressure. A further object is to provide an improved material-breaking shell having improved differential valve means for releasing the charge of material-breaking pressure when a predetermined pressure is attained within the shell, the release means acting automatically upon attainment of such pre-

determined pressure to effect automatically such release. Yet another object is to provide in a gas shell of the above character improved means for automatically cutting off the flow of gas to the pressure chamber when release of the material-breaking charge from the shell is effected. Still another object is to provide an improved material-breaking method. These and other objects will, however, subsequently more fully appear.

In the accompanying drawing there are shown for purposes of illustration two forms which the invention may assume in practice.

In this drawing,—

Fig. 1 is a view in longitudinal section of one illustrative embodiment of the improved material-breaking apparatus,

Fig. 2 is a fragmentary view taken in the plane of Fig. 1, showing a modified form of construction.

In Fig. 1 of the drawing there is shown a material-breaking shell of the type wherein a high-pressure gas, such as highly compressed air, is employed as a material-breaking medium, comprising a tubular casing 1 having a chamber 2 for receiving a charge of high pressure gas. Threadedly secured at 3 within the inner end of the casing is a discharge cap 4 having an axial discharge orifice 5 communicable with the pressure chamber 2 and connected by a series of radial discharge ports 6 with the shell exterior. Secured between the discharge cap and an internal annular flange 7 formed on the shell is a washer 8 providing a valve seat for a control valve 9. Formed integral with the valve 9 and guided at 10 in an axial bore formed in the discharge cap is a valve guide stem 11 for centering the valve with respect to its seat. Threadedly secured at 12 to the outer end of the casing 1, is a terminal cap 13, while formed in the outer portion of the casing in alignment with the pressure chamber 2 is a control chamber 14, the chambers 2 and 14 being separated by a transverse partition 15 on the casing. Reciprocable in the control chamber 14 is a piston 16 carrying suitable cap packings and having a piston rod 17 extending inwardly through an opening 18 in the partition 15, and secured at its inner extremity to the control valve 9. Formed integral with the piston 16 is a rearward extension 19 of larger cross sectional area than the valve head 9, guided in a bore 20 formed in the terminal cap 13. Carried by the partition 15 are suitable packings 21 for preventing leakage of high pressure gas along the valve rod 17 between the chambers 2 and 14, while a suitable

packing 22 is provided within the terminal cap 13 for sealing the exterior periphery of the guide projection 19 to prevent leakage of high pressure gas from the portion of the control chamber 14 outside the piston 16 past the guide extension. The bore 20 at the outer side of the guide projection 19 is vented to atmosphere through a vent passage 23 while connected at 24 to the terminal cap 13 is a supply pipe connection 25 leading to a suitable source of high pressure gas supply, the pipe 25 communicating through a stationary connection 25' and connection 26 in the piston portion 19 with the control chamber 14 at the outer side of the piston 16. A suitable packing 26' in piston portion 19 prevents leakage outwardly along the stationary connection 25'. Communicating with the control chamber 14 at the outer side of the piston 16 and formed in the latter is a passage 27 connected by an axial passage 28 formed in the valve rod with a radial passage 29 communicating with the pressure chamber 2. One or more passages 30, formed in the partition 15, and each controlled by a spring pressed check valve 31, are provided to connect, when desired, chamber 2 with the control chamber 14 at the inner side of the piston 16. The spring 32 of each check valve 31 is provided with a suitable adjustable follower 33 accessible from the shell exterior for varying the tension of the spring.

In the modified form of construction shown in Fig. 2 the shell structure is substantially as that shown in Fig. 1, except in this instance the spring pressed check valves in the casing partition are omitted. The partition 35 which divides the pressure chamber 2 from the control chamber 14 is in this instance provided with a series of longitudinal passages 36 controlled by a disc valve 37 surrounding the valve control rod 17 and seating against the plane face 38 of the partition. Interposed between the piston 16 and this valve, and likewise surrounding the valve control rod 17, is a coiled spring 39. Otherwise this form of the improved material-breaking shell is generally similar to that above described.

The method of use of the improved material-breaking shell will be clearly apparent from the description given. In Fig. 1 the piston and valve assembly is shown in its innermost closed position with the control valve 9 seating on the washer 8 to close communication of the discharge passage with the pressure chamber 2. Let it be assumed that the shell is properly positioned in the material to be broken down and high pressure gas is flowing through pipe connection 25 and passage 26 to the control chamber 14, the gas acting on the outer pressure area of the control piston 16 to hold the valve 9 tightly against its seat. At this same time pressure fluid flows through passages 27, 28, 29 to the main pressure chamber 2, and its action on valve 9 aids in maintaining the latter closed. When a pressure of the desired value is attained within the pressure chamber 2 (the critical pressure depends upon the tension of the check valve spring or spring 32), the check valves 31 automatically open to admit pressure fluid from the pressure chamber 2 through the passages 30 to the control chamber 14 at the inner side of the control piston 16. As the pressure area on the inner side of the control piston 16 is materially greater than the sum of the pressure areas on the outer side thereof and on the valve 9, the pressure acting on the inner side of the piston effects movement of the piston 16 to the left as viewed in Fig. 1, thereby moving the pressure

release valve 9 into its open position, and as a result the charge of material-breaking pressure is released from the chamber 2 through discharge orifice 5 and discharge ports 6 into the material to be broken down. As the control piston 16 moves rearwardly the radial passage 27 moves within the bore 20, thereby cutting off the supply of high pressure gas from the control chamber 14 at the outer side of the piston 16 to the pressure chamber 2. Recycling will be prevented in any suitable way, as by stopping the compressor, automatically or by the operator; and if the passage 29', which is desirably provided to permit more rapid reuse, be omitted, no recycling would be possible until the pressure in the space at the right of piston 16 is reduced, as could be done by a suitable bleed valve, or as would take place in time due to leakage.

The mode of operation of the form of the invention shown in Fig. 2 is similar to that above described. In this instance, however, when a predetermined pressure is attained within the pressure chamber 2 the disc valve 37 automatically opens against the tension of the coiled spring 39, thereby admitting high pressure gas from the chamber 2 through the passages 36 to the chamber 14 at the inner side of the control piston 16. In this construction as the control piston 16 moves outwardly to effect opening of the valve 9, the tension of the spring 39 is suddenly decreased, thereby permitting wide-opening of the disc valve 37. Otherwise, this form of the invention operates in a manner generally similar to that above described.

As a result of this invention it will be noted that an improved material-breaking shell is provided having improved control means for the pressure release means, whereby when a predetermined pressure is attained within the shell chamber the release means is automatically moved into its open position thereby to release suddenly the charge of material-breaking pressure from the shell chamber. It will further be noted that by the provision of the improved control means release of the material-breaking pressure from the shell is not only automatically effected upon the attainment of a predetermined pressure, but the supply of high pressure gas flowing to the shell chamber is also automatically shut off. It is accordingly evident that charging of the shell chamber, pressure release, and the cutting off of the pressure flow occur in a continuous sequence from the introduction of high pressure gas to the supply connection 25 through the release of material-breaking charge without any manual intervention. It will further be evident that by the provision of the adjusting means for the check valves it is possible to vary the maximum pressure within the pressure chamber as desired. These and other uses and advantages of the improved material-breaking shell will be clearly apparent to those skilled in the art.

While I have in this application specifically described two forms which my invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration, and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. A material-breaking shell having a chamber for receiving a charge the pressure of which is to

be built up to a desired material-breaking pressure, a valve for controlling the discharge of pressure from the shell chamber, means for opening the valve and means automatically operative upon the attainment of a predetermined pressure within the shell chamber for causing said first mentioned means to operate to open the valve.

2. A material-breaking shell having a chamber for receiving a charge at material-breaking pressure, a valve controlling the discharge of pressure from said shell chamber, means for supplying pressure to said chamber, means automatically operative upon the attainment of a predetermined pressure within the shell chamber for effecting automatic opening of said valve, and means automatically operative when said valve is in open position for cutting off the supply of pressure to said shell chamber.

3. A material-breaking shell having a chamber for receiving a charge the pressure of which is to be built up to a desired material-breaking pressure, a valve for controlling the discharge of pressure from said chamber, a piston for controlling said valve, and means automatically operative upon the attainment of a predetermined pressure within said shell chamber for admitting pressure from said pressure chamber to act on a pressure area of said piston to effect opening of said valve.

4. A material-breaking shell having a chamber for receiving a charge at material-breaking pressure, a valve for controlling the discharge of pressure from said chamber, a piston for controlling said valve, means for supplying pressure to said pressure chamber, means automatically operative when a predetermined pressure is attained within said chamber for supplying pressure fluid from said pressure chamber to act on a pressure area of said piston to effect opening of said valve, and means automatically operative when said valve is moved by said piston into its wide open position for cutting off the supply of pressure to said pressure chamber.

5. A material-breaking shell having a chamber for receiving a charge the pressure of which is to be built up to a desired material-breaking pressure and a control chamber, a valve for controlling the release of pressure from said pressure chamber, a piston reciprocable in said control chamber and having a piston rod connected to said valve, and means automatically operative upon the attainment of a predetermined pressure within said pressure chamber for admitting pressure from said pressure chamber to said control chamber to act on a pressure area of said piston to effect movement of said valve into its open position.

6. A material-breaking shell having a chamber for receiving a charge at material-breaking pressure and a control chamber, a valve for controlling the release of pressure from said pressure chamber, a piston reciprocable in said control chamber and having a piston rod connected to said valve, means for supplying pressure to said pressure chamber, and means automatically operative upon the attainment of a predetermined pressure within said pressure chamber for admitting pressure from said pressure chamber to said control chamber to act on a pressure area of said piston to effect movement of said valve into its open position, said automatic means being adjustable at will for varying the maximum pressure attainable within the pressure chamber.

7. A material-breaking shell having a chamber for receiving a charge at material-breaking pres-

sure and a control chamber, a valve for controlling the discharge of pressure from said pressure chamber, a piston reciprocable in said control chamber and having its piston rod connected to said valve, means including a passage formed in said piston and piston rod for supplying pressure from said control chamber at one side of said piston to said pressure chamber, and means automatically operative upon attainment of a predetermined pressure in said pressure chamber for admitting pressure from said pressure chamber to said control chamber at the opposite side of said piston to effect movement of said valve to its open position.

8. A material-breaking shell having a chamber for receiving a charge at material-breaking pressure and a control chamber, a valve for controlling the discharge of pressure from said pressure chamber, a piston reciprocable in said control chamber and having its piston rod connected to said valve, means including a passage formed in said piston and piston rod for supplying pressure from said control chamber at one side of said piston to said pressure chamber, means automatically operative upon attainment of a predetermined pressure in said chamber for admitting pressure from said pressure chamber to said control chamber at the opposite side of said piston to effect movement of said valve to its open position, and means automatically operative when said valve is moved to its open position for cutting off the supply of pressure fluid through said passage to said pressure chamber.

9. A material-breaking shell having a chamber for receiving a charge at material-breaking pressure and a control chamber, a valve for controlling the release of pressure from said chamber, a cap forming a closure for one end of said control chamber and having an axial bore, a piston reciprocable in said control chamber and having a rearward extension guided in said cap bore, a partition separating said control chamber from said pressure chamber, a piston rod secured to said piston and extending through a packed opening in said partition into connection with said valve, means for supplying pressure to said control chamber at the outer side of said piston, a passage formed in said piston and piston rod for supplying pressure fluid from said control chamber at the outer side of said piston to said pressure chamber, and valve means adapted to open automatically upon the attainment at a predetermined pressure within said pressure chamber for admitting pressure from said pressure chamber to said control chamber at the inner side of said piston to effect movement of said valve into its open position.

10. A material-breaking shell having a chamber for receiving a charge at material-breaking pressure and a control chamber, a valve for controlling the release of pressure from said chamber, a cap forming a closure for one end of said control chamber and having an axial bore, a piston reciprocable in said control chamber and having a rearward extension guided in said cap bore, a partition separating said control chamber from said pressure chamber, a piston rod secured to said piston and extending through a packed opening in said partition into connection with said valve, means for supplying pressure to said control chamber at the outer side of said piston, a passage formed in said piston and piston rod for supplying pressure fluid from said control chamber at the outer side of said piston to said pressure chamber, and valve means adapted to

open automatically upon the attainment of a predetermined pressure within said pressure chamber for admitting pressure from said pressure chamber to said control chamber at the inner side of said piston to effect movement of said valve into its open position, said passage formed in said piston and piston rod closing automatically to cut off the supply of pressure fluid to said pressure chamber when said valve is moved into its open position.

11. A material-breaking shell having a chamber for receiving a charge at material-breaking pressure and a control chamber, a valve for controlling the release of pressure from said chamber, a cap forming a closure for one end of said control chamber and having an axial bore, a piston reciprocable in said control chamber and having a rearward extension guided in said cap bore, a partition separating said control chamber from said pressure chamber, a piston rod secured to said piston and extending through a packed opening in said partition into connection with said valve, means for supplying pressure to said control chamber at the outer side of said piston, a passage formed in said piston and piston rod for supplying pressure fluid from said control chamber at the outer side of said piston to said pressure chamber, and valve means adapted to open automatically upon the attainment of a predetermined pressure within said pressure chamber for admitting pressure from said pressure chamber to said control chamber at the inner side of said piston to effect movement of said valve into its open position, said valve means being adjustable at will for varying the maximum pressure attainable within said pressure chamber.

12. A material-breaking shell having a chamber for receiving a charge the pressure of which is to be built up to a desired material-breaking pressure, a valve for controlling the discharge of pressure from the shell chamber, means for opening said valve and charge actuated means remote from said valve automatically operative upon the attainment of a predetermined pressure within the shell chamber for effecting operation of said first mentioned means.

13. A method of blasting which comprises building up, from an external source, a charge of gas at a desired pressure capable of performing the intended work, in a container located in material to be broken, liberating the charge upon attainment of the desired pressure, and causing liberation of the charge to concurrently effect disconnection of the interior of the container from the source while maintaining a physical connection between the source and container.

14. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber when the desired pressure is reached in the chamber, and means operable as a result of operation of the charge releasing means for discontinuing feeding of the charge.

15. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber, means for operating the charge releasing means when the desired pressure in the chamber is reached, and means for discontinuing feeding of the charge as a result of actuation of the means for operating the charge releasing means.

16. A material breaking shell having a chamber for receiving a charge at material breaking pres-

sure, means for feeding a charge to the chamber, means for releasing the charge from the chamber when the desired pressure is reached in the chamber, means for varying the pressure at which the same charge releasing means will operate to effect charge release, and means operable as a result of operation of the charge releasing means for discontinuing the feeding of the charge.

17. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber, means for operating the charge releasing means when the desired pressure in the chamber is reached, means for varying the pressure at which the same charge releasing means will operate to effect charge release, and means for discontinuing feeding of the charge as a result of actuation of the means for operating the charge releasing means.

18. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber, means for operating the charge releasing means when the desired pressure in the chamber is reached, means for rendering said operating means inoperative after release of the charge, and means for discontinuing feeding of the charge as a result of actuation of the means for operating the charge releasing means.

19. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber, means for operating the charge releasing means when the desired pressure in the chamber is reached, means for rendering said operating means inoperative after release of the charge, means for varying the pressure at which the charge is released, and means for discontinuing feeding of the charge as a result of actuation of the means for operating the charge releasing means.

20. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber, and means operated by the pressure of the charge in the chamber for actuating the charge releasing means and for discontinuing the feeding of the charge.

21. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber, means for actuating the charge releasing means, means for rendering said actuating means operative when the desired pressure is reached in the chamber, and means for discontinuing the feeding of the charge to the chamber when the charge is released.

22. A material breaking shell having a chamber for receiving a charge at material breaking pressure, means for feeding a charge to the chamber, means for releasing the charge from the chamber, means for actuating the charge releasing means, means for rendering said actuating means operative when the desired pressure is reached in the chamber, means for varying the pressure at which the charge is released, and means for discontinuing the feeding of the charge to the chamber when the charge is released.

23. In combination, a blasting cartridge having a chamber for receiving a blasting charge

the pressure of which is to be built up to the desired blasting pressure, release means for the blasting charge held closed by the pressure of the charge, and means located outside said chamber and operable upon the attainment of a predetermined pressure in said chamber for opening said release means to discharge the charge.

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24. In combination, a blasting cartridge having a chamber for receiving a blasting charge the pressure of which is to be built up to the desired blasting pressure, release means for the blasting charge held closed by the pressure of said charge, and means located outside said chamber and operated by the pressure of the

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chamber charge when said pressure reaches a predetermined value for opening said release means.

25. In combination, a blasting cartridge having a chamber for receiving a blasting charge the pressure of which is to be built up to the desired blasting pressure, a valve controlling discharge of the blasting charge from said chamber, and means located entirely outside of said chamber and operable upon the attainment of a predetermined pressure in said chamber for opening said valve to discharge said charge.

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