(No Model.) 2 Sheets—Sheet 1.

A. J. SYPHER.

ROCK DRILL.

No. 485,720. Patented Nov. 8, 1892.

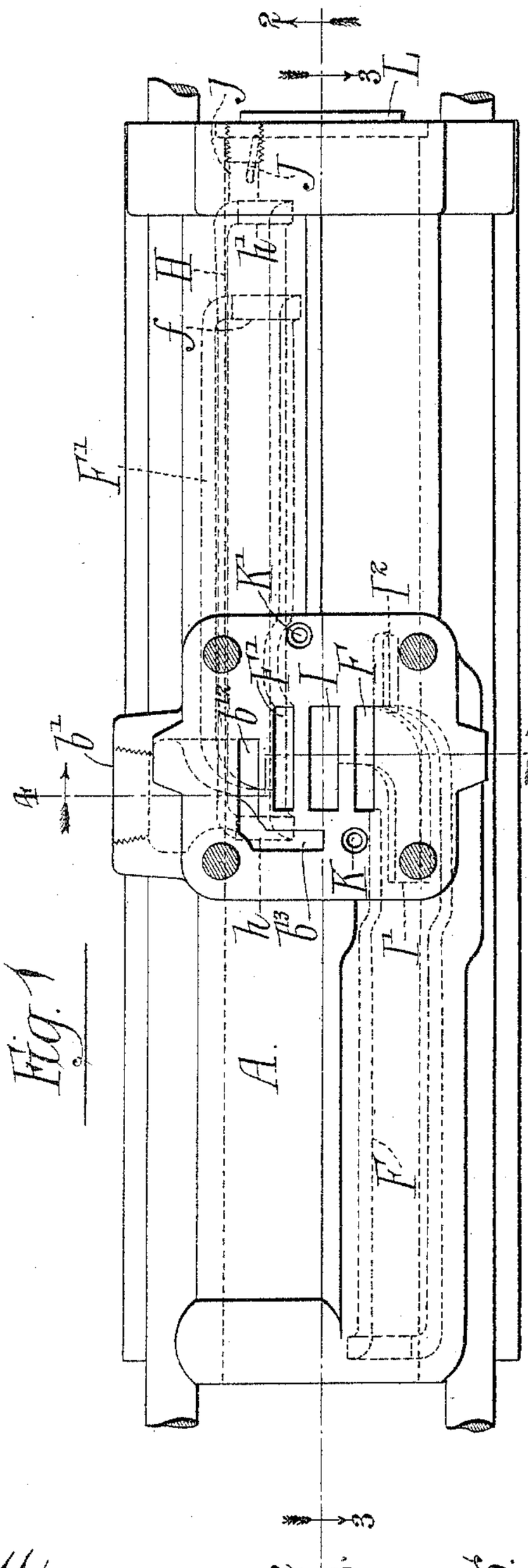

Fig. 1.

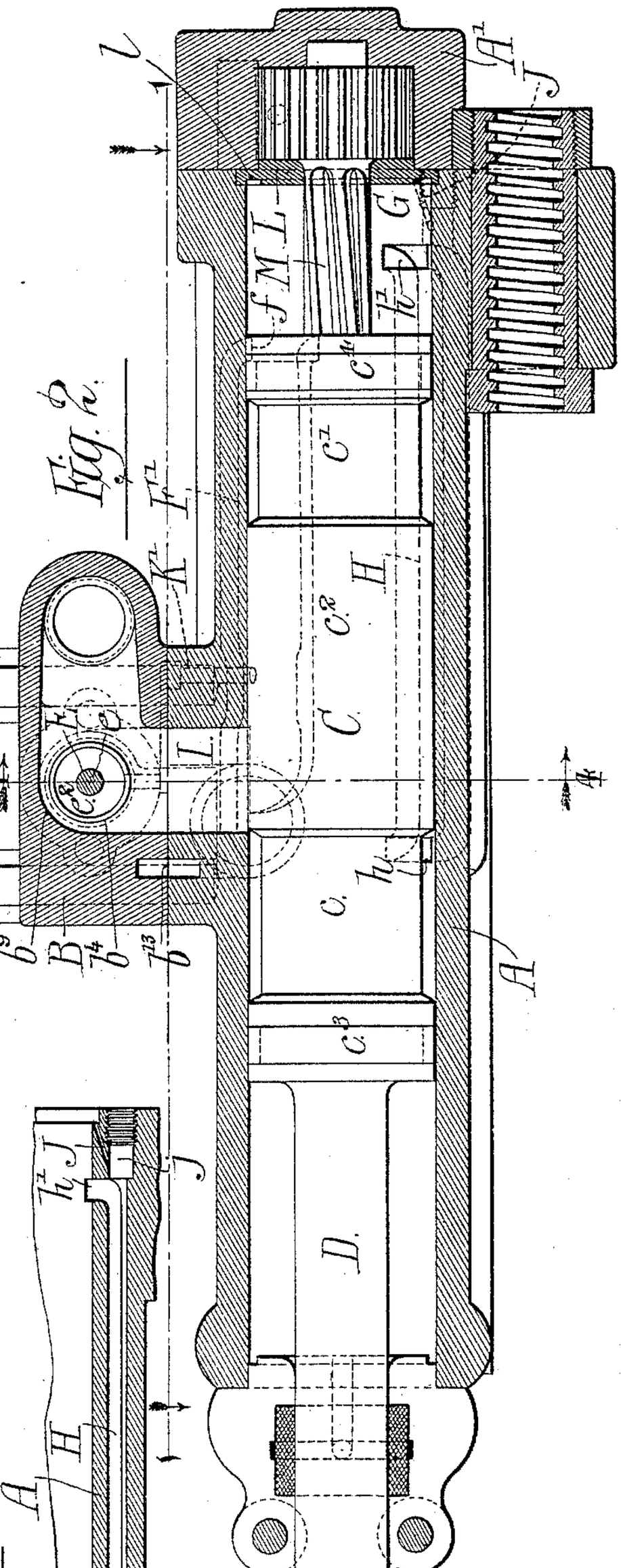

Fig. 2.

Fig. 6.

Witnesses:
Louis M. F. Whitehead.
C. E. Tomlinson.

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his Attorneys.

(No Model.) 2 Sheets—Sheet 2.

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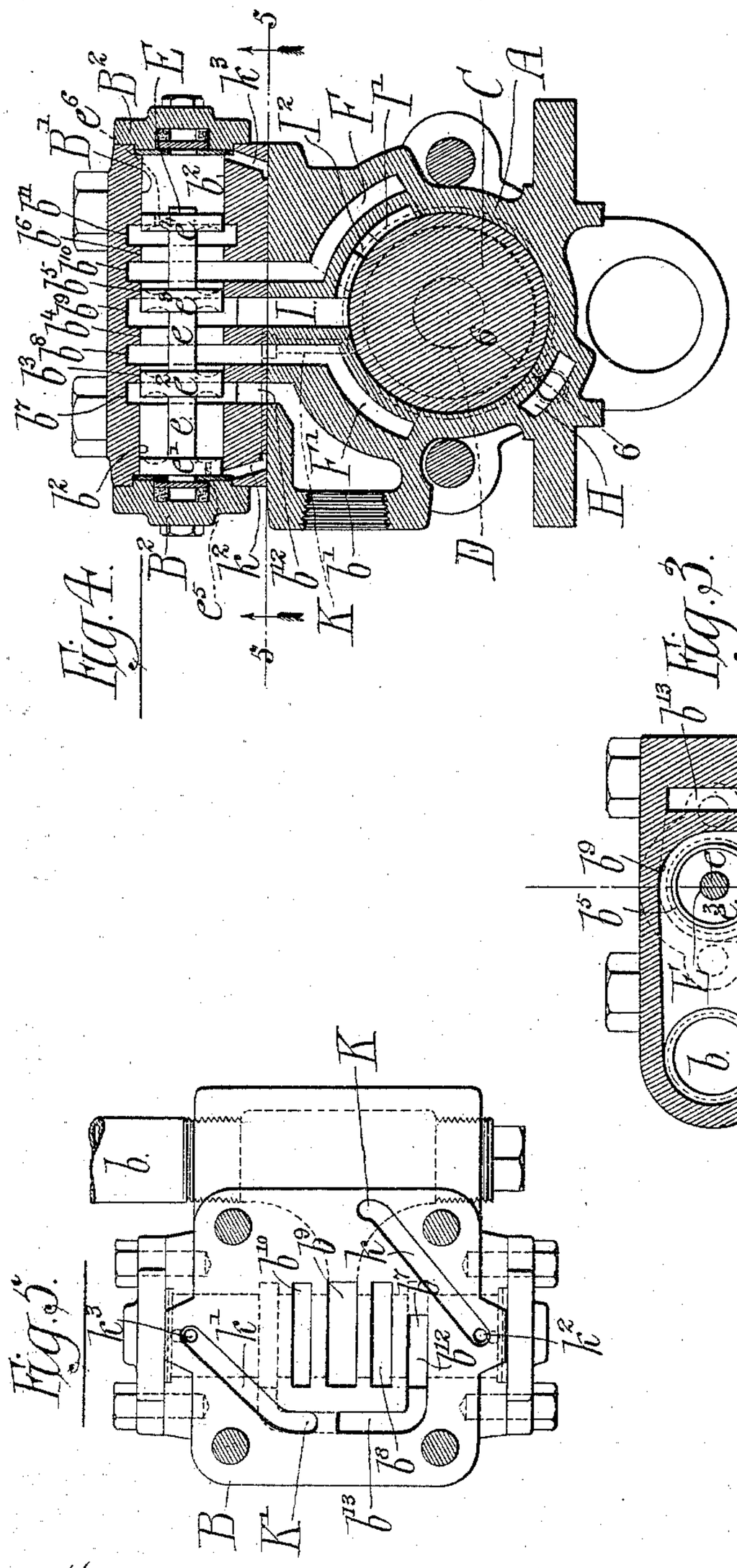

Fig. 4.

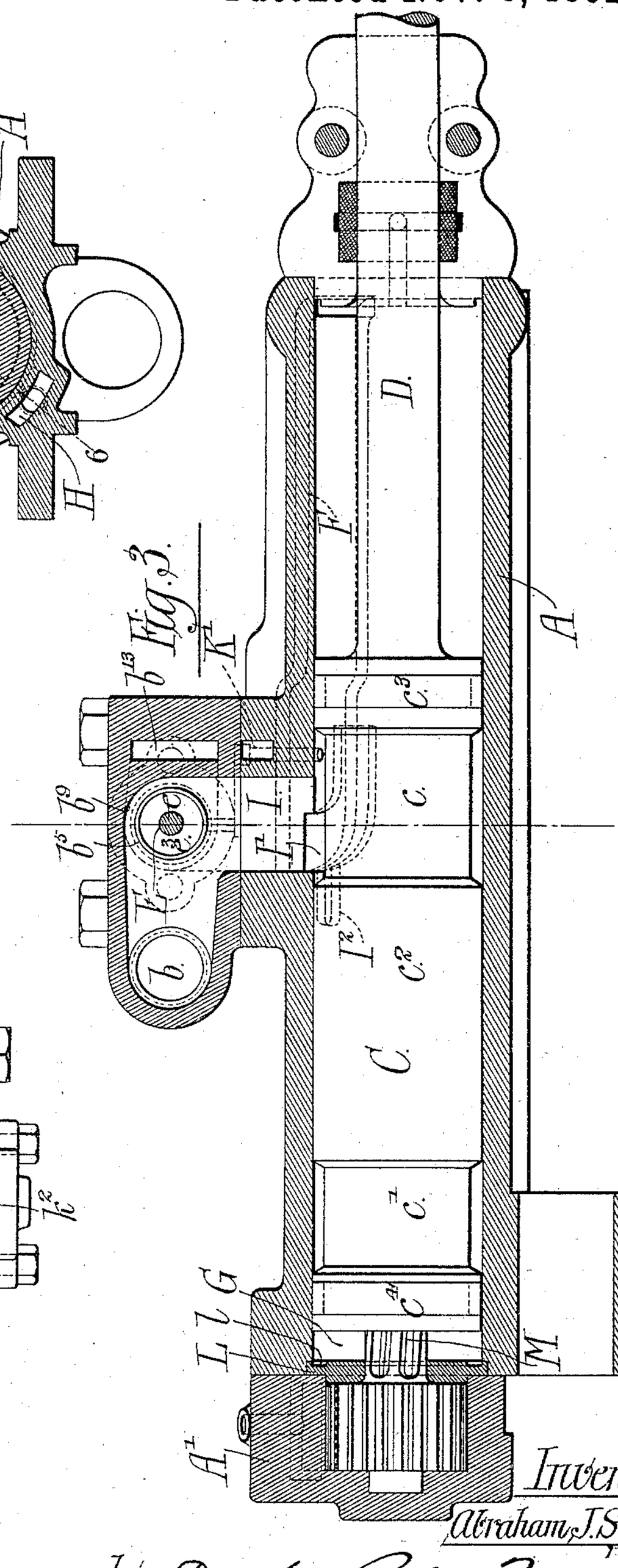

Fig. 3.

Fig. 5.

Witnesses:-

Louis M. F. Whitehead.

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Inventor:

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His Attorneys:-

UNITED STATES PATENT OFFICE.

ABRAHAM J. SYPHER, OF CHICAGO, ILLINOIS.

ROCK-DRILL.

SPECIFICATION forming part of Letters Patent No. 485,720, dated November 8, 1892.

Application filed February 9, 1892. Serial No. 420,875. (No model.)

To all whom it may concern:

Be it known that I, ABRAHAM J. SYPHER, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Rock-Drills; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in means for cushioning the cylinder-piston in rock-drills of that kind shown and described in a prior patent, No. 403,496, granted to me May 14, 1889, wherein steam is supplied to the end of the cylinder for cushioning the piston through a steam-passage, which is controlled by the piston and is independent of the steam-passages by which steam is admitted to the cylinder for actuating the piston.

The invention also embraces improvements in other features of rock-drills of the kind shown in said patent, as will hereinafter fully appear.

The invention consists in the matters hereinafter described, and pointed out in the appended claims.

In the accompanying drawings, Figure 1 is a plan view of a drill-cylinder embodying my improvements, the valve-casing being removed to expose the steam-ports. Fig. 2 is a central longitudinal section of the cylinder and valve-casing, as seen when looking in the direction of the arrows 2 2, applied to the section-line of Fig. 1. Fig. 3 is a similar section on the same line of Fig. 1, looking in the opposite direction, or as indicated by the arrows 3 3 of Fig. 1. Fig. 4 is a transverse section through the cylinder and valve-casing, taken on lines 4 4 of Figs. 1 and 2. Fig. 5 is a sectional view taken on line 5 5 of Fig. 4 and looking in the direction of the arrows 5 5. Fig. 6 is a detail section taken on line 6 6 of Fig. 4 and showing the auxiliary steam-passage.

As shown in the said drawings, A indicates the cylinder of the drilling apparatus; B, the valve-chamber thereof; C, the piston within the cylinder; D, the piston-rod, which passes through one end of the cylinder and to which the drilling-tool is attached; and E, a valve-piston located within the valve-casing B.

F F′ are steam-passages leading from the valve-casing to the opposite ends of the cylinder for the purpose of admitting steam to and exhausting it from the same.

G is a steam-cushioning space at the end of the cylinder, and H a steam-passage supplying steam to the cushioning-space, said passage being entirely separate from and independent of the steam-passages F F′ and the valve mechanism.

The piston C is made of considerable length, and is provided near its ends with annular grooves or recesses c c', forming a central bearing-surface c^2, which fits the bore of the cylinder, and annular bearing-surfaces c^3 c^4 at opposite ends of the piston. The piston thus constructed operates, in connection with certain ports and passages formed in the cylinder and valve-casing, to afford steam-pressure alternately at opposite ends of the valve-piston E in a manner to actuate said valve, and thereby control the admission of steam to and its exit from the opposite ends of the cylinder for actuating the piston. The piston thus constructed is, furthermore, adapted to operate, in connection with the independent steam-passage H, to admit steam to the cushioning-space G of the cylinder for cushioning the piston, as will hereinafter fully appear. The valve mechanism, including the valve-piston E, is constructed generally as set forth in said prior patent, No. 403,496, and will be now briefly described in order that the operation of the drill as a whole may be more readily understood.

Steam is supplied to the valve-chamber through the inlet b and is exhausted therefrom through the outlet b', the inlet b communicating with the central part of the valve-chamber, while the outlet b' communicates with the ends thereof. The valve-piston E consists of a stem e and four disks e' e^2 e^3 e^4. The said valve-piston is fitted within a valve-seat B′, closed at its ends by heads B^2 B^2 and having cylindric end bearing-surfaces b^2 b^2 and intermediate narrow bearing-surfaces b^3 b^4 b^5 b^6, within which the several valve-disks are adapted to closely fit. Between the bearing-surfaces named are formed annular recesses b^7 b^8 b^9 b^{10} b^{11}. Of these recesses the middle recess b^9 is in communication with the steam-inlet port or passage b, and also

with the port or passage I, leading to the interior of the steam-cylinder. The recesses b^8 b^{10} at either side of the central recess communicate with the steam-passages F F′ of the cylinder, as clearly seen in Fig. 4, and the external recesses b^7 b^{11} communicate with the exhaust-outlet b'. The recess b^7, seen at the left-hand side of Fig. 4, communicates by a passage b^{12} directly with said exhaust-outlet b', while the recess b^{11}, seen at the right-hand side of Fig. 4, is connected with the said exhaust-outlet by means of a passage b^{13}, extending at one side of the valve-seat, as seen in Fig. 5, and opening into the passage b^{12}, said passage b^{13} being formed partially in the wall of the valve-chest and partially in the wall of the cylinder, as clearly seen in Figs. 1, 2, 3, and 5.

K K′ are steam-passages leading from the interior of the cylinder outwardly through the wall of the same to the inner surface of the steam-chest, where they are connected with passages k k', formed between the adjacent surfaces of the steam-chest and cylinder casting, and which lead to points adjacent to the ends of the valve-seat B′ and communicate with the spaces in said valve-seats outside of the end disks of the valve-piston by means of ports k^2 k^3. Steam entering the valve-chest through the said ports k^2 k^3 acts upon the ends of the valve-piston to move the latter endwise in its seat.

At the inner end of the passage I is formed a recess I′, which extends along the inner surface of the cylinder toward the outer end thereof, said recess I′ being deflected laterally, as shown, so as to pass at one side of the passage K. A similar recess I^2, Figs. 3 and 4, extends from said passage I along the inner surface of the cylinder in the opposite direction or toward the inner end of the cylinder, said recess being shown as forming a branch or extension of the recess I′.

The valve mechanism shown operates as follows: The valve-piston E being at or near one limit of its throw, as seen in Fig. 4, live steam entering the passage b will pass from the recess b^9 through the recess b^8 and steam-passage F′ to the inner end of the cylinder. At this time steam is free to pass from the inlet b through the port I and the recess c' to the passage K′ and thence to that end of the valve-chest which is seen at the right-hand side of Fig. 4, and holds the valve-piston in position for the delivery of steam to the inner end of the cylinder. While live steam is thus being delivered through the passage F to the inner end of the cylinder, steam is exhausted from the opposite or outer end of the cylinder through the passage F′, the recesses b^{10} and b^{11} and passages b^{13} and b^{12} to the exhaust-outlet b'. As soon as the piston has moved outwardly such distance that its central bearing-surface c^2 covers the passage K′ access of live steam to the end of the valve-chest is cut off and the steam contained in that end of the valve-chest leaks through a small aperture e^6 in the disk e^4 to the passage b^{11} and exhausts therefrom. This leakage of the steam through the disk e^4 takes place while the piston is making its outward stroke and during the time that both passages k k' are closed or covered by the bearing-surface c^2 of the piston. When the piston approaches the outward limit of its stroke, the said surface c^2 passes and leaves open the passage K, and as soon as the recess c reaches the recess I^2 steam passes from the port I to the passage K and thence through the passages k and k^2 to the valve-chest behind the disk e', whereby the valve-piston E is shifted into position to admit steam to the outer end of the cylinder at the time the piston reaches the forward limit of its stroke. By reason of the longitudinal extension of the steam-passage I, by means of the recesses I′ I^2, communication between the said passage I and the passages K K′ takes place sooner than would be the case if said recesses were not present.

To now refer more particularly to the cushioning devices, the inlet h of the passage H is so located, as seen in Fig. 2, as to be uncovered by the bearing-surface c^2 shortly after the piston reaches the point in its backward or inward stroke at which steam may obtain access to the recess c of the piston from the port I and when the port or outlet f of the passage F′ has been closed by the bearing-surface c^4 of the piston, said port or outlet f being arranged at a greater distance from the inner end of the cylinder than the outlet h' of the said passage H. As soon as the recess c comes opposite the inlet h live steam flowing into said recess from the port I through the recess I′ passes from said recess c through the passage H and outlet h' of said passage into the steam-cushioning space G. Said outlet h' is arranged at such distance from the inlet h that the outlet h' will be covered by the bearing-surface c^4 before the bearing-surface c^3 at the opposite end of the piston reaches the said inlet h. It follows that as the piston continues to move inward the outlet h' will be closed as soon as the piston reaches the same, and all of the steam contained in the cushioning-space G will be locked or imprisoned in said space and will be utilized to cushion the stroke of the piston. Expansion of the steam thus confined operates to start the return stroke of the piston, and as soon as the port h' is uncovered live steam will be admitted through the passage H, and when the port f is subsequently uncovered steam entering through the passage F′ will complete the outward stroke of the piston. The principal office of the recess I′ is to secure the admission of steam to the recess c before the inlet h of the passage H is uncovered by the bearing-surface c^2 of the piston, so that live steam will promptly enter said passage as soon as its inlet is opened, it being obvious that the access of steam to the cushioning-chamber would be considerably retarded if it were necessary for the steam to

first pass through said recess *c*, as was the case in the construction shown in my said prior patent, wherein the access of steam to the cushioning-chamber did not take place until after the central bearing-surface passed and uncovered the live-steam port of the cylinder.

In the construction shown in said prior patent, No. 403,496, an independent cushioning steam-passage similar to the passage H is employed to admit steam to the cushioning-space at the end of the cylinder. As shown in that patent, however, the outlet of said passage is arranged adjacent to the head of the cylinder and the inlet-opening of the passage is so located that it is covered by the annular bearing-surface at the end of the piston remote from the head, when the piston reaches the usual limit of its stroke, so that the outlet-opening is not closed by the piston, but remains constantly open in the usual operation of the drill. It follows that in the construction referred to, in the usual operation of the drill, the cushioning is accomplished by the steam confined within the cushioning-space added to that confined in the continuous steam-passages. This construction has been found objectionable because the said passage forms a relatively-large space in addition to the cushioning-space within the cylinder, with the result that a relatively-small degree of compression of the steam is produced by a considerable movement of the piston. This may be better understood by the statement that if the area of the said steam-passage is equal to the area of the cushioning-space in the end of the cylinder then the steam will be compressed during the movement of the piston through a space of one inch only half as much as it would be if the passage were not in communication with the cylinder at the time of compression, and if the impetus of the piston in its back stroke were sufficient to compress the steam into a space not larger than that afforded by the said passage then all of the steam would be forced into the passage and the piston would strike the inner end of the cylinder. In the construction shown in said patent the outlet-opening of the cushioning steam-passage is located near the head of the cylinder and at a point remote from the outer end or limit of the cushioning space or chamber, the length of which space in the construction shown in said patent is determined by the point at which the annular bearing-surface at the outer end of the piston closes the inlet-opening to the cushioning steam-passage. The construction herein described differs from that shown in said prior patent by the location of the outlet-opening of said cushioning steam-passage at the outer end or limit of said cushioning steam-space, so that the steam space or chamber is defined or its length determined by the position of the outlet-opening of the steam-passage, instead of the inlet-opening thereof, as is the case in the construction shown in said prior patent. In the improved construction described all of the steam within the cushioning-space is positively locked or confined therein as soon as the piston passes the outlet-opening referred to, and the full cushioning effect of all of the steam is thus afforded to take up the impetus of the piston. In this construction, furthermore, the inlet of the said cushioning steam-passage being uncovered and in communication with the annular recess *c* during the time the outlet-opening therein is closed by the piston, the cushioning steam-passage remains in communication with the live-steam supply-passage I, and live steam therefore fills said passage and is in readiness to enter promptly behind the piston as so on as the said outlet-opening is uncovered in the return stroke of the piston. The construction described has the same advantages obtained by that set forth in said prior patent of avoiding the necessity of giving a long lead to the main valve, which would be necessary to secure a sufficiently-prompt admission of steam to the cushioning-space in case the cushioning steam-passage were not independent of the steam-valve and controlled solely by the piston. The construction herein described has, however, other and further advantages which may be better understood from the following:

In all engines where the length of the stroke is not determined by a crank there is liable to be great concussion at the end of each stroke of the piston, and this is especially true of rock-drills, owing to the rapid movement of the piston thereof. Many patents have been issued showing devices intended to prevent such concussion or pounding of the piston—as by the use of elastic buffers to receive the blow or by admitting steam behind the piston by means of a valve.

Devices of the character referred to might be made to work in a fairly-satisfactory manner if the machine were used to drill in one direction only—as, for instance, vertically downward; but when the machine is made to act both upwardly and downwardly a construction which will work satisfactorily in drilling downwardly will when reversed result in the striking of the piston against the back head of the cylinder, which is liable to be knocked out by the force of the concussion.

In the construction herein proposed I can efficiently cushion the piston in a very short movement thereof after the cushioning begins, such movement in ordinary drills not being required to be over one and one-fourth inches. This result is accomplished by imprisoning or locking the steam in the cushioning-space entirely by the action of the piston on the outlet-opening of the cushioning steam-passage, so that the cushioning is entirely independent of the main valve or its passages and is secured by a small quantity of steam. In a machine thus made the valve has virtually no lead, inasmuch as the piston closes the main steam-inlet port to the cylinder before the valve is moved to admit steam therethrough, and this port remains closed until

the piston passes the same on its outward stroke. In other words, no movement of the valve to admit steam to the end of the cylinder at which the cushioning-space is located need take place until after the end of the piston has passed the inlet-port and has entered the cushioning-space, so that the movement or shifting of the valve may take place at any time before the piston again uncovers the said port in its outward movement.

When working a drill of the character described in overhead work or where the working end of the drill is directed upwardly, the piston when the drill is not in operation will descend by gravity into contact with the inner end of the cylinder A, and when in this position it becomes impossible to move the piston unless steam is introduced at a point below or behind the same. It has been heretofore proposed to employ for the purpose a branch steam-passage leading from the main steam-passage which supplies the inner end of the cylinder and containing a check-valve. As an improved means of accomplishing this result, I provide in the wall of the cylinder a small passage or opening J, leading from one of the live-steam spaces or passages to the end of the cylinder, said passage J being unobstructed or without any check-valve and being so small as to have no effect upon the cushioning action of the steam confined in the cushioning space or chamber G of the cylinder. This passage, inasmuch as it opens into a steam-supply passage, will be subject to boiler-pressure, and a small quantity of steam may be forced through the same under the extreme pressure produced in the cushioning-chamber by the impetus of the piston; but the said passage will be made so small that the quantity of steam which can escape therethrough in the brief period of time during which the pressure takes place will have no appreciable effect on the cushioning action of the imprisoned steam.

As herein shown, the passage J is connected with the cushioning steam-passage H at a point adjacent to the exit-opening of the same, so that said passage J is supplied with steam in first starting the drill through the medium of the steam-passage I and recess *c*, the inlet-opening *h* of said passage H being in constant communication with said recess *c* when the piston is at the backward limit of its throw. The connection of the said passage J with the cushioning steam-passage H has the advantage of insuring a supply of steam to start the piston without reference to the position of the main valve E. The passage J is shown as connected with an annular groove *l*, formed in a plate L, which is secured between the head A′ of the cylinder and the end of the same, and which holds in place the spirally-grooved spindle M, through the medium of which rotary motion is given to the drill, as heretofore common. A hole *j*, Fig. 6, is shown as being formed in the end of the cylinder in communication with the passage H, and into which the small passage J extends, said hole *j* being closed by a screw-plug in the manner shown.

While I have shown the cushioning device as applied to one end only of the cylinder, yet it is obvious that the same features of construction may be applied to the outer or forward end as well as to the inner or rear end of the cylinder, so as to cushion the piston at the end of both its out and in stroke or at the end of its stroke in either direction. I have referred in the foregoing description to the use of steam for actuating the piston; but it will of course be understood that compressed air or other gaseous agent under pressure may be used with the same effect.

I claim as my invention—

1. The combination, with the cylinder provided with a live-steam port, steam supply and exhaust passages, and with a cushioning steam-chamber at one end, and a piston provided with annular recesses near its ends, and a main valve actuated by the passage of steam through said recesses and controlling said steam supply and exhaust passages, of a cushioning steam-passage separate from the supply and exhaust passages leading from the central part of the cylinder to the cushioning-chamber, the inlet-opening of said cushioning-passage being arranged in position to take steam from one of the said annular recesses when the latter is in communication with the live-steam port of the cylinder and the outlet-opening of said steam-passage being located at a distance from the end of the cylinder equal to the length of the cushioning-chamber, substantially as described.

2. The combination, with a cylinder provided with central live-steam port, steam supply and exhaust passages leading to its ends, and a cushioning steam-chamber at one end, of a piston provided with annular recesses near its ends, a main valve actuated by the passage of steam through said recesses and controlling said steam supply and exhaust passages, a cushioning steam-passage separate from the supply and exhaust passages and leading from the central part of the cylinder to the cushioning-chamber, the inlet-opening of said cushioning steam-passage being arranged in position to take steam from one of the said annular recesses when the latter is in communication with the live-steam port of the cylinder and the outlet-opening of said passage being located at a distance from the end of the cylinder equal to the length of the cushioning-chamber, said cylinder being also provided with a recess I′, leading from the live-steam port past the inlet-opening of said cushioning steam-passage, substantially as described.

3. The combination, with the steam-cylinder of a rock-drill, provided with a cushioning-space at one end with steam-supply passages, of a small unobstructed steam-passage leading from one of said steam-supply passages to the end of the cushioning-space of

the cylinder, substantially as and for the purpose specified.

4. The combination, with the steam-cylinder of a rock-drill, provided with steam-supply passages, a cushioning-space at one end, and a separate cushioning steam-passage opening into said cushioning-space, of a small unobstructed passage leading from the cushioning steam-passage to the extreme end of the cylinder, whereby steam for starting the piston is obtained through said cushioning steam-passage, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

ABRAHAM J. SYPHER.

Witnesses:
C. CLARENCE POOLE,
TAYLOR E. BROWN.