(No Model.) 3 Sheets—Sheet 1.

F. A. HALSEY.

VALVE GEAR FOR ROCK DRILLS.

No. 295,002. Patented Mar. 11, 1884.

Fig. 1.

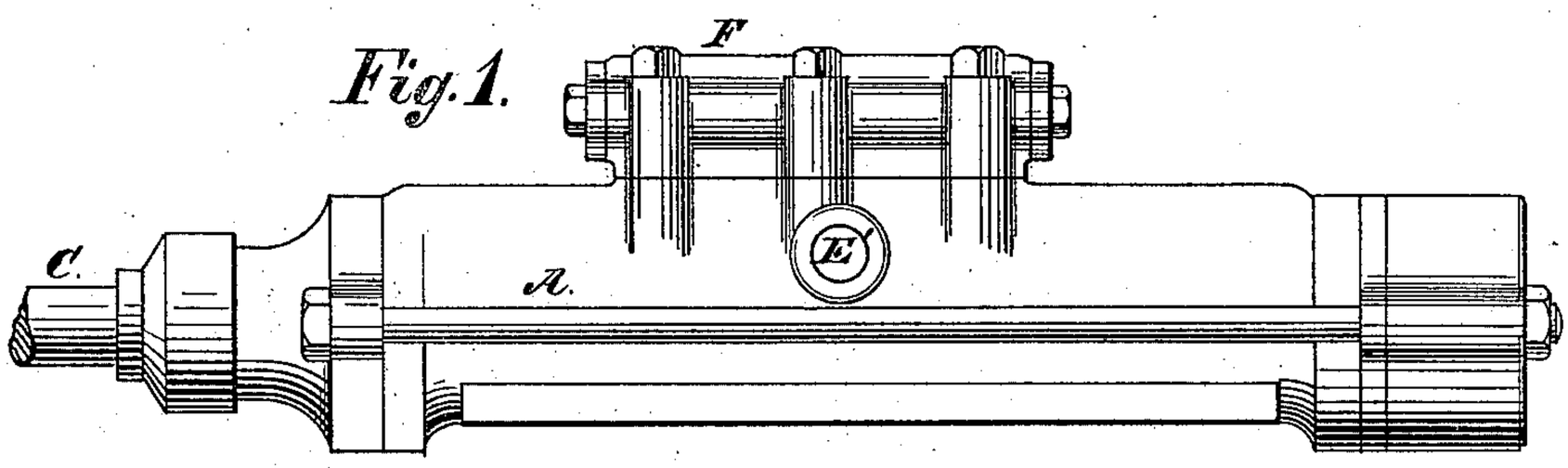


Fig. 2.

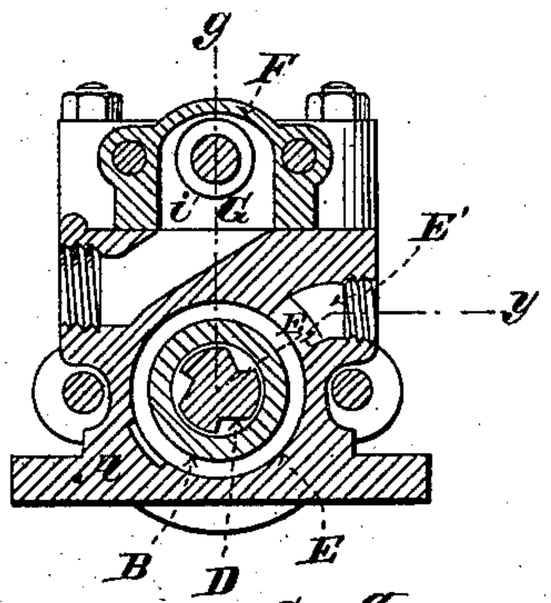


Fig. 3.

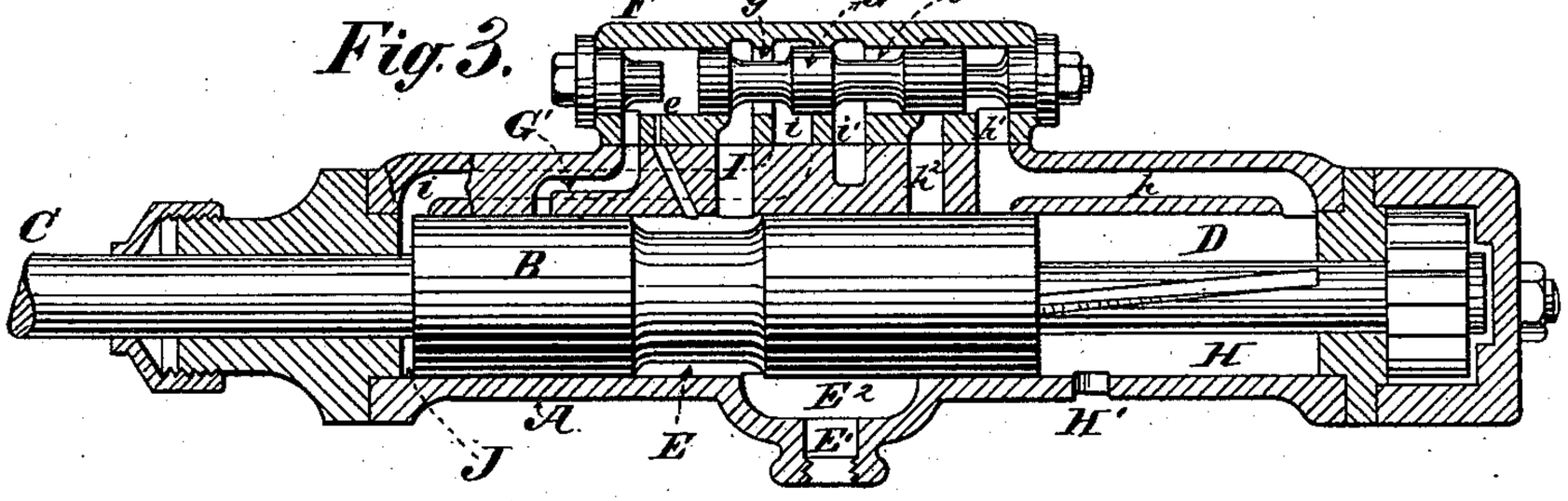
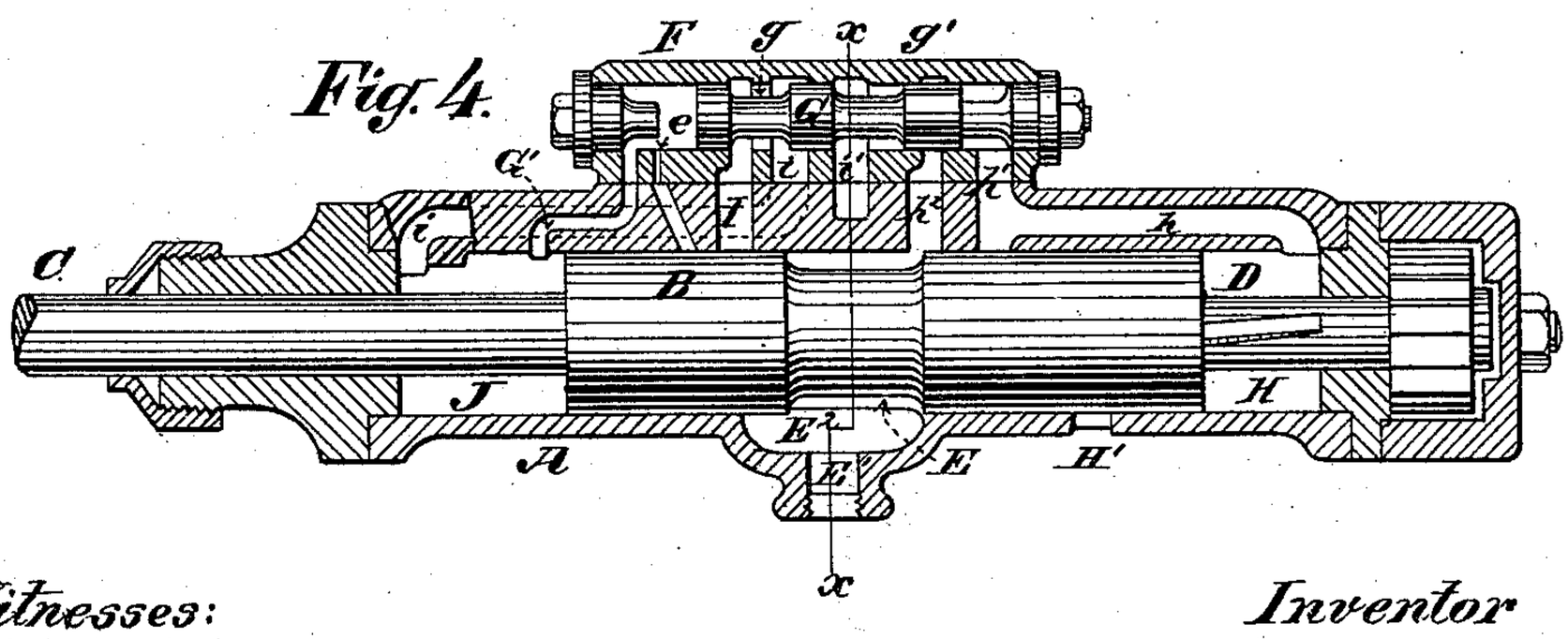


Fig. 4.



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(No Model.) 3 Sheets—Sheet 2.

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VALVE GEAR FOR ROCK DRILLS.

No. 295,002. Patented Mar. 11, 1884.

Fig. 5.

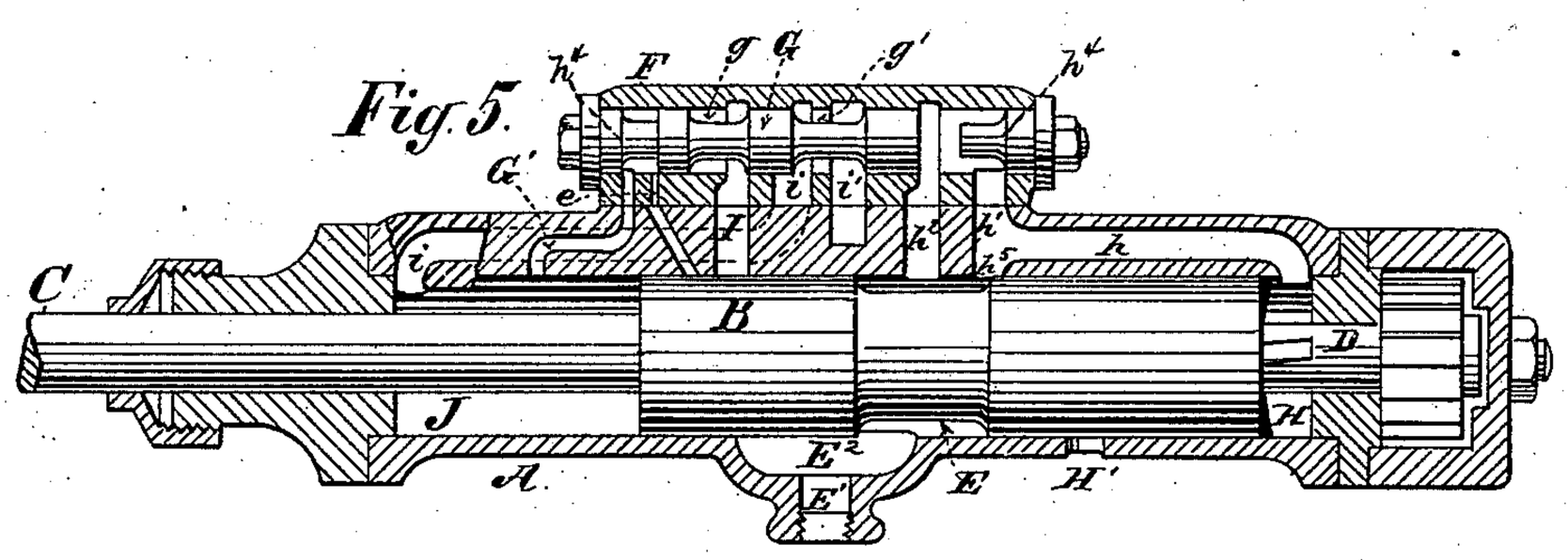


Fig. 6.

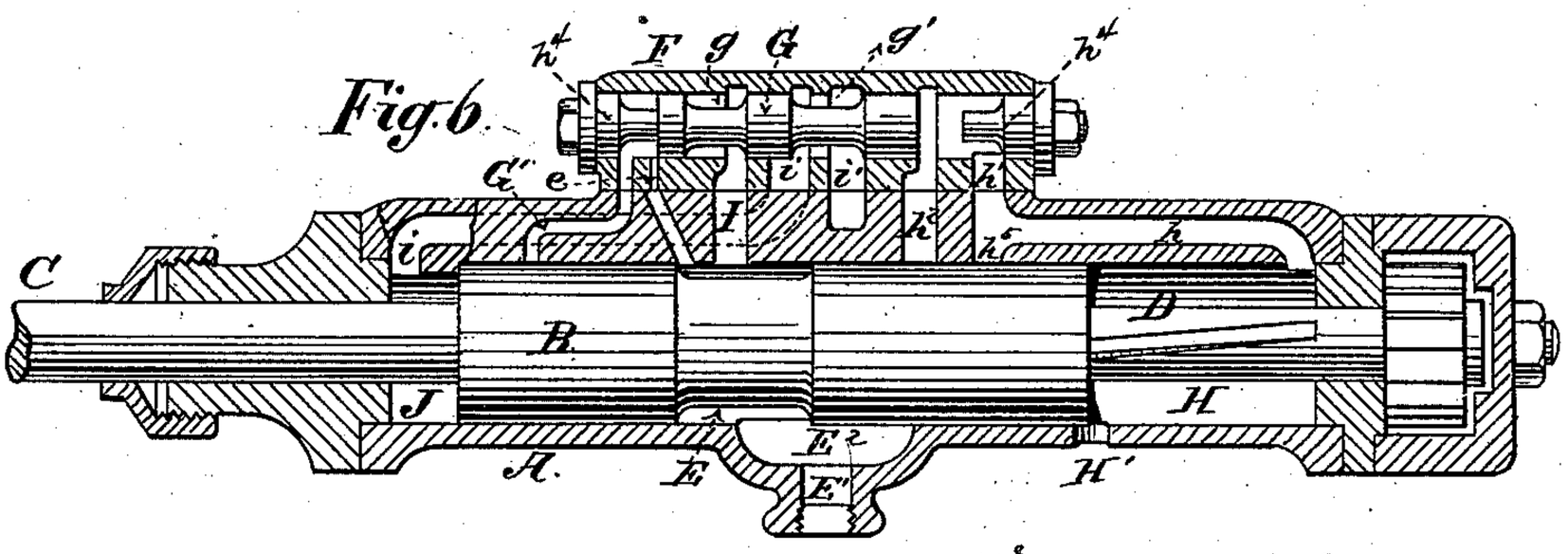


Fig. 7.

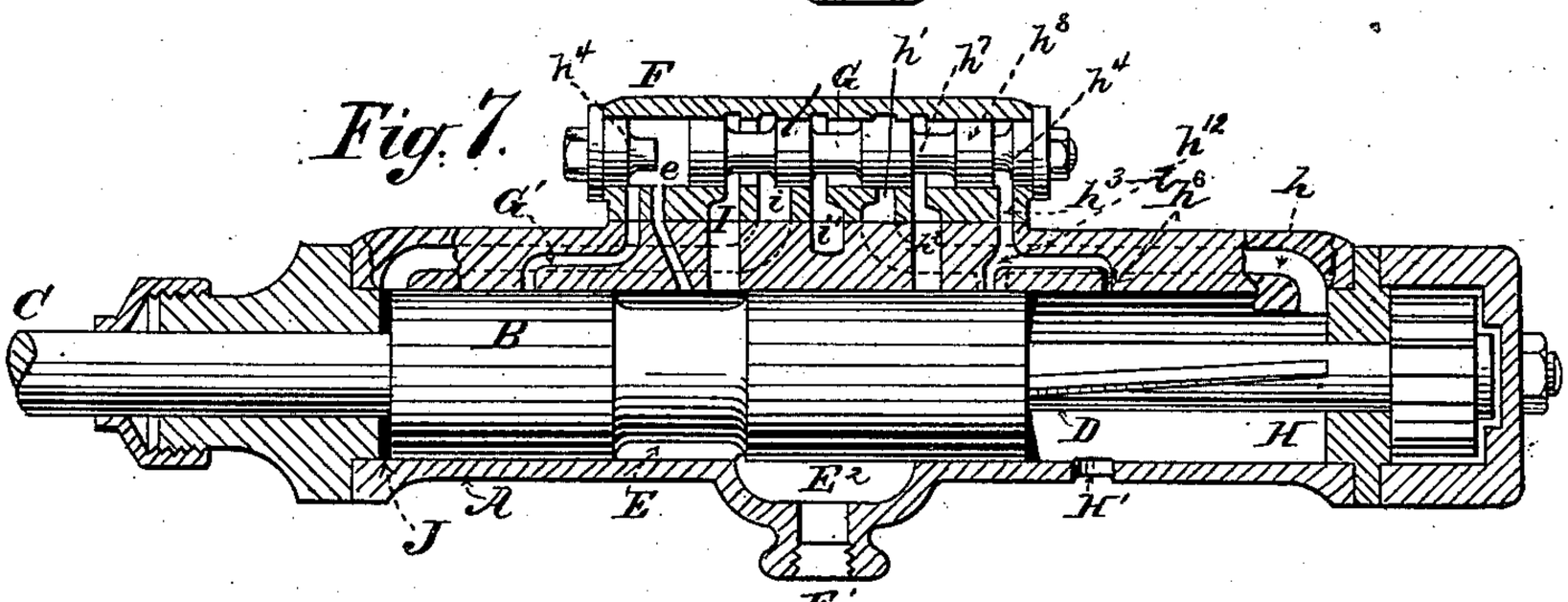
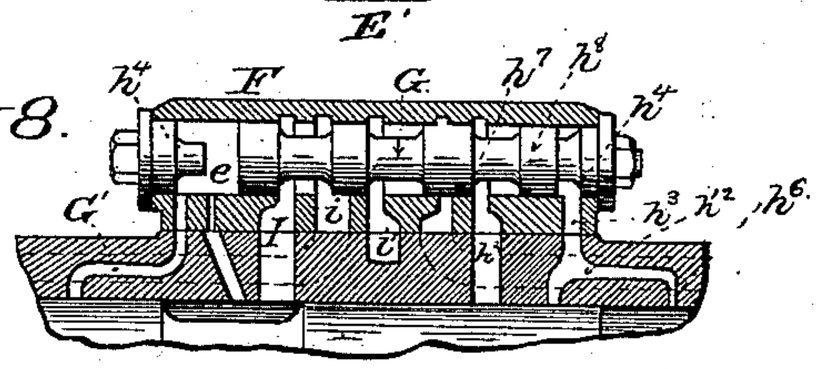


Fig. 8.



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(No Model.) 3 Sheets—Sheet 3.

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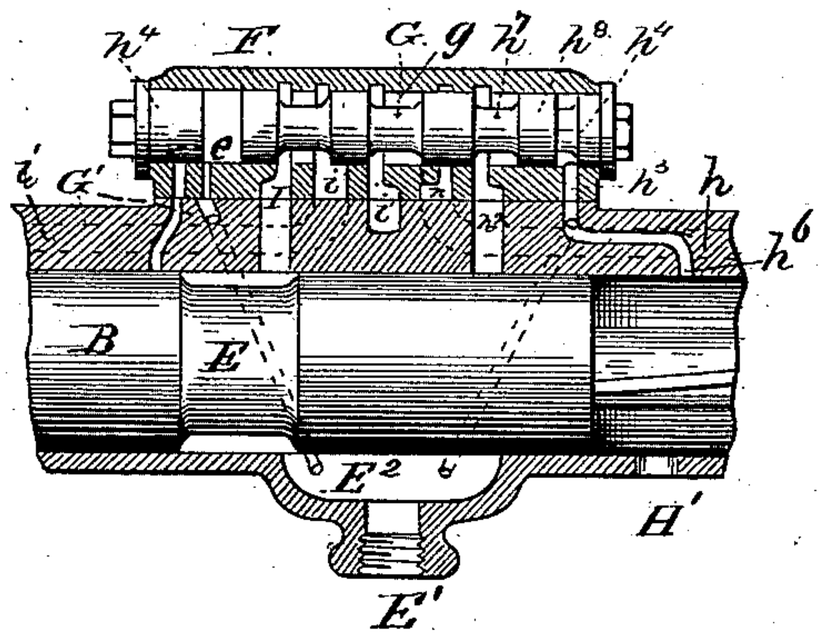
VALVE GEAR FOR ROCK DRILLS.

No. 295,002. Patented Mar. 11, 1884.

Fig. 9.



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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.

VALVE-GEAR FOR ROCK-DRILLS.

SPECIFICATION forming part of Letters Patent No. 295,002, dated March 11, 1884.

Application filed October 26, 1883. (No model.)

To all whom it may concern:

Be it known that I, FREDERIC A. HALSEY, formerly of West Brighton, New York, now a resident of the city of New York, in the county and State of New York, and a citizen of the United States of America, have invented an Improvement in Rock-Drills, of which the following is a specification, reference being had to the accompanying drawings, forming part of the same.

My invention relates to steam rock-drills which comprise a steam-cylinder and reciprocating piston and piston-rod carrying a drill, steam-passages for distributing the steam in the cylinder to reciprocate the piston, a valve-chest, and a steam-moved valve therein, constructed and arranged to co-operate with the piston in governing said passages, together with suitable mechanism to feed the drill to its work, the work designed to be done by the machine being that of striking a succession of blows with the drill by the reciprocation of the piston. As the efficiency of this machine is in proportion to the force of the blows struck and the rapidity of the reciprocation of the piston, it is important that the piston should move to the end of its working-stroke with as little obstruction as possible from the steam introduced into the cylinder to effect the return-stroke, and to the extent that steam is introduced before the piston reaches the limitation of its working-stroke is the force of the blow struck lessened by the cushioning of the piston on the steam. In this class of rock-drills as ordinarily constructed, such cushioning necessarily takes place in practice by reason of the variation in the length of the working-stroke, which results from the variation of the point of the collision of the drill with the rock and the want of uniformity in the feed of the drill. It is necessary that by the time the piston reaches the termination of its shortest practical stroke it shall have performed its part of the work of bringing about the introduction into the cylinder of the steam to effect the return-stroke; otherwise at that point the piston would stop; but when, as is the case in drills as heretofore made, the uncovering of the inlet-port to the cylinder takes place substantially simultaneously with the said action of the piston at the end of its shortest working-stroke, the piston in all longer strokes will necessarily be met at all points between its shortest and longest strokes by the incoming steam, by which the force of its blows will be diminished in proportion to the amount of steam thus prematurely introduced.

The object of my invention is to remedy this defect, and, while securing in any event the introduction of steam to effect the return of the piston after its shortest working-stroke, to prevent the introduction of steam and the consequent cushioning of the piston when longer working-strokes are made. This object I attain by making the passage through which passes the steam by means of which the valve is shifted to admit steam to the cylinder to effect the return-stroke of the piston of suitably small cross area or conducting capacity, to so limit the rate of transmission of steam through it that there will necessarily occur between the opening of said passage at the end of the shortest practical working-stroke of the piston and the actual shifting of the valve to open the inlet-passage to the cylinder a determinate delay for the purpose of allowing the piston to complete longer strokes by the time the said passage is opened.

I will now proceed to describe a steam rock-drill embodying my invention, and in doing so I shall, for convenience of description and to save prolixity, designate the movement made by the piston in delivering its blows as the "down" or "working" stroke, and its movement in the opposite direction its "up" or "return" stroke. The end of the cylinder toward which the piston moves on its working-stroke I shall call the "lower" end, and the opposite end the "upper" end. Similarly, I shall designate as the "lower" end of the valve and valve-chest that to which the steam is admitted to shift the valve for opening the inlet-port to the lower end of the cylinder, and the opposite the "upper" end; and the movement of the valve toward the lower end of the valve-chest is called the "downward" movement, and the reverse the "upward" movement.

I have represented in the drawings, and shall set forth herein, a complete working machine,

which embodies, I believe, other patentable novelties beside the one above referred to; but I intend in this specification that my claim shall relate to and include only that which pertains to the said "cushioning" of the piston, reserving all others for separate applications for Letters Patent, which I file simultaneously herewith. I desire it to be further understood that I do not confine myself, in all its parts, to the machine herein represented and described, it being obvious that the devices and mechanism which I employ to effect the object attained by my present invention may be employed in steam rock-drills and analogous machines differing in many other respects from the one here shown and described.

The accompanying drawings illustrate a steam rock-drill embodying my invention.

Figure 1 is a side elevation. Fig. 2 is a transverse section through the lines 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 Fig. 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 is a modification, showing an arrangement of steam passages and valves adapted to a restriction of the exhaust-port at the upper end of the cylinder, for a purpose hereinafter fully described. Fig. 8 is a detached part, representing the valve-chest and valve, a broken part of the cylinder and piston, and the steam-passages communicating with the valve, hereinafter fully described; and Fig. 9 is also a detached part of the machine, showing the middle portion of the cylinder and piston, the valve-chest and the valve, and passages for distributing the steam to the cylinder hereinafter described.

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

C is the piston-rod, which carries the drill or other tool, and D the spiral rod for effecting the rotation of the drill. The middle portion of the piston is circumferentially grooved, and the annular space, E, between the grooved portion of the piston 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 with the side of the cylinder, as shown, and G is a single cylindrical valve fitted to work in a correspondingly-shaped chamber in said chest, which said valve is operated by steam introduced into said chamber by ports leading from the steam-chest E.

h is the inlet-port communicating between the upper end, H, of the cylinder and the upper end of the valve-chest, and also opening into the cylinder at a point where it will communicate with the steam-chest E when the piston is at the end of its upward stroke, as seen in Fig. 5.

h^2 is a port, also communicating between the interior of the cylinder A and the valve-chest F, near its upper end, opening into the cylinder at a point where it will be uncovered and communicate with the steam-chest E when the piston has reached in its upward movement the position shown in Fig. 4, and will be closed by the piston in its downward movement, thereby cutting off the steam from the upper end of the cylinder before the piston has reached the limit of its downward stroke. In the drawings this cut-off is represented as taking place at about half-stroke; but it is obvious that the position of the inner mouth of the port h^2 may be varied.

i' is the exhaust-port leading from the valve-chest.

i is a steam-passage communicating between the lower end, J, of the cylinder and the valve-chest, as shown in the drawings, which serves both as an inlet and outlet port.

I is a port communicating between the cylinder and the valve-chest, and so located that it will be uncovered by the piston and communicate with the steam-chest E when the piston is in the position shown in Fig. 6.

e is a port communicating between the lower end of the valve-chest and the cylinder, and located, as shown in the drawings, so as to be controlled by the portion of the piston below its circumferential groove; and G′ is an exhaust-port communicating between the lower end of the valve-chest and the cylinder A, the same also being controlled by the said lower portion of the piston. The valve-chest is internally circumferentially grooved, forming internal annular steam-spaces, into which the outer mouths of the ports h^2, i, and I respectively open, the portions of the interior wall or face of said chest not included in said annular grooves constituting the valve-seats of the cylindrical portions of the valve G. The said valve G is formed, as hereinbefore stated, of a single cylinder of metal circumferentially grooved, as shown in the drawings, the cylindrical parts fitting with steam-tight joints into the said valve-seats. The heads h^4 h^4 of the valve-chest at either end, against which the ends of the valve abut, project into the chest with reduced diameters, thus respectively providing steam-spaces in the valve-chest at the ends of the valve when it is in contact with said heads, which communicate, respectively, with ports e, h, and G′.

E^2 is a longitudinal groove or recess in the cylinder, communicating with the steam-chest formed in the piston at E, and into which opens the steam-supply pipe E′, that communicates with the boiler. This groove E^2 permits the circumferential groove in the piston,

and of course the piston itself, as well as the cylinder, to be made considerably shorter than it would otherwise have to be in order to maintain constant communication between the pipe E′ and the said steam-chest, and yet permit the piston to have the requisite length of stroke.

The operation of the said device is as follows: Assuming the parts to be in the position shown in Fig. 3, the steam passing through the steam-chest E will pass through the port I into the passage *i*, through the annular space *g* into the lower end, J, of the cylinder, and throw the piston upward. When the piston thus begins its upward movement, the steam from the steam-chest E is acting against the lower end of the valve G and holding it in the position shown in said figure, the exhaust-port G′ being closed. As the piston moves upward it will first close the port *e*, then the port I, cutting off the steam from the lower end, J, of the cylinder, and also open the exhaust-port G′. When it has reached the position shown in Fig. 5, the piston will uncover the inner mouth, h^5, of the port *h*, and thereby admit steam into the upper end of the valve-chest, whereby the valve will be thrown downward into the position shown in Figs. 5 and 6, thus closing the communication through the annular space between the ports I and *i* and opening communication through the annular space between *i* and *i′*, thus closing the inlet-port to the lower end of the cylinder, even when the port I is opened by the piston, and opening the channel for exhausting from the lower end of the cylinder. By the uncovering of said port h^5, steam is also admitted into the upper end, H, of the cylinder. The piston will now begin its downward movement, and, closing successively the inner mouths of the ports *h* and h^2, thereby cuts off the steam from the upper end of the cylinder. Then, as it continues its downward movement, it will uncover the port I; but as the communication between I and *i* is at the moment closed, steam is not then admitted to the lower end of the cylinder through port *i*. The piston next uncovers the port *e* after closing the exhaust-port G′, steam being thus admitted to the lower end of the valve-chest through port *e*, and operating to throw the valve upward, the steam at the upper end of the valve-chest being at the moment exhausting through ports *h′* and *h*, the upper end, H, of the cylinder, and exhaust-port H′, by which movement of the valve communication is opened between I and *i* and steam is again admitted into the lower end of the cylinder. Now, it will be observed that the port *e* is uncovered sometime before the piston has reached the limit of its downward stroke in the cylinder, and that if steam were at that moment admitted into the valve-chest at full pressure, so as to reverse the valve, steam would be thereby admitted into the lower end of the cylinder, and the piston during the remainder of its stroke would be cushioned against the steam, thus impeding its movement and diminishing the force of the blow of the drill. To obviate this result, I make the inlet-port *e* of small diameter, so that the steam will be admitted into the lower end of the valve-chest so slowly that it will not reverse the valve until the piston has had time to move from the point where it uncovers the port *e* to near the limit of its downward movement in the cylinder. When the piston, in its downward movement, has uncovered the port *e*, the condition is thereby established in which the valve will certainly be reversed eventually. If by collision of the drill with the rock the piston should be arrested immediately after the port *e* is opened, there will be a momentary pause before the piston will commence its upward movement, the pause being for the time required for sufficient steam to pass through the port *e* to reverse the valve, and it is intended that this shall be equal to that occupied by the piston in moving from the inner mouth of the port *e* to the limit of any strokes beyond that point. Then, in proportion as the feed is less excessive and the length of the stroke of the piston is extended, the duration of the said pause is decreased until the stroke reaches the limit of motion in the cylinder, when the reversal of the valve occurs, and the introduction of the steam into the lower end of the cylinder takes place simultaneously with the termination of the stroke, and the piston begins its upward movement immediately after the blow is delivered. The port *e* is intended to open into the cylinder at a point where it will be reached and uncovered by the piston under the most excessive feed ordinarily practiced, so that the opening of said port at the termination of the working-stroke will at all times be assured under the greatest practical variations of feed. I find that locating the inner opening of this port so that the piston will move, after opening it, about one and three-quarter inch before reaching the limit of its movement in the cylinder will provide for sufficient variation of feed for practical puposes, while avoiding under all circumstances the premature introduction of the steam into the lower end of the cylinder. In order to attain the above-named result, it is necessary that the area of cross-section or conducting capacity of the passage *e* should bear a certain relation to the weight, diameter, and length of stroke of the valve G, and also to the velocity of the piston and the distance it moves from the point where it uncovers the port *e* to the limit of its stroke in the cylinder. The following statement of the proportions which are found to give satisfactory results in an ordinary working-drill of the usual dimensions will enable a skilled mechanic to adapt the size of the port *e* to variations in the dimensions of the machine. 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. It is obvious that the same result will be attained by enlarging the inlet-port *e* and constricting the exhaust-port of the opposite end of the valve-chest. If, when the steam should be let in full pressure to one end, this pressure should be balanced by equal steam-pressure at the opposite end, the valve will not, of course, be shifted until the pressure at the opposite end is reduced so far that the overbalancing pressure at the one end is sufficient to overcome the inertia and friction of the valve. The effect, therefore, is the same whether the exhaust is immediate and the inlet gradual or the inlet is immediate and the exhaust gradual; or both may be gradual, with the restriction of both together equal to the restriction of either one when the entire effect of the gradual admission or exhaustion of the steam is to be accomplished by the restriction of one alone.

The modification of the valve and exhaust-port at the upper end of the cylinder, by which the said gradual exhaust may be accomplished, is shown in Fig. 7, and consists in making the exhaust h^6 of the port h^3 in said figure of small diameter or cross-area and the port *e* of large diameter, as shown therein. The mouth h^6 should preferably be so located relatively to the inner mouth of the port *e* that it will be uncovered simultaneously therewith and simultaneously with the exhaust-port H′. By this arrangement the steam is let in so as to shift the valve G immediately upon the opening of said port *e*, were it not for the pressure of the steam at the upper end of the valve-chest. In order to adapt the valve G to the desired modification of the valve-chest exhaust shown in Fig. 7, the said valve is provided with an additional circumferential groove, h^7, forming an additional cylindrical part or head, h^8, and the steam-spaces in the steam-chest, the port h^2, and the main inlet-port *h* are so arranged that when the valve G is thrown down steam is let into the upper end, H, of the cylinder A from the steam-chest E through the port h^2, the steam-space surrounding the annular groove h^7, and the inlet-port *h*, and when the valve is thrown up it closes the outer mouth, *h*′, of the port *h* and cuts off the steam, the lower branch, h^{12}, acting only to admit steam to the upper end of the valve-chest to impel the valve downward.

In Fig. 8 are represented both the inlet to the lower end of the valve-chest and the exhaust-passage from the upper end of said chest, constricted so that jointly they will retard the transmission of steam, by the agency of which the valve is shifted to admit steam to the lower end of the cylinder, so that a delay occurs in the shifting of the valve, as hereinbefore described. It is obvious that with this arrangement both passages should be suitably constricted, so as to produce conjointly substantially the same result in retarding the transmission of steam as will be produced by the constriction of either one alone when the entire effect of the gradual transmission of steam is to be accomplished by the constriction of one. This any one skilled in the art will be enabled to do by reference to the directions hereinbefore given.

Another modification within the spirit of my invention would be to establish by suitable passages open communication between the supply-pipe E′ and both ends of the valve-chest with the exhaust-passages from the lower end of the said chest, and, if preferred, from both ends governed by the piston. Under these conditions, with both exhaust-passages closed, it is apparent that the valve would remain at rest, and that it would be reciprocated by the alternate opening of the exhaust at the opposite ends of the valve-chest. Now, if either the inlet-passage to the lower end of the said chest or the exhaust-passage at its opposite end were constricted as above described, the upward movement of the valve, after the commencement of the movement of the steam through such constricted passage, would be delayed until the gradual increase of pressure upon the valve should be sufficient to overcome the weight and inertia of the valve, as herein specified, and shown in Fig. 9.

In Fig. 9 are shown passages whereby open communication is maintained between the ends of the valve-cylinder and the live-steam supply. L L′ are said passages, communicating between the longitudinal groove E^2 and severally the ends of the valve-chest. By constricting the inner mouth of the inlet-passage L to the lower end of the valve-chest, or by constricting the outer mouth of the exhaust at the opposite end of the same, or by constricting both, the retarding of the steam, as before described, is effected. When these open steam-passages are used, the head h^3 of the lower end of the valve-chest should not be tapered, but should fill the steam-chest, so that when the piston abuts against it it will have substantially no steam-space in this end of the valve-chest. Then the passage-way for the exhaust through G′ can be made by a small groove in the under side of the head, which projects into the valve-chest.

The combination and arrangement described in the last preceding paragraph I claim in a separate application for a patent, Serial No. 117,724, filed January 16, 1884, and before this application was allowed and the patent passed to issue.

From the foregoing description it will be clearly understood that the essence of my invention is, together with suitable means for

transmitting steam by the agency of which the valve is shifted to open the inlet-port to the lower end of the cylinder that is brought into operation when the piston reaches the point of limit of the shortest working-stroke which, in practice, it is intended to be permitted to make, the described means and method whereby such transmission of steam is so controlled and limited that between the commencement of such transmission and the actual shifting of the valve there shall necessarily occur a determinate delay, for the purpose of enabling the piston to make its longer working-strokes by the time the steam is, by the shifting of the valve, introduced into the cylinder to effect the return-stroke of the piston, such control and limitation being effected by making the passage for such transmission of said steam of small cross-area or conducting capacity relatively to the diameter, weight, and length of stroke of the valve, the velocity of the piston, and the difference between its shortest and longest working-stroke, as described. The said described construction of the said passage is a necessary condition; but it is obviously not essential that the precise devices herein described for introducing the steam into said constricted passage (whether it be the inlet or the exhaust) at the termination of the shortest practical working-stroke of the piston should be employed. Any other suitable devices for that purpose adapted to the general structure and parts of the machine may be used.

It will be understood that my invention is applicable to other machines analogous to steam rock-drills—such as steam-hammers, pneumatic motors, &c.—in which the work done is the striking of a succession of blows by the reciprocation of a piston impelled by steam or other elastic fluid, and that when steam rock-drills are mentioned in this specification I intend to include such other analogous machines.

In three separate applications numbered, respectively, 117,722, 117,723, and 117,724, all filed on the 16th day of January, 1884, and before this present application was passed to issue, I have claimed several of the devices herein described, namely: In No. 117,722 I have claimed the means for cutting off the steam, whereby it is used expansively. In No. 117,723 I have claimed the means for compressing and confining the residual steam in the upper end of the cylinder, and in No. 117,724 I have claimed the combination of the means for preventing the premature introduction of steam into the lower end of the cylinder with the means for using steam expansively.

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

1. In a steam rock-drill or analogous machine in which the length of its working-strokes is liable to variation, the combination, with a steam-moved valve governing the inlet-port to the lower end of the cylinder, of a passage communicating with the valve-chest for the transmission of steam, by the agency of which the valve is shifted to introduce steam to the lower end of the cylinder, said passage being suitably constricted, as described, to so limit the transmission of steam that between the commencement of the movement through it of the steam whereby the valve is shifted and the actual shifting of the valve there shall necessarily occur a determinate delay, in which the piston may move beyond the point of the shortest working-stroke which, in practice, it is intended to be permitted to make, and make its longer strokes, as described, by the time steam is introduced into the lower end of the cylinder, as and for the purpose specified.

2. The method of decreasing the steam-cushioning in the working-stroke of the piston of a rock-drill or other analogous machine liable to make strokes of variable length, which consists in the application, at the time the piston reaches its shortest practical stroke, of a gradually-increased steam-pressure to the steam-moved valve governing the inlet-port to the lower end of the cylinder, whereby between the beginning of said pressure and the shifting by it of the said valve there will necessarily occur a determinate delay, as and for the purpose specified.

3. In a steam rock-drill or other analogous machine wherein the piston is liable to make strokes of variable length, the combination, with the piston and a steam-moved valve governing the inlet-port to the lower end of the cylinder, of an exhaust-passage from the upper end of the valve-chest and an inlet-passage to the lower end of the valve-chest, said inlet-passage being constricted, as described, for the purpose of compelling the gradual admission of steam to the valve-chest, whereby there shall necessarily occur a determinate delay between the commencement of the transmission of steam through said inlet-passage to shift the valve to admit steam to the lower end of the cylinder and the actual shifting of the valve, as and for the purpose described.

4. In a steam rock-drill or other analogous machine wherein the piston is liable to make strokes of variable length, the combination, with the piston and a steam-moved valve governing the inlet-port to the lower end of the cylinder, of an inlet-passage to the lower end of the valve-chest and an exhaust-passage from the upper end of the valve-chest, the said exhaust-passage being constricted, as described, for the purpose of compelling the gradual exhausting of the steam from said upper end of the valve-chest, whereby there will necessarily occur a determinate delay between the opening of said exhaust-passage and the shifting of the valve, as and for the purpose described.

5. In a steam rock-drill or other analogous machine wherein the piston is liable to make

strokes of variable length, the combination, with the piston and a steam-moved valve governing the inlet-port to the lower end of the cylinder, of the inlet-passage to the lower end of the valve-chest and the exhaust-passage from the upper end of the valve-chest, both being suitably constricted to conjointly retard the action of the steam to shift the valve, whereby there shall necessarily occur a determinate delay between the commencement of the movement through said passage of the steam to shift the valve to admit steam to the lower end of the cylinder and the actual shifting of said valve, as and for the purpose described.

6. In a steam rock-drill or other analogous machine, the steam-moved valve governing the distribution of steam to the cylinder, and the inlet and exhaust-passages to and from said valve, one of said passages—either the inlet or exhaust—at one end of the valve-chest, being constricted, as described, relatively to the corresponding passage at the other end of said chest, whereby the valve has a slow motion in one direction and a quick motion in the opposite direction, as and for the purpose described.

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