(No Model.) 2 Sheets—Sheet 1.

F. A. HALSEY.

STEAM ROCK DRILL.

No. 295,001. Patented Mar. 11, 1884.

Fig. 1.

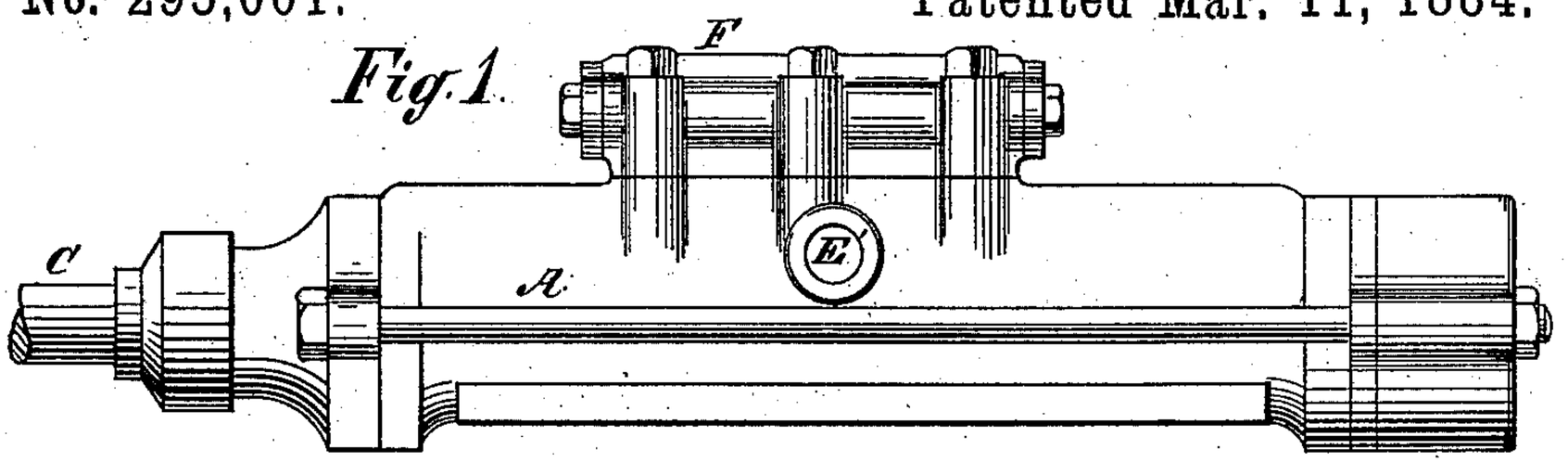


Fig. 2

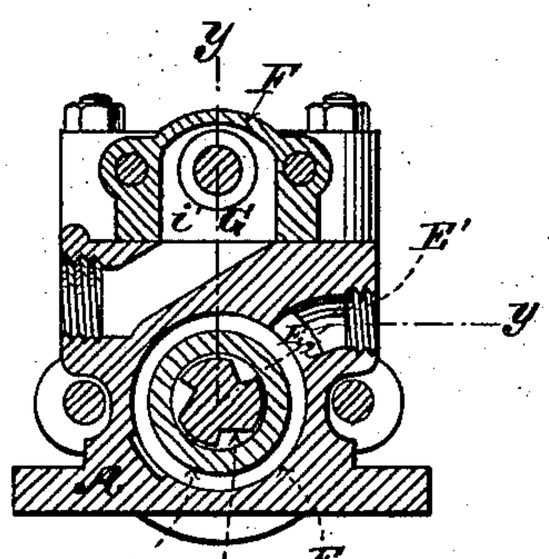


Fig. 3.

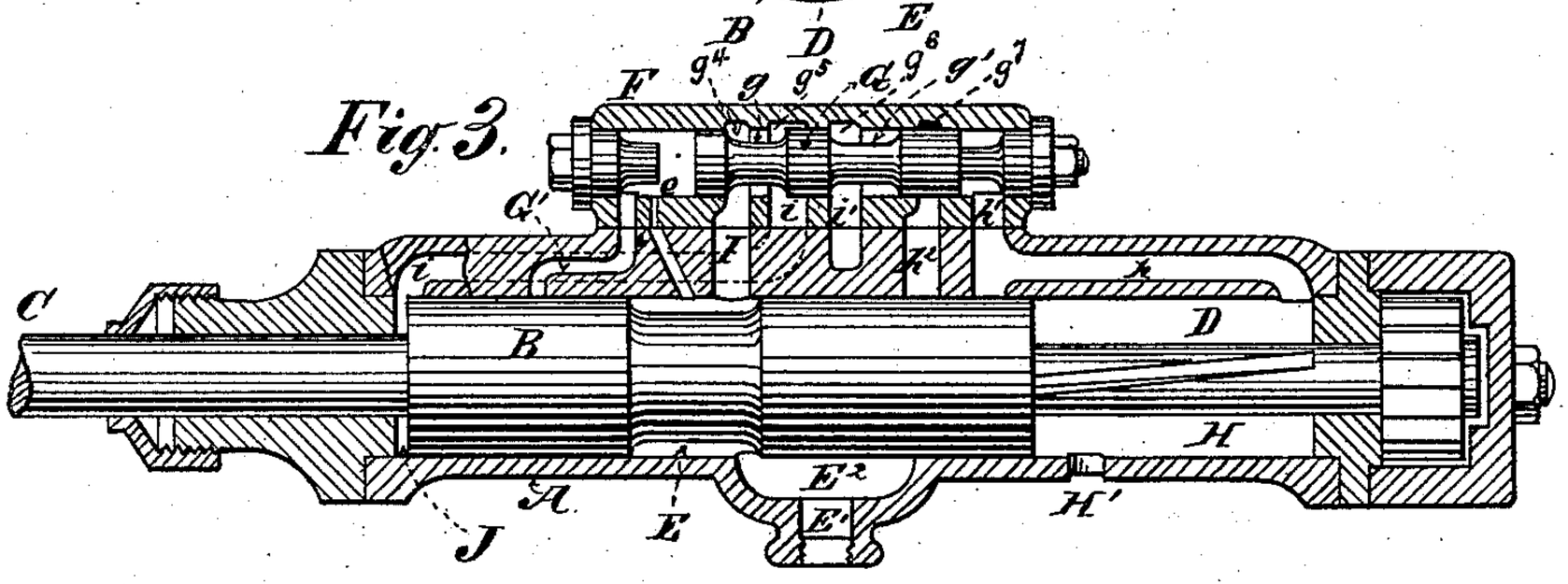
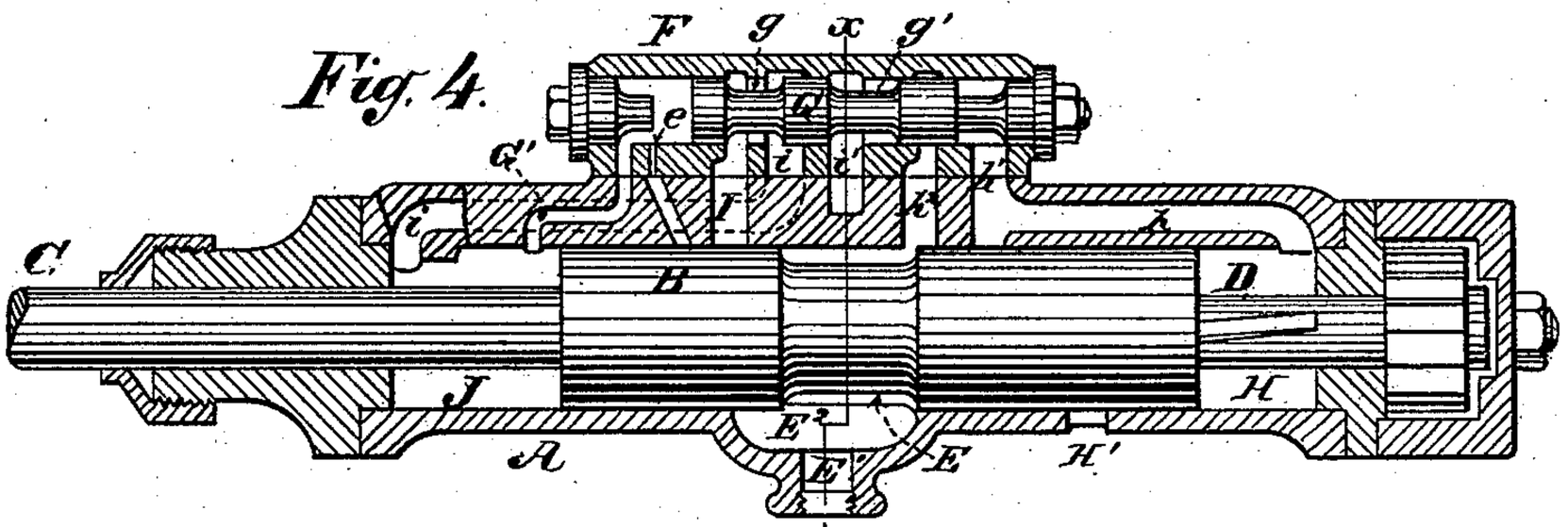


Fig. 4.



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(No Model.) 2 Sheets—Sheet 2.

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STEAM ROCK DRILL.

No. 295,001. Patented Mar. 11, 1884.

Fig. 5.

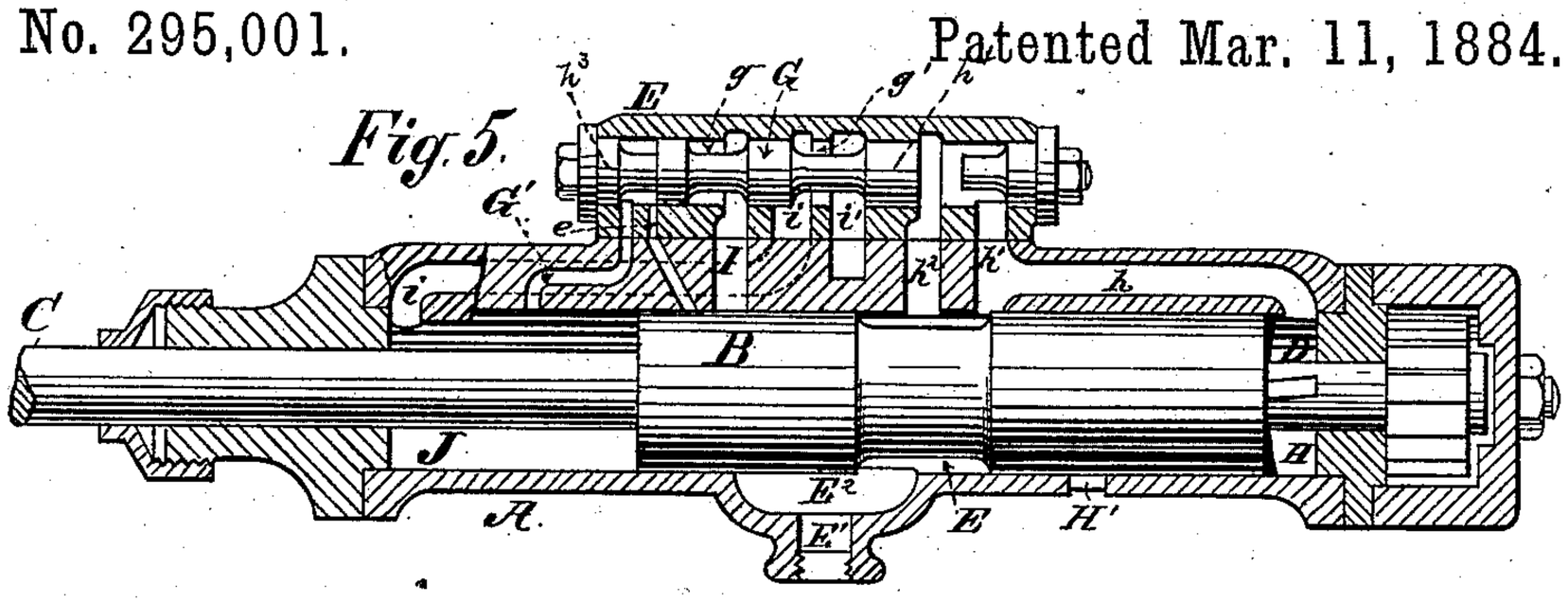


Fig. 6.

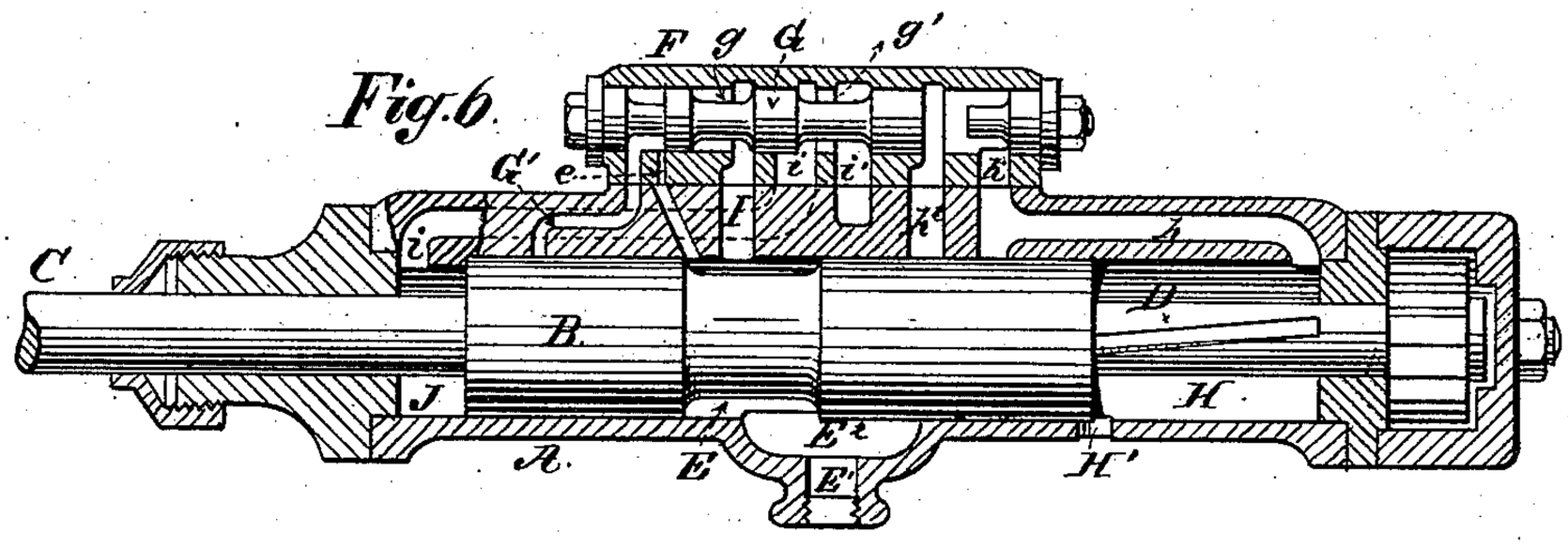


Fig. 7.

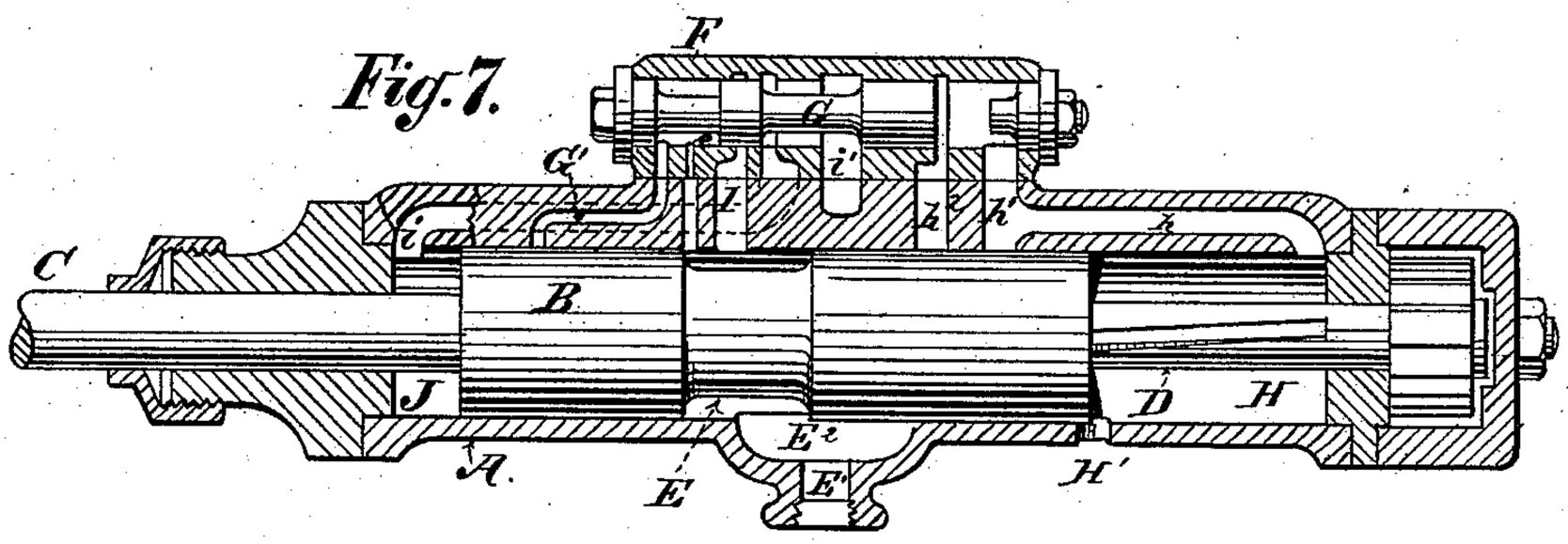
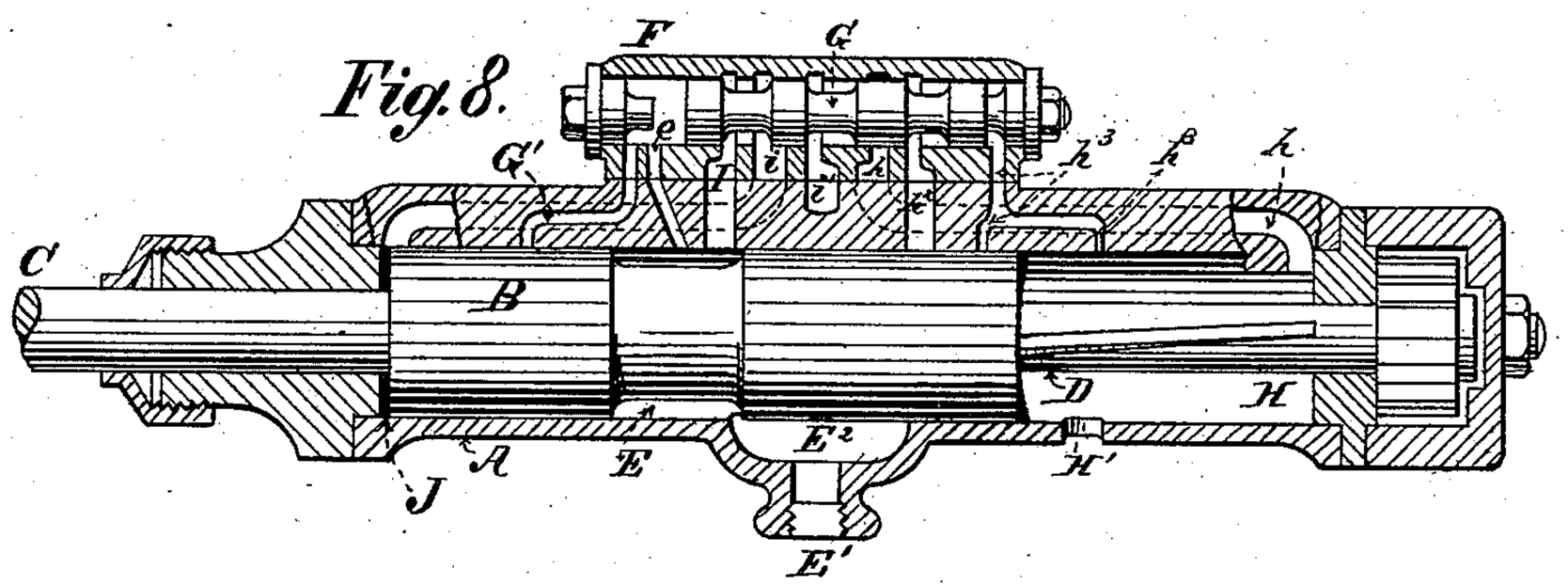


Fig. 8.



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UNITED STATES PATENT OFFICE.

FREDERIC A. HALSEY, OF NEW YORK, N. Y., ASSIGNOR TO THE RAND DRILL COMPANY, OF SAME PLACE.

STEAM ROCK-DRILL.

SPECIFICATION forming part of Letters Patent No. 295,001, dated March 11, 1884.

Application filed January 16, 1884. (No model.)

To all whom it may concern:

Be it known that I, FREDERIC A. HALSEY, formerly of West New Brighton, New York, now a resident of the city of New York, in the county and State of New York, have invented a new and useful Improvement in Steam Rock-Drills and Analogous Machines, of which the following is a specification, reference being made to the accompanying drawings, forming part of the same.

The work done by this class of machines is the striking of a succession of blows by a reciprocating piston actuated by steam, compressed air, or other elastic fluid, (which in this specification I shall comprehend under the term "steam.") The efficiency of these machines is in proportion to the force and rapidity of the blows struck.

It is the object of my present invention to secure the utmost practicable efficiency by the most economical use of the steam. This object I endeavor to attain by the co-operation in the same machine of means for using steam expansively and for diminishing the cushion in the working-stroke of the piston, which, in these machines as heretofore constructed, results from the premature introduction of steam to the cylinder as the piston approaches the termination of its longer working-strokes, the length of the strokes of the piston being, as is known, subject to variation. I shall describe a complete working steam rock-drill in all its parts; but I do not intend to claim here the devices or methods for attaining either of the above-named results separately, each separately being the subject-matter of an application for a patent which I file in the Patent Office simultaneously herewith, my present claims being intended to be limited to the combination in the same machine of devices or methods for simultaneously attaining both of said objects, whereby the advantage gained by obviating the cushioning of the piston in its downward stroke compensates for the diminished force of its blow due to the use of steam expansively.

The accompanying drawings represent a rock-drill embodying my invention, in which Figure 1 is a side elevation. Fig. 2 is a transverse section through the line *x x* on Fig. 4. Figs. 3, 4, 5, and 6 are longitudinal sections taken through the line *y y* on Fig. 2, respectively showing the piston in elevation in various positions. For clearness of illustration, the lower portions of Figs. 3, 4, 5, and 6 represent, as in a vertical plane, that portion of the line *y y* which extends obliquely upward from the center of the cylinder, and then horizontally outward through the nozzle, which is for connection with the steam-pipe. Fig. 7 illustrates a modification in the forms of the valve and in the arrangement of the steam-passages from the cylinder to the valve-chest, which permits the employment of a piston-valve having but one circumferential groove. Fig. 8 is a modification showing an arrangement of steam-passages adapted for the employment of a piston-valve having three circumferential grooves.

A is the cylinder, and B the piston, which is elongated sufficiently to afford a steam-chamber in its middle portion, and also to perform the office of governing the steam-ports, hereinafter described.

C is the piston-rod, which carries the drill or other tool. The middle portion of the piston is circumferentially grooved, and the annular space between the grooved portion and the wall of the cylinder serves as a steam-chest to receive steam through the nozzle E′, which projects from the side of the cylinder, as shown in the drawings.

F is a valve-chest, connected to the cylinder, as shown; and G is a valve-piston fitted to work in said chest, the said valve-piston being actuated by steam introduced into said valve-chest through ports leading from the steam-chest E. This piston-valve is also circumferentially grooved, forming spaces *g* and *g′* between the walls of the chest. The interior of the chest is also circumferentially grooved, forming annular spaces g^4 g^5 g^6 g^7. The cylindrical portions remaining after the said grooves are formed constitute valve-seats, with which the cylindrical portions of the valve form steam-tight joints.

i′ is the exhaust-port from the valve-chamber.

i is the inlet-port to the lower end of the cylinder, opening from the valve-chest, and it serves also as the exhaust-port.

h is the inlet-port to the upper end of the cylinder, opening into a branch passage, *h′*,

which communicates between the upper end of the valve-chest and the cylinder.

h^2 and I are passages leading from the cylinder to the valve-chest, which communicate between said valve-chest and steam-chest E, for the introduction of steam to the valve-chest, from which it is distributed from the valve-chest by the inlet-ports to the cylinder.

G′ is the exhaust-port from the lower end of the valve-chest. From the upper end of the valve-chest the steam exhausts through h' and h into the upper end, H, of the cylinder.

c is an inlet-port communicating between the steam-chest E and the lower end of the valve-chest. The inner mouth of this passage is located relatively to the piston as shown in the drawings, so that it will be uncovered for the admission of steam from the steam-chest E at the moment when the piston reaches the limit of the shortest downward or working stroke which in practice it is intended to be permitted to make, as intended to be represented in Fig. 6. This passage is constricted or made of relatively small cross area or conducting capacity, whereby there will be a determinate delay between the uncovering of the passage by the piston and the transmission through it of sufficient steam to shift the valve to open the inlet-port to the lower end of the cylinder. The passage I is located relatively to the piston as shown in the drawings, so that the piston in its upward movement will close said passage and cut off the steam from the lower end of the cylinder before the piston reaches the limit of said upward movement, for the purpose of using the steam expansively in the lower end of the cylinder. The location of said port may be such as to cut off the steam during any part of the upward movement of the piston to use the steam expansively to any extent that may be desired. I find it preferable to cut off at about half-stroke. So, also, the port h^2 may be located relatively to the piston, so as to cut off the steam to the upper end of the cylinder in the downward movement of the piston preferably at about half-stroke. Thus the steam may be used expansively at either or both ends of the cylinder. The aperture H′ is the exhaust-port for the upper end of the cylinder, opening directly through its wall. This is governed by the piston, and located as shown in the drawings, where it will be uncovered when the piston reaches the limit of the shortest practical working-stroke at or about the same time that the passage is uncovered.

The operation of the machine is as follows: Commencing with the parts in the positions shown in Fig. 3, with the piston at the limit of its longest practical downward or working stroke, with the port *e* uncovered and the valve shifted to admit steam to the lower end of the cylinder, the exhaust-port H′ open, and the communication cut off between passage h^2 and h', the piston will now be started on its upward stroke, and will close the exhaust-port H′ and the inlet-port *e* as soon as it passes the point of the limit of its shortest practical downward stroke. Then it will close the passage I, thus cutting off the steam from the lower end of the cylinder. When the piston reaches the position shown in Fig. 5, the port *h* being open, steam will enter the upper end of the cylinder to arrest the piston and impel it in its downward stroke. The piston in its upward stroke having uncovered the exhaust-passage G′, after having closed the inlet-passage *e*, the steam will be partially exhausted from the lower end of the valve-chest into the lower end of the cylinder, in which steam is expanding as stated. Then as soon as the passage h' is opened, steam at full pressure will be introduced to the upper end of the valve-chest from the steam-chest E, thereby shifting the valve and opening communication between the passages h^2 and h', so that when the piston closes the lower mouth of the passage h' steam will be conducted from the steam-chest E, through h^2, h', and *h*, to the upper end of the cylinder, and thus will continue until the piston has closed the lower mouth of h^2, from which point the steam will act expansively in the upper end of the cylinder until the piston uncovers the exhaust-port H′.

Referring again to the constricted inlet-port *e*, it should be observed that in this class of machines, when the length of the stroke of the piston is subject to variation, it is necessary to provide means for the opening of the inlet-port to the lower end of the cylinder, which shall be brought into operation as soon as the piston reaches the limit of the shortest downward stroke which in practice it is intended to be permitted to make; but if at this point the steam is actually admitted, then in making longer strokes the incoming steam will act as a cushion to impede the piston and lessen the force of the blow of the tool actuated by it. By constricting the said passage *e* and locating it relatively to the piston as described, while means are thus provided which will insure the introduction of the steam by the time the piston has reached the limit of its longest practical working-stroke, the introduction will be delayed, after the opening of the said passage, at the point of the termination of the shortest stroke of the piston until it has had time to make any longer strokes, as a little time will be required after the port *e* is opened for sufficient steam to be transmitted through it to overcome the friction and inertia of the valve and shift it to open the passage *i*. It is evident that in order to accomplish this purpose a certain proportion must be observed between the size or conducting capacity of the constricted port *e* and the diameter, weight, and length of stroke of the valve, and the velocity of the piston, and the difference between the shortest and longest practical working-strokes.

The following is a statement of the proportions which are found to give satisfactory results: In such a machine in which the diameter of the piston is three and one-eighth inches,

the entire stroke six and one-half inches, and after opening the port *e* one and three-quarter inch, striking four hundred to four hundred and twenty blows per minute under a pressure of seventy pounds per square inch above the atmosphere, and the diameter of the valve is one and a sixteenth inch, its weight seventeen ounces, and its stroke five-eighths of an inch, the diameter of the passage *e* is about five thirty-seconds of an inch. Now, it will be observed that by the simple movement of the main piston in its reciprocation and the reciprocating movement of a single valve, there is accomplished the prevention or diminishing of the cushioning of the piston during its working-stroke upon steam prematurely admitted to the cylinder; also, the working of steam expansively at one or both ends of the cylinder, and the utilizing of the energy expended in propelling the piston in its upward movement against the cushion by which its said upward movement is arrested in assisting to propel the piston in its downward stroke. I find that by preventing the cushioning of the piston in its downward stroke I can use steam expansively, as described, and obtain equal efficiency, and the drill will do as much work as when steam at full stroke is used with the cushioning that necessarily takes places when steam is let into the lower end of the cylinder at the termination of the shortest practical stroke of the piston, thus economizing the use of steam. In this specification by the "lower" end of the cylinder I intend that end to which the piston moves in making its working-stroke. The opposite end I call the "upper" end. Similarly, the "lower" end of the valve-chest and valve is that to which the steam is introduced to shift the valve to open the inlet-passage to the lower end of the cylinder, and the opposite end I call the "upper" end.

Modifications may be made in the induction-passages and the form of the valve within the spirit of my invention. As illustrations I have represented two such modifications in Figs. 7 and 8. As shown in Fig. 7, the valve G has but one circumferential groove. The upper or right-hand end of the valve is like that already described; but the lower or left-hand end consists of but one swell instead of two, being in that respect like the upper end. In the position shown the passage *i* is in communication with the exhaust *i'*, as it is in Fig. 5. Communication between *i* and the induction-port I is established, when the valve moves to the right, by the left-hand end of the valve registering with the right-hand edge of the port *i*. Fig. 8 represents a further modification in the valve, which consists in providing it with three circumferential grooves, so that each end of the valve consists of two swells. The left-hand end in this case is exactly the same as the one first described; but the right-hand end has two swells instead of one. In the position in which the parts are shown in Fig. 8 the piston has completed its working-stroke, the valve has been reversed, and the passage *i* is in communication with the induction-port I. When the piston has moved upward sufficiently to uncover the lower leg of the passage *h*, steam is admitted from the steam-chest into the upper end of the valve-chest, the mouth of the upper leg of the passage being at that time covered by the elongated upper end of the piston. By the admission of steam through the passage the valve is driven to the left and establishes communication between the induction-port h^2 and the passage *h*, leading to the upper end, H, of the cylinder. By this left-hand movement of the valve, communication is also established between the passage *i* and the exhaust *i'*.

In all the modifications of the form of the valves and the modifications of the steam-passages and ports, the distinguishing characteristics of the mode of operation are the same in respect of the facts that in each instance a single valve governs the distribution of steam to both ends of the main cylinder by opening the communication from the steam-chest and the ports which respectively supply steam to the opposite ends of the cylinder, while the cutting off of the supply is in all cases effected by the movement of the main piston. The germ of the two modified forms of valves and arrangements of passages, and of other modified forms which will readily suggest themselves, is contained in the form of valve first described, in which the left-hand end of the valve is double—that is, it has two swells—and the right-hand end single. In the form of the valve represented in Fig. 7 both ends are single, and in that represented in Fig. 8 both ends are double. It will, of course, be seen that the form of the original may be exactly reversed—that is, the left-hand end may be single and the right-hand end double. With the single-ended valve the steam passes through the end of the valve-chest on its way to the main cylinder, while with the double-ended valve it passes through the annular groove between the two swells, both of which methods of operation are characteristic of the form of valve first described.

In three separate applications, numbered, respectively, 110,082, filed October 26, 1883, 117,722, and 117,723, the latter two filed simultaneously herewith, I have claimed several of the devices herein described, namely: In No. 110,082 I have claimed the means for controlling the transmission of steam for preventing its premature admission to the lower end of the cylinder, and the consequent cushioning of the piston thereon, in No. 117,723 I have claimed the means for confining and compressing the residual steam in the upper end of the cylinder, and in No. 117,722 I have claimed the means for cutting off the steam, whereby it is used expansively.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a steam rock-drill or other analogous machine in which the length of the working-stroke is subject to variation, the combination,

with the main piston and a valve governing the inlet-port to the lower end of the cylinder, of a passage for the transmission of steam whereby said valve is actuated, said passage being constricted, as and for the purpose described, and an inlet-passage to the upper end of the cylinder arranged so that it is closed before the piston reaches the limit of its downward stroke, as described.

2. In a steam rock-drill or other analogous machine in which the length of the working-stroke of the piston is subject to variation, the combination, with the main piston, the inlet-passages to the cylinder leading from the valve-chest, and the valve governing said passages, of the port *e*, leading to the valve-chest, governed by the piston and located relatively thereto, as described, so that it is opened when the piston in its downward stroke reaches the point of limit of the shortest practical working-stroke which in practice it is intended to be permitted to make, and the inlet-port h^2, for conducting steam to the upper end of the cylinder, which actuates the piston in its downward stroke, also governed by the piston and located relatively thereto, as described, so that it is closed before the piston reaches the end of its downward stroke, whereby the steam is used expansively during a portion of said stroke, all constructed and arranged to operate as and for the purpose specified.

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