

June 15, 1937.

R. W. DULL

2,083,696

BLASTING METHOD AND APPARATUS

Filed June 17, 1933

Fig. 1

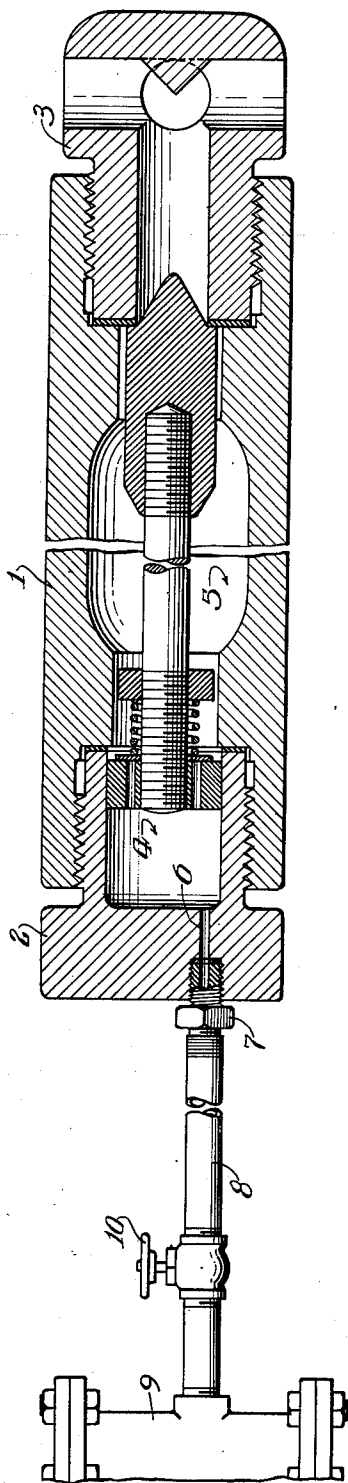
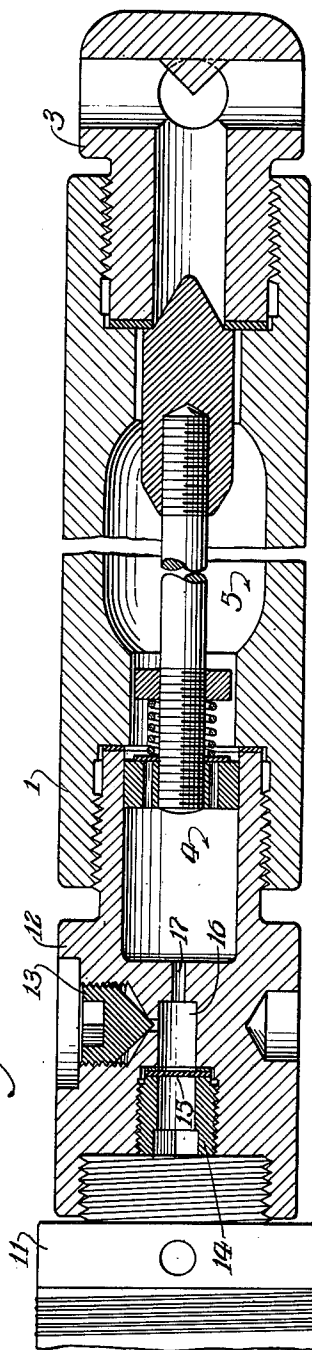


Fig. 2



Inventor
Raymond W. Dull
By Allyn Harris Atty.

UNITED STATES PATENT OFFICE

2,083,696

BLASTING METHOD AND APPARATUS

Raymond W. Dull, La Grange, Ill., assignor to
Safety Mining Company, a corporation of
Illinois

Application June 17, 1933, Serial No. 676,227

20 Claims. (Cl. 102—5)

This invention relates to a new method of applying energy in the breaking down of coal or in the performance of any analogous class of work and to a type of apparatus designed to carry out the new method.

In a pending application filed in my name under date of May 27th, 1933 Serial Number 673,146 there is disclosed a method of breaking down coal by means of controlled pressures and in particular an apparatus consisting of a substantially indestructible cartridge adapted to be positioned in a drill hole in the coal to be broken and to receive a charge of high pressure air while so positioned in the drill hole, said cartridge also having therein a differential valve designed to effect the release of the charge of high pressure air through a suitable discharge arrangement provided on one end of the cartridge. According to this pending application the charge of high pressure air is introduced into the cartridge by means of a suitable pipe or high pressure hose extending from the cartridge to a remote point where it has connection with a suitable source of high pressure air which may be in the form of an air receiver or a compressor, and the discharge of the cartridge is effected by means of a valve positioned in the pipe or hose line, said valve being designed to stop the flow of high pressure air from the source and to vent to the atmosphere the section of pipe or tubing extending from the valve to the cartridge. The sudden drop in pressure caused by venting the pipe and of a portion of the cartridge in communication therewith serves to bring about the operation of the differential valve, thus permitting the entire charge of high pressure air to escape from the cartridge in an instantaneous manner.

While the discharging action of the cartridge covered in the pending application as disclosed above is quite satisfactory and corresponds with the standard practice of subjecting the coal to a single discharge of a considerable volume of energy, experimentation has developed that certain important advantages may be obtained by dividing the normal volume of discharged energy into a rapid succession of distinct discharges. It has been found possible to accomplish this desirable result by a simple modification of the cartridge described in the aforementioned application, which modification together with the newly developed method constitute the principal subject matter of the present application.

The primary object of the invention is to pro-

vide a method whereby the application of any given quantity of energy may be applied to the work to be accomplished in a succession of distinct releases, and with the provision of an apparatus suitable for the practice of this method.

Referring to the drawing Figure 1 is a view in longitudinal section illustrating a typical form of apparatus according to the present invention. Figure 2 is a view in longitudinal section illustrating a slight modification of both the method and apparatus represented in Figure 1.

Referring to Figure 1, there is shown a cartridge body 1 having a terminal cap 2 and a discharge cap 3. The body is formed with an internal chamber 5 designed to receive and hold a substantial quantity of high pressure air or other gas. The cartridge is provided with a differential valve mechanism consisting of a rod extending throughout the length of the cartridge and having secured on one end thereof a valve designed to close the opening of the discharge cap 3 and on its opposite end is provided with a plunger slidably fitting the bore of chamber 4 formed in the terminal cap 2. The plunger is provided with a plurality of ports which extend entirely therethrough and adjacent the plunger there is provided a spring compressed check valve which serves to limit the flow of air or gas to a single direction.

High pressure air may be introduced into the cartridge through a charging passage 6 formed in terminal cap 2, a nipple 7 having threaded connection with the terminal cap, a piping 8 extending therefrom to a suitable source of high pressure air indicated generally at 9. This source of high pressure air may take the form of a compressor or of a high pressure air receiver, as desired. Provided in the pipe line 8 there is a valve 10 having a lateral discharge port 10'. Attention is directed to the fact that at this point the charging passage 6 is of relatively small cross sectional area.

In the practice of this method and the operation of the typical apparatus illustrated, the cartridge is first inserted in a drill hole formed in the material to be broken and is then connected by suitable piping or tubing 8 to a source of high pressure air 9. This source of high pressure air is preferably located at a point sufficiently remote from the cartridge to provide adequate safety. The movement of valve 10 to one position permits the flow of high pressure air from the source 9 directly into chamber 4 of the cartridge from whence it flows through the several ports formed in the plunger past the check valve into

the main charge receiving chamber 5. When a charge of the desired pressure has been introduced into chamber 5, as may be indicated by a suitable gage provided at the source of supply or in the pipe line 8, the valve 10 may be operated to effect the release of this charge through the discharge cap 3 of the cartridge. Thus, by moving valve 10 into position to cut off the flow of high pressure air from the source 9 to the cartridge and to vent to the atmosphere the section of pipe or tubing 8 extending between valve 10 and the cartridge a substantial drop in pressure is brought about in chamber 4 which, owing to the substantially higher pressure in chamber 5 results in an instantaneous movement of the entire differential valve mechanism toward the terminal end of the cartridge, thus permitting the flow of high pressure air from chamber 5 outwardly through the discharge cap 3. Bearing in mind the above comment regarding the relatively small cross sectional area of the discharge passage 6, it will be readily understood that the escape of high pressure air from chamber 5 through the discharge cap 3 for only a very small fraction of a second will result in a drop in pressure within chamber 5 to a point below the value of the pressure in chamber 4. When this condition arises the differential valve mechanism will immediately move axially in the opposite direction and close the discharge opening of cap 3. At this point it is well to refer again to the relatively small area of passage 6 and to mention the fact that if this passage were of sufficiently large cross sectional area the closing action of the differential valve as just described would not occur. In other words, if the area of passage 6 were such that the venting of pipe 8 would result in a more rapid reduction in pressure within chamber 4 than occurs in chamber 5 when the differential valve is in open position, the differential valve mechanism would remain in open position until the entire charge contained in chamber 5 had escaped through the discharge cap 3. It should be pointed out also that the rate of drop in pressure within chamber 4 prior to the initial opening of the differential valve is not important as the venting of chamber 4 to the atmosphere through any opening however small would eventually result in a differential pressure condition wherein the pressure in chamber 5 would exceed that in chamber 4 by a sufficient margin to cause the opening of the differential valve. Once the differential valve has been moved to open position, however, the relative rate of pressure drop in chambers 4 and 5 becomes important and it is for this reason that the small area of the passage 6 results in the action above described.

It should be understood, of course, that the opening and closing of the differential valve as described above represents but a single cycle of the operation and that in practice this valve will open and close a number of times, providing a succession of distinct discharges, depending as to number and intensity upon the pressure and volume of air or other gas introduced into the cartridge. Experience indicates that with a charge of air at 10,000 pounds pressure in chamber 5 of the cartridge the result will usually be four or five distinct discharges diminishing in force and volume progressively from the first to the last. Although the action has been referred to as a succession of distinct discharges it should be understood that these discharges occur in exceedingly rapid succession. The repeating action

of the differential valve continues in any case until the pressure values within the cartridge have dropped to a point where they are no longer sufficient to actuate the differential valve.

The method and apparatus described above are designed particularly for underground operation where a source of high pressure air is available. The differential valve type cartridge however is well adapted for charging at some central point either within or without the mine from which it may be transported to any desired point of use. In adapting the cartridge to this class of service it is necessary to confine the charge until such time as it is desired to use the same and to then effect the release thereof after the cartridge has been positioned in or adjacent the work to be accomplished. Referring to Figure 2 there is shown a cartridge designed for this class of service. This cartridge is essentially the same as that illustrated in Figure 1 except that in place of passage 6 of Figure 1 there is provided a passage 17 in Figure 2 which communicates with chamber 4 of the terminal cap and with an enlarged passage 16 also formed in the terminal cap. This passage 16 is normally closed by a disc 15 which may be made of metal, fiber or other suitable material possessing sufficient strength to withstand the pressure involved. The disc 15 is held in sealing position by means of a hollow nut 14. A valve 13 is provided in the terminal cap in this case to permit the introduction of high pressure air into the cartridge at the central charging station mentioned above.

In order to effect the discharge of a cartridge of the type illustrated at Figure 2 it is simply necessary to puncture or shear out the center of disc 15 thereby venting chamber 4 to the atmosphere. This may be accomplished by means of an air gun as indicated generally at 11 which is designed for attachment to the end of the cartridge. This gun may consist of a pneumatically actuated plunger carrying a small chisel designed to be forcefully projected against the disc 15, to shear out the central portion thereof. The flow of air outwardly from chamber 4 through passage 17, 16 and through the ruptured disc 15 enters the end of the air gun 11 and escapes through a plurality of radial ports 11'. This, of course, results in a drop in pressure in chamber 4 and consequently in an immediate opening of the differential valve. If the passage 17 were of the same diameter as passage 16 it is probable that the puncturing of disc 15 would result in a single discharge of the entire volume of high pressure air contained in chamber 5, but owing to the restriction of port 17 the repeating action described above is accomplished.

In view of the foregoing it should be realized that the present invention provides a new and improved method of applying energy to the breaking down of coal or to analogous work which method is characterized by the division of a total force or charge of potential energy into a number of distinct discharges in rapid succession. The effectiveness of successive energy impulses, which might be likened to a series of hammer blows, in the performance of useful work will be readily appreciated. The invention also provides a simple and reliable mechanism for the practice of this desirable method of operation. It should be pointed out also that this desirable method of operation combines within it the ability to effect the discharge of the cartridge at accurately controlled pressures within the entire range of the pressure capacity of the

source of supply. In other words, referring particularly to Figure 1, it is possible to effect the discharge of the cartridge by simply operating the valve 10 when the pressure within chamber 5 has reached any desired value and in addition the release of the charge whatever its value may be will occur in a succession of distinct discharges.

I claim:

1. A method of breaking down materials which consists in confining a single energy storing charge of expansible fluid at material breaking pressure in the material to be broken down, and releasing said charge in the material to be broken in a succession of distinct discharges to break down the material by the expansive action of the fluid thereon.

2. A method of breaking down materials which consists in confining a predetermined quantity of expansible material possessing potential energy at material breaking pressure in the material to be broken and applying said quantity of material possessing potential energy to the material to be broken in a succession of distinct energy impulses to break down the material by the expansive action of the expansible material thereon.

3. A method of breaking down coal or other materials which consists in confining a quantity of material possessing potential energy in or adjacent the material to be broken down, and applying said potential energy to the work in a rapid succession of distinct energy impulses of progressively diminishing intensity.

4. A method of breaking down materials which consists in the introducing and confining a controlled quantity of expansible material possessing potential energy at material breaking pressure in the material to be broken down, and applying said quantity of material possessing potential energy to the material to be broken in a succession of distinct energy impulses to break down the material by the expansive action of the expansible material thereon.

5. A method of breaking down coal or other materials which consists in introducing and confining a controlled quantity of material possessing potential energy in the material to be broken down, and applying said potential energy to the work in a rapid succession of distinct energy impulses of progressively diminishing intensity.

6. An apparatus of the character described comprising a cartridge adapted to receive a charge of high pressure air or other gas and embodying a discharge orifice for the release of such charge, a differential valve for controlling said discharge orifice, and means for causing said valve to alternately open and close, thereby releasing said charge in a succession of distinct energy impulses.

7. A material breaking apparatus comprising container means for confining gas compressed to a desired work performing pressure, valve means for controlling the discharge of said gas, and pressure responsive means for operating said valve means to effect repeated opening and closing of the latter during discharging of a single charge from the container means.

8. A material breaking apparatus comprising container means for confining gas compressed to a desired work performing pressure, valve means for controlling the discharge of said gas, and pressure responsive means acted upon by the compressed gas confined in said first mentioned means for operating said valve means

to effect repeated opening and closing of the latter while discharging a single charge from the container means.

9. In a blasting cartridge, a container for receiving a blasting charge of expansible fluid and adapted for insertion in a blast hole drilled in the material to be broken, and means operative subsequent to the positioning of the cartridge in the blast hole for releasing said charge from said container into the material to be broken in a rapid succession of distinct energy impulses to break down the material by the expansive action of the fluid thereon.

10. In a blasting cartridge, means insertable in the material to be broken for receiving and confining a quantity of blasting pressure and having a discharge orifice, and valve means for releasing the blasting pressure from said receiving means through said discharge orifice into the material to be broken in a plurality of distinct blasts in rapid succession.

11. In a blasting cartridge, a container for receiving a blasting charge at material breaking pressure and insertable in an opening in the material to be broken, a valve for controlling the discharge of said charge from said container, and means for effecting alternate opening and closing of said valve to discharge said charge from said container into the material to be broken in a number of distinct energy impulses.

12. In a blasting cartridge, means insertable in the material to be broken for receiving a quantity of expansible fluid at blasting pressure, and means for releasing the fluid from said receiving means into the material to be broken in a plurality of distinct blasts to break down the material by the action of the fluid thereon.

13. In a blasting cartridge, means insertable in the material to be broken for receiving a quantity of expansible fluid at blasting pressure, and means for releasing the fluid from said receiving means into the material to be broken in a plurality of distinct blasts in rapid succession to break down the material by the action of the fluid thereon.

14. A material breaking apparatus comprising container means to be charged with highly compressed gas at material breaking pressure and means operatively associated with the aforementioned means for releasing said gas in the material to be broken in a succession of distinct energy impulses to break down the material by the action of the gas thereon.

15. A material breaking apparatus comprising container means for confining gas compressed to a desired work performing pressure in the material to be broken, and pressure responsive means for releasing said gas in the material to be broken in a succession of distinct energy impulses to break down the material by the action of the gas thereon.

16. A material breaking apparatus comprising container means for confining gas compressed to a desired work performing pressure in the material to be broken, and pressure operated valve means for releasing said gas in the material to be broken in a succession of distinct energy impulses to break down the material by the action of the gas thereon.

17. In a material breaking apparatus, means for confining gas compressed to a desired work performing pressure and differential valve means located within the aforementioned means constructed and arranged to effect release of said gas into the material to be broken in a succession of

distinct energy impulses to break down the material by the action of the gas thereon.

18. A blasting apparatus comprising a cartridge structure insertable in the material to be broken and adapted to confine a predetermined volume of gas compressed to a pressure sufficiently high to accomplish the desired work, means for charging the cartridge, and means for intermittently releasing fractional portions of the charge from said cartridge in the material to be broken.

19. A blasting apparatus comprising a cartridge structure insertable in the material to be broken and adapted to confine a predetermined volume of gas compressed to a pressure sufficiently high

to accomplish the desired work, means for charging the cartridge, and pressure operated valve means for intermittently releasing fractional portions of the charge from said cartridge in the material to be broken.

20. In a blasting cartridge, a container insertable in the material to be broken for receiving a blasting charge of expansible fluid, and means for releasing said charge from said container into the material to be broken in a rapid succession of distinct energy impulses to break down the material by the expansive action of the fluid thereon.

RAYMOND W. DULL.