3 Sheets--Sheet 1.

H. RICHMANN.

Rock Drilling Apparatus.

No. 233,020. Patented Oct. 5, 1880.

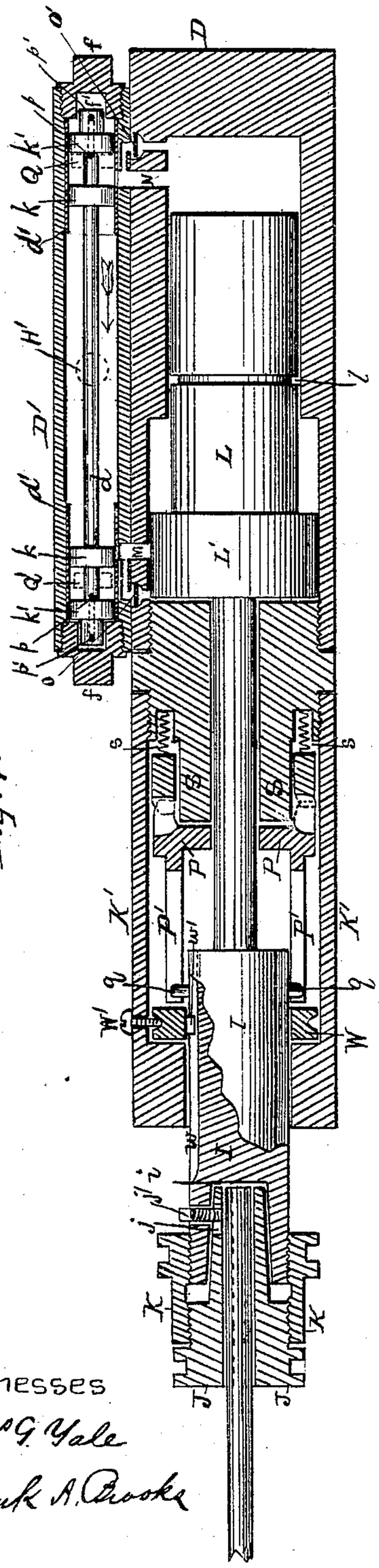

Fig. 1.

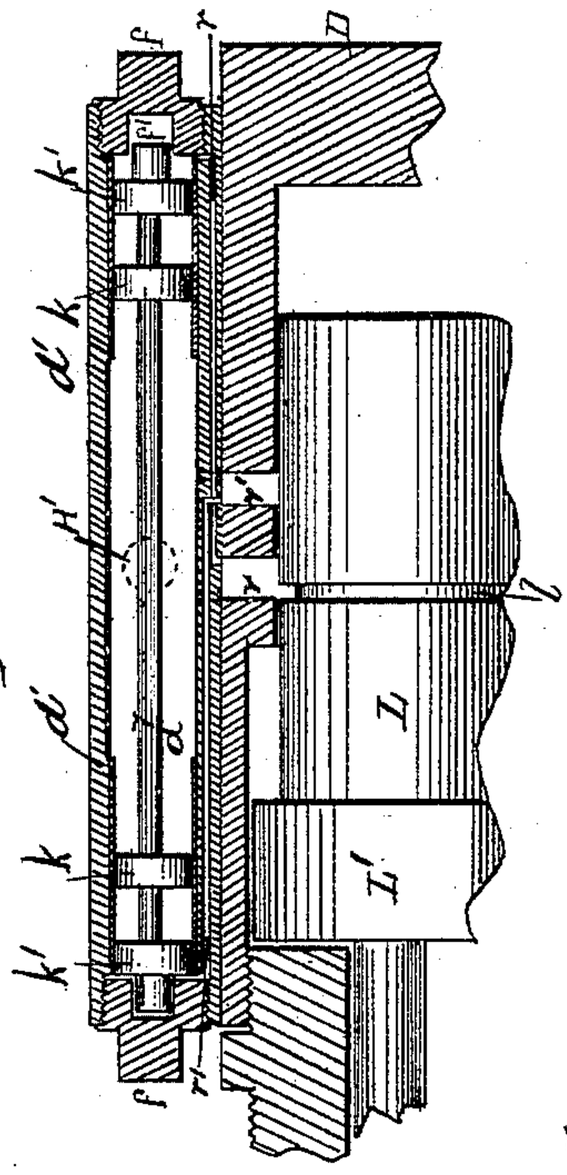

Fig. 2.

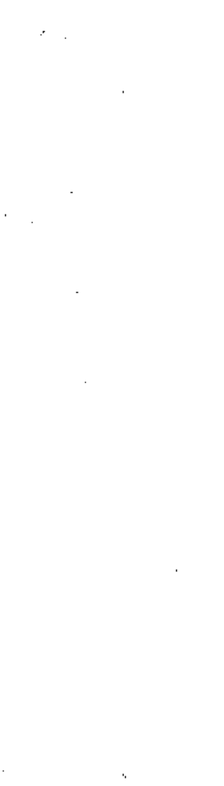

Fig. 5.

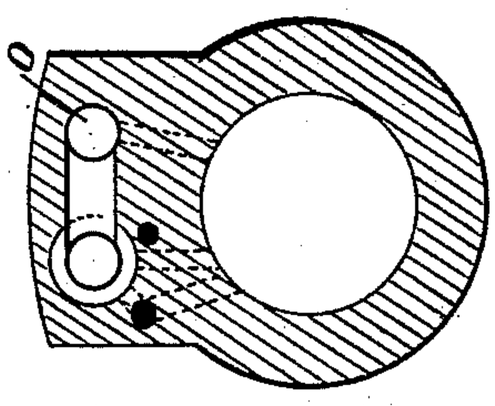

Fig. 4

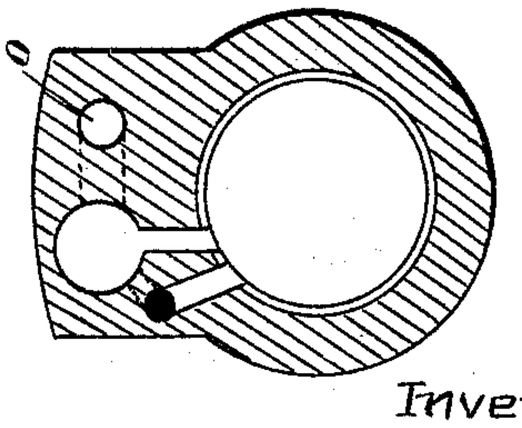

Fig. 3

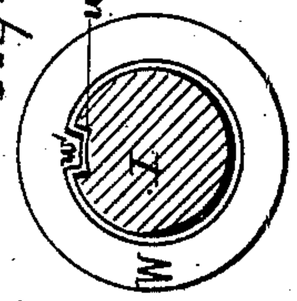

Fig. 6.

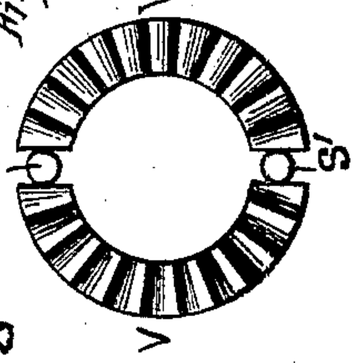

Fig. 7.

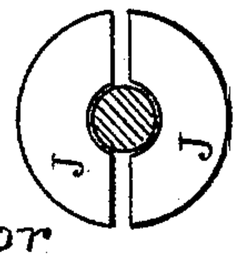

Fig. 8

Witnesses

Chas G. Yale

Frank A. Brooks

Inventor

Henry Richmann

3 Sheets—Sheet 2.

H. RICHMANN.

Rock Drilling Apparatus.

No. 233,020. **Patented Oct. 5, 1880.**

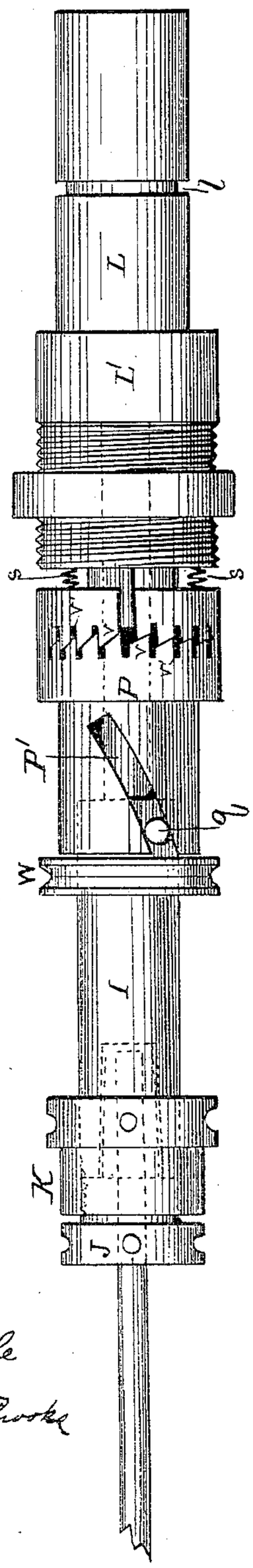

Fig. 9.

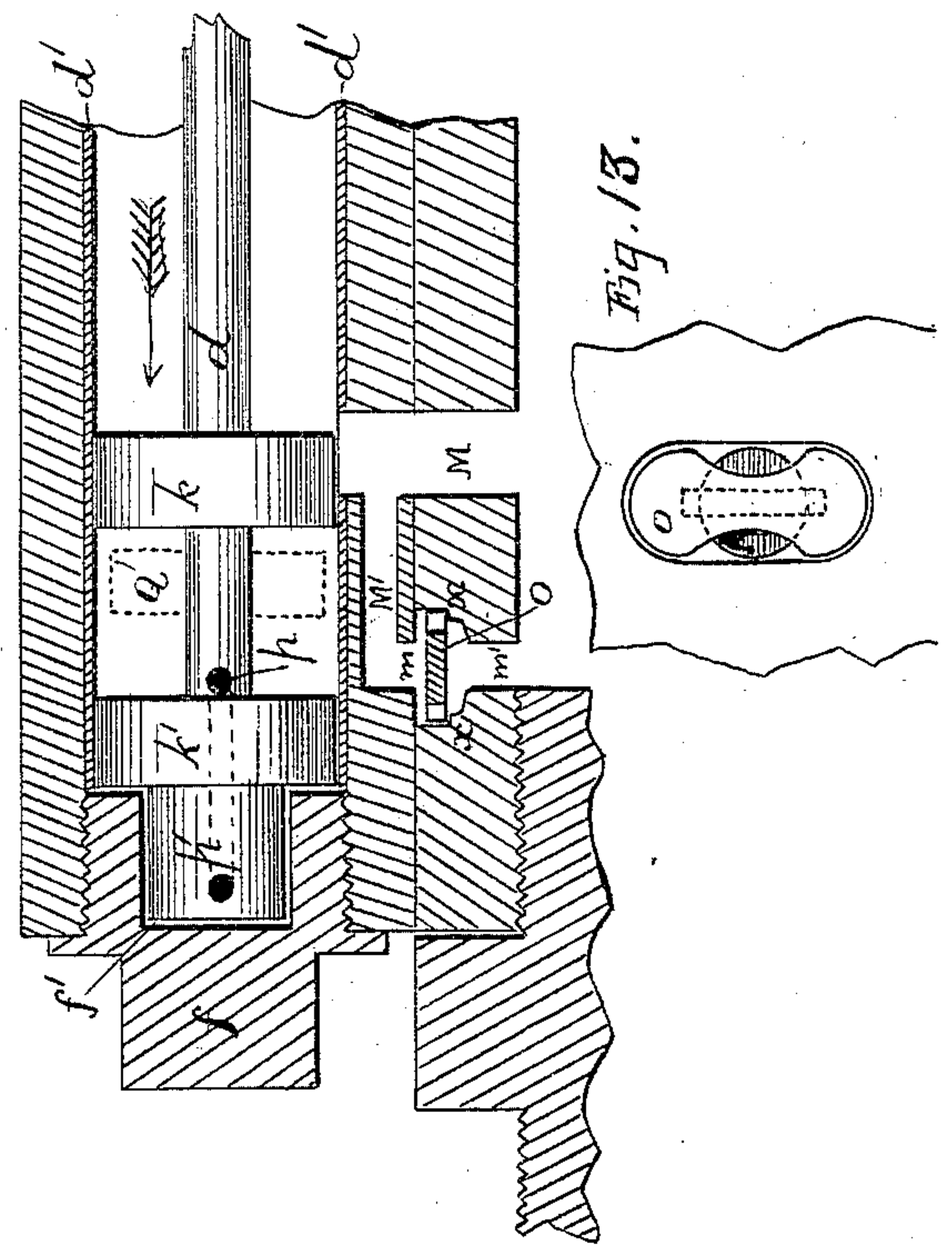

Fig. 10.

Fig. 13.

Fig. 11.

Fig. 12.

Witnesses
Chas G. Yale
Frank A. Brooks

Inventor
Henry Richmann

3 Sheets--Sheet 3.

H. RICHMANN.

Rock Drilling Apparatus.

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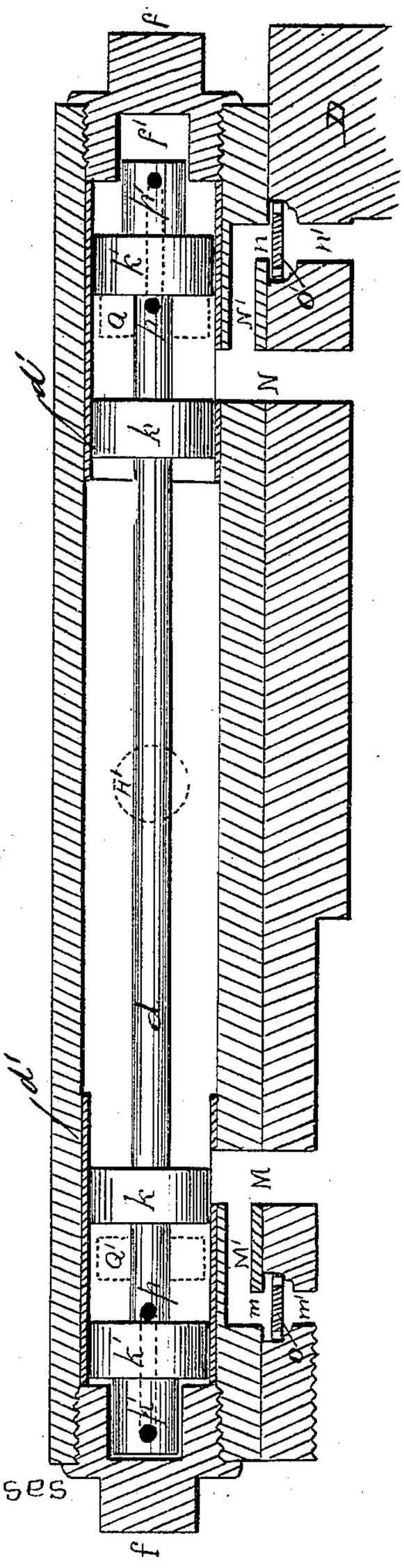

Fig. 14.

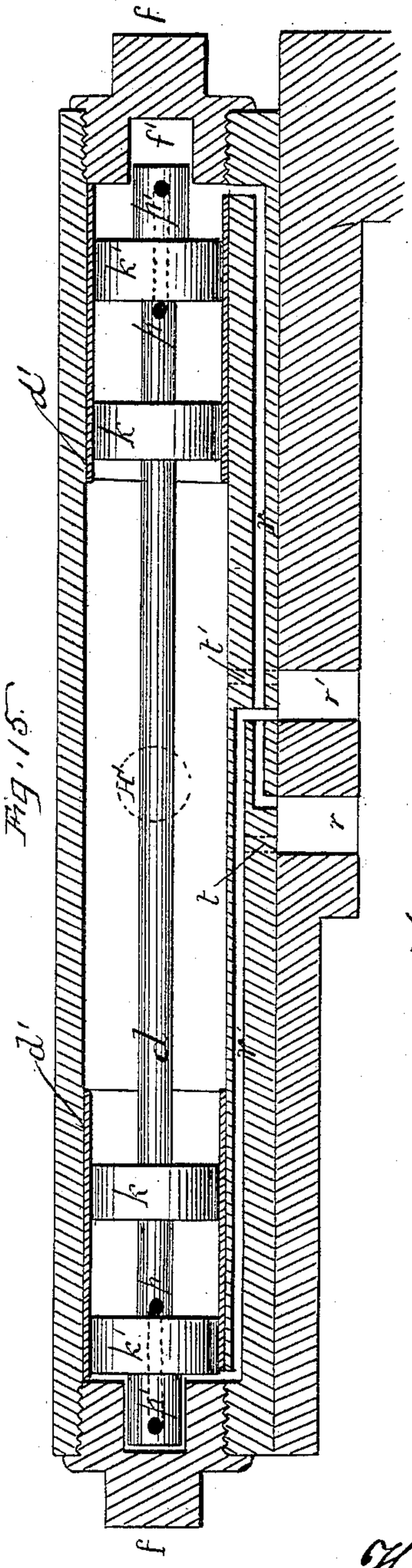

Fig. 15.

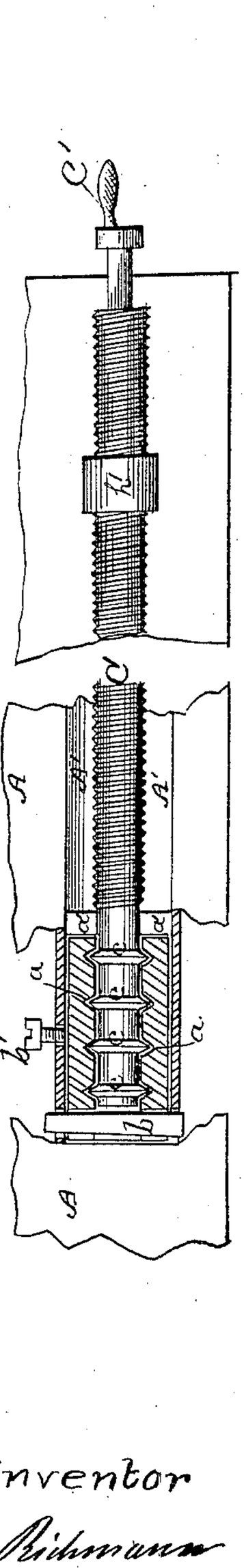

Fig. 16

Witnesses

Chas. G. Yale.

Frank A. Brooks

Inventor

Henry Richmann

UNITED STATES PATENT OFFICE.

HENRY RICHMANN, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR OF FIVE-EIGHTHS OF HIS RIGHT TO URIAH K. ARNOLD, OF SAME PLACE.

ROCK-DRILLING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 233,020, dated October 5, 1880.

Application filed February 2, 1880.

To all whom it may concern:

Be it known that I, HENRY RICHMANN, of the city and county of San Francisco, and State of California, have invented an Improved Rock-Drilling Apparatus; and I hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to certain improvements in that class of direct-acting engines intended to actuate, by air or steam, a drill or tool for boring rock, the drill being actuated directly from a piston moving within a cylinder, which cylinder is, in turn, guided in a case or carriage suitably connected with a column or tripod for holding it in any desired position.

My invention consists in a peculiar arrangement of the valves and ports of the drill-operating piston and its actuating-valve, by which both valve and piston are cushioned and a high speed can be obtained without striking the heads of the cylinders, and by which the operating mechanism is simplified.

It also consists in an improved means for rotating the drill and in an improved means for protecting the feed-screw of the cylinder from the effects of the jar or wear.

It further consists in a peculiar means of attaching the drill-tool to the head or piston, and in certain details of construction, which are more completely shown in the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view through cylinder and air-chest. Fig. 2 is a longitudinal section through the air-chest, showing passages *r r'*. Figs. 3 and 4 are transverse sections of the cylinder and air-chest. Fig. 5 is a longitudinal section of exhaust-passage. Fig. 6 shows the ring W with its lug. Fig. 7 shows the face of the ratchet. Fig. 8 shows the face of the drill-clamp. Fig. 9 is a plan of the drill removed from the casing. Fig. 10 is an enlarged section of one end of the air-chest. Figs. 11 and 12 show the under and upper faces of the air-chest. Fig. 13 shows the face of the valve O. Figs. 14 and 15 are enlarged sections of the air-chest. Fig. 16 is a broken section of feeding-screw in case or carriage.

Let A represent the semi-cylindrical case or carriage in which the cylinder and the operating mechanism of the drill are supported, this case or carriage having formed upon its side a hollow bevel-edged trunnion, by means of which it is attached to the column or tripod by a suitable clamp. The case or carriage is made of such a shape that the cylinder may slide back and forth in it, but can only be removed at the ends.

On one side of the case or carriage is formed the feed-screw chamber or cover, A', this cover projecting up beyond the upper end of the case and inclosing or covering the feed-screw C, at the upper end of which is the feed-screw crank C'. On the side of the cylinder D is the carrier *h'*, through which the screw C passes, so that by turning the said screw the cylinder with its drill is moved back and forth as desired.

In the ordinary method of fitting feed-screws to drills the screw is liable to become loose by the continued back-and-forth motion of the drill, owing principally to the defective means of securing the screw itself, the bearing of which becomes worn by the jar. This defect I overcome by forming on the lower end of the screw C two, three, or four, or more annular V-shaped flanges or rings, *c*, which fit in corresponding grooves in a box, *a*. This little box *a* is made in two parts, and fits in the lower end of the chamber or screw-cover A', between a shoulder, *a'*, and a key, *b*, a set-screw, *b'*, keeping the two sides of the box together in position. By having three or four V-shaped flanges on the lower end of the screw plenty of bearing is given to hold it, and the key keeps the box ahead and prevents it or the screw from jarring. The screw is not therefore liable to become loose, and the cylinder and drill are held rigidly to their work.

The method by which I secure my drilling-tool to the drill-head or piston-rod is peculiar, and is such that it is griped securely, not at one point alone, but for all of its length inside the drill-head. In order to accomplish this the drill-head I, which is attached to or forms part of the piston-rod, has a tapering hole, *i*, formed in its end, and its outer end has right-hand threads upon it, as shown.

The drill-clamp J is made in two or more pieces, and is tapered to correspond with the

tapering hole in the drill-head. In this instance I have shown it in two pieces. A slot, *j*, is formed in the tapering portion, into which a small screw, *j'*, projects, this screw passing through the drill-head and setting on flush. The slot *j* is extended or elongated to allow of the clamp being moved inward or outward for a certain distance; but the screw *j'* prevents the clamp coming out altogether. The outer end of the clamp has left-hand threads formed upon it inside of the shoulder, as shown.

To cause the clamp to gripe the drill I employ a sleeve, K, the inner portion of which is threaded half right and half left with threads of different pitch. That portion nearest the drill-head is threaded to take the right-hand threads of the drill-head, and that portion nearest the drill is threaded to take the left-hand threads of the clamp, which are of different pitch from the threads of the drill-head end. To insert the drill in the clamp the clamp proper is slightly screwed out by turning the sleeve K, and opens enough to allow the drill-butt to enter, and is then screwed back. To cause the clamp to gripe the drill tightly the sleeve is screwed in, thus drawing farther into the beveled hole in the drill-head the beveled clamp carrying the drill-tool. As this clamp comes in the beveled sides squeeze the clamp more tightly, and cause it to gripe the drill-tool for the whole length of said clamp, but at no one point more than another.

The screw-threads on the sleeve are so formed that the rotation of the drill with its attendant jar tend to screw it tighter instead of loosening it, and, being internally threaded in two directions, it also acts as a jam-nut to hold the clamp to the drill-head. The drill-tool is thus held rigidly in place and has a long bearing, but is readily removed by loosening the clamp, which cannot jam, owing to the peculiar construction described.

To tighten or remove the drill it is necessary to put a pin or lever in one of the holes of the drill-clamp and hold it, and by turning the sleeve when the clamp is held still the drill can be either removed or tightened, according to the direction in which the sleeve is turned.

A novel feature in my device is the operation of the valves controlling the admission and emission of steam or air to the piston, and the means by which the piston itself is operated, and also the method by which both valve and piston are cushioned.

The cylinder D has attached to it, on one side, the air-chest D', in which the valve moves. A valve-chamber is formed in this air-chest by placing therein a steel bushing, *d'*, and the valve fits inside of this steel bushing, which is slotted to communicate with the parts, as hereinafter described. The valve or bushings may be removed or examined at any time by taking out the hollowed heads or screws *f* at the ends of the chamber. The cylinder is not bored the same size all the way through, since I make my piston of two diameters, to which the cylinder must be accommodated.

Usually in rock-drills there is not as much force exerted on the piston on the back stroke as on the forward stroke, since the presence of the piston-rod at the front end reduces the effective area of the piston at that end. Drills sometimes, therefore, stick or move slowly in being moved back, a defect which I remedy by making the front end, L', of the piston L larger than the rear. The increased diameter of the front end is sufficient to account for the loss from the diameter of the rod, and the opposite ends of the pistons are therefore of the same effective area. I have, consequently, the same piston-area at both ends, and the piston is given the same power in drawing back as in going ahead.

Near the center of the piston is an annular groove, *l*, for establishing connection between two ports, as hereinafter described, in order to give motion to the air-valve.

The air or steam for driving the drill is admitted to the valve through the neck or opening H', and then fills the valve-chamber between the inner heads or pistons, *k*, of the valve. As the valve moves forward, as indicated by the arrow, the head *k* passes by the opening or inlet-port M, allowing the air to pass into this port; but as the piston L and the valve move in the same direction at the same time, this port or inlet M is closed at its lower end by the piston itself. The air, therefore, cannot enter the cylinder through this port, but goes through the longitudinal passage M' and through the supplemental ports *m m'*, which are at the extreme end of the cylinder and open behind the piston. In passing through these ports *m m'* the air goes around the plate or valve *o*, which is so arranged as to admit air to the cylinders, but not to allow it to pass out, for the purpose hereinafter described.

The small plates or valves *o o'* are made in a peculiar shape, being narrower at the center than at the ends, as shown. They do not sit down on the bottom of the port in which they are placed, but rest on a ridge or shoulder, *x*, which is formed for it to drop upon. The air or steam may, therefore, enter the cylinder past this valve when it is sitting on the ridge or shoulder by passing by the narrower central part of the plate or valve, but it cannot pass out of the cylinder, since the plates or valves *o o'*, when the exhaust-air lifts it, shuts up against the port *m* or *n*, as hereinafter described. The air, then, as it comes from the valve-chamber through into the cylinder through the passage *m m'*, starts the piston ahead, but as soon as it has moved a short distance the whole force of the air will come in direct through the large port M without having to pass through M' *m m'*. The air at the other end of the piston, which has to be exhausted, then passes up out of the port N and out of the exhaust-port Q. These exhaust-ports Q and Q' are near each end of the valve-

chamber, and are so situated as to be nearer the ends of said chamber than the inner pistons, *k*, ever reach. The said pistons *k k* are so placed on the valve-stem *d* with relation to the ports M N, which form alternately inlet and outlet passages, that for the admission of air the piston is partly over the inlet-port, so as to leave a comparatively small opening to admit the compressed air through the passages M or N, as the case may be, while either of said passages which is acting on the exhaust is left wide open by the piston *k* sliding far enough by the opening to let the air escape freely.

The exhaust-ports Q Q′, at opposite ends of the valve-chamber, are always between the two pistons *k k′*, and their passages are carried across the valve-chest to the common discharge O. These exhaust-ports being between the pistons, the compressed air admitted between the central pistons, *k k′*, can only enter either of the passages M or N, as the case may be, while the exhaust-air issuing from either of these same ports M N is directed behind the piston *k* and between it and the piston *k′*, so that it may escape by said exhaust-ports Q or Q′. The ports M N, therefore, act both as outlet and inlet ports alternately, the pistons *k* regulating their functions in this respect. The air continues to exhaust out of the passage N, as described, until the end of the piston passes by said passage N in the cylinder, when no more of the exhaust-air can escape. What air then remains in the cylinder beyond the end of the piston in trying to escape through the small port *n′* shuts the plate or valve *o′* up against the port *n*, thus closing said port, so the said air cannot escape. An air-cushion is thus formed in said cylinder, which prevents the piston ever reaching the cylinder-head. When the valve is in the position to admit air at this end the operation is repeated in the same manner, the air entering through N N′ *n n′*, the valve *o′* dropping to admit it to the cylinder behind the piston, and when the end of the piston passes N the air all comes in through that port in the same manner as hereinbefore described as occurring at the other end, the exhaust also taking place at the opposite end in the same manner.

In order that the compressed air admitted to the valve-chamber for working the piston may also operate the valve suitably without the necessity of too many valves or working parts, I employ the following peculiar arrangement of parts:

Let us suppose the valve to be at that end of the chamber where it is admitting air through the port M to start the piston, the valve and piston being at the same end at the same time. From the valve-chamber in which the valve-stem *d* moves, and between the inner heads, *k*, of the valve, lead two ports, *t t′*, which are cut so as to communicate with the cylinder in which the actuating piston moves, in order, at the proper time, as hereinafter described, to allow some of the compressed air entering the opening H′ to enter said cylinder near the center, as well as at the ends. In the cylinder, registering with these slots *t t′*, are cut corresponding slots *r r′*, communicating with passages formed in the air-chest, which cross each other and lead to the extreme ends of the valve-chamber, as shown, so as to open outside of the outer piston, *k′*, of the valve.

As has been before described, the piston has an annular groove, *l*, formed at a suitable point, the object of which is to connect these passages *t t′ r r′*, in order to actuate the valve in the same direction as the piston. Now, as the piston starts forward, impelled by the air entering through M, the valve is at the same end as that from which the piston starts. The passages *t t′* are also both filled with compressed air, which cannot, however, enter the cylinder on account of the face of the piston closing said ports *t r′* when they enter the cylinder. As soon, however, as the annular groove *l* in the piston comes opposite the slots *t′ r′* said passages are connected, and the compressed air may pass out of the valve-chamber through the passage *t′* into the groove or channel *l*, and thence into the passage *r′*, leading in behind the valve-piston *k′*. The valve is then thrown forward, so as to admit air at the other end of the piston, the valve being actuated in the same direction as the piston. The slots of the passages *r r′ t t′* where they enter the cylinder are somewhat elongated, and are wider than the groove in the piston, so that as this groove or channel is passing by said slots plenty of time is given for sufficient air to enter the valve-chamber to actuate the valve. In fact these slots are made about as wide as the length of travel of the valve.

In the reverse motion the operation is the same—that is, the air comes through *t*, and the channel connects this with the passage *r*, throwing the valve in the direction of the piston travel. The passages *r r′* are so formed in the air-chest to cross each other, as shown, without communicating with each other, in order that the valve may be moved in the proper direction.

It will be seen that in starting the piston from the end where the air enters through M, as described, the groove *l* in the piston connects the passages *t r*, so the air may enter the valve-chamber and keep the valve at the same end as the piston. When the groove *l* reaches the slots *t′ r′*, then the air entering the valve-chamber throws the valve over to the other end to follow the piston. When the piston, therefore, is at the end of the stroke, the groove is in the proper position to connect the slots which will keep the valve at the same end, whichever that may be.

By moving the valve and piston in the same direction, the admission and exit of air is regular, and the jar communicated to the parts does not affect it.

The gradual cushioning of the valve is accomplished by the hole *p p′* through the spin-

dle of the valve. As soon as the neck of the valve-stem begins to enter the hollow or countersink f' in the valve-chamber head f, the air is compressed in the hollow head; but some of this compressed air can escape gradually through the small hole $p\ p'$ to the outside of the piston k'. There is some compression also between the outside of the piston k' and the inside of the head f; but the openings $p\ p'$ admit of enough air passing out to bring the valve up easily. A small disk of rubber or leather is put on the inside of the hollow f', so the valve-stem, if it strikes, will do so without noise or jar.

A hole, l', is made through the cylinder, just at the offset in said cylinder, so that there will be no vacuum and no compression behind the rear portion of the enlargement L′ of the piston L. As the piston travels back and forth free ingress and egress of air is given behind this enlarged portion L′ through the hole l'. Otherwise the piston would not travel freely.

A ratchet-sleeve, P, having diagonal slots P′, is fitted over the drill-head or spindle I, inside of the cylinder-extension K′, and lugs q fit into these diagonal slots, as shown, the drill-head or spindle itself being attached to or forming part of the piston, as hereinbefore described.

The method by which I impart a rotary motion of the drill is such that a very small rotary movement can be made, while at the same time plenty of gripe is given to the ratchet, &c., by which it is accomplished.

The extension-head S of the cylinder D is extended into the cylinder-extension K′, as shown at Fig. 1, and on opposite sides of this extension S are the pins or lugs S′. Between these lugs, fitting in the head, are springs s, on which rest the ratchet-sections V, these sections encircling the extension-head S, as shown. The ratchet-sections V are not made in a complete circle, but the pins take up part of the circle, and as the ratchets on the sleeve with which they engage are evenly cut on a circle, only half of the teeth will engage at one time when two segments or ratchet-sections are used, and only one-third when three are used. A very slight turn may therefore be given to the drill without having very small teeth to the ratchets, which are objectionable in devices of this kind.

The teeth of the ratchets I make in a peculiar form to adapt them to take up wear. Between each tooth v is a slot, v', cut deeper than the tooth, as shown. It is on the beveled faces of the teeth themselves that the wear occurs from constant friction; but the faces of teeth formed in this manner may wear until the lower edge of the tooth is worn down to the bottom of the slot before the point of the tooth will touch and be worn off.

In the working of ratchets, when the teeth disengage, the point of the upper tooth will not drop from the point of the lower tooth in a vertical line in taking a new gripe, but will jump slightly. In doing this in my improved form of tooth the point of the upper one will catch on the back of the slot and be directed against its disengaging tooth without much slip. In this way all wear is taken up automatically, and the teeth are sure to engage.

As the piston is moved back by the air or steam the drill-head and drill are rotated by the pins or lugs in said drill-head sliding in the diagonal slots in the ratcheted sleeve, the sleeve itself being held by the ratchets of one of the sections V engaging with the sleeve-teeth. The drill-head, piston-rod, and piston are therefore turned slightly, so that at the forward stroke the cutting-edge of the tool in the drill-head is presented in a new position in the drill-hole. The springs under the sections keep them engaged at all times with the teeth of the ratcheted sleeves. A good firm gripe or engagement of the ratchet-teeth is insured by this arrangement, and when the turn of the drill and head is only slight there is no danger of the teeth missing, since with two sections a turn of only half the width of a tooth will admit of an engagement with one or the other of the sections.

Another difficulty experienced in rotating rock-drills is that the drill-head or spindle will sometimes go back and forth and be turned just as much as the diagonal slot will admit, but will not turn clear around gradually. This is due to the fact that the piston rod or clamp is loose in its packing and slides back and forth too readily. In tightening them too much to overcome this, power is lost in the increased effort to reciprocate and revolve the drill. This I obviate by placing on the drill-head or spindle a grooved ring, W, through which the spindle reciprocates freely. A channel, w, is cut longitudinally in the drill-head or spindle, and a key or lug, w', on the ring W, fits in this. A set-screw, W′, projects through from the cylinder-extension into the groove on the ring W, by which the friction on this ring is regulated. I can, therefore, while permitting a free reciprocating motion to the drill, give friction enough to the drill-head or spindle to cause the drill to turn properly. The face of the ring may be made flat or grooved, as desired, the set-screw fitting against it and giving any desired friction. This friction-ring is preferable to a ratchet in the same position.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a rock-drill, the combination, with the feed-screw C, provided with two or more V-shaped flanges, c, of the grooved box a, fitting in the feed-screw chamber A′, against the shoulder a', said box being provided with a key, b, whereby wear is taken up and jar of the screw is prevented, substantially as herein described.

2. In a rock-drill, the combination, with the case or carriage A, adapted to carry the cylinder D and drill-operating mechanism, of the

supplemental chamber or feed-screw cover A′, adapted to carry the screw C, with its flanges *c*, and the box *a*, with its regulating-key *b* and set-screw *b′*, whereby said screw and its parts are protected from accident, substantially as herein described.

3. In a rock-drill, the method of attaching the drill-tool to the head, consisting in forming a tapering recess in said head, and providing a tapering clamp, made in two or more pieces, for the drill, and interposing between said clamp and head an oppositely-threaded sleeve which connects the head and clamp, whereby a long gripe or bearing is obtained on the drill-tool, substantially as herein described.

4. In combination with the externally-threaded drill-head I, provided with a tapering recess, *i*, and the threaded drill-clamp J, made in two or more parts, tapered as shown, and having a slot, *j*, for securing the screw *j′*, the sleeve K, with its internal threads formed half right and half left, or of different pitch, said sleeve being interposed between the clamp and head, whereby the clamp is connected to the head without liability of jamming, and the sleeve acts as a jam-nut as well, substantially as herein described.

5. The improvement in the rotating mechanism of rock-drills, consisting in forming the ratchets which engage with the ratcheted sleeve having the diagonal slots, in which the lugs of the drill-head move, in two or more sections, so placed that only one of said sections of teeth will engage with those of the sleeve at one time, whereby a very slight turn may be given to the drill-tool, and at the same time the teeth may be large enough to take a firm hold, substantially as and for the purpose herein described.

6. In combination with the drill-head having lugs which move in the diagonal slots of the ratcheted sleeve, the two or more ratchet-sections V encircling the extension-head S, and held between the circle-breaking pins S′, said sections V being provided with the springs *s*, to keep them in contact with the teeth of the sleeve, substantially as and for the purpose herein described.

7. In combination with the ratchet-teeth *v* of the rotating mechanism of a rock-drill, the interposing deepened slots *v′*, whereby the wear of the teeth is automatically taken up, substantially as herein described.

8. In an engine having a piston and valve adapted to be moved in the same direction by air, gas, or vapor under pressure, the main piston L L′, and the valve consisting of the heads *k* and *k′* in pairs, which are united by the stem *d*, so that the heads of the valve stand opposite the extreme ends of the cylinder, in combination with the ports M N, the supplemental ports *m n* and *m′ n′*, and the plates *o o′*, fitted into the supplemental ports, so that the air under pressure passes directly from the valves to the piston without the intervention of long passages, substantially as herein described.

9. The double piston L L′ of different diameters, moving in a correspondingly-shaped cylinder, the part L having a single groove, *l*, formed around it, as shown, in combination with the ports *t t′ r r′*, whereby the valve is caused to travel in the same direction with the piston, and operated substantially as herein described.

10. The valve consisting of the heads *k k′*, united by the stem *d*, and provided with extensions which move in the chambered head F of the valve-chest, to cushion the valve at each end of the stroke, in combination with the connecting-ports *p p′*, opening through the sides of the stem, and extension of the valve upon opposite sides of the head *k′*, so that the movement of the valve toward the end of the chamber carries the port *p′* into the chambered head *f* and closes it, to allow the air admitted through the passages *r r′* to act upon the head *k′*, to start the valve, substantially as herein described.

11. The valve consisting of the double pistons or heads *k k′*, with their connecting-rod *d*, moving in the independent chamber, which is provided with a central inlet-port between the heads *k k′*, and the two exhaust-ports Q Q′, between the heads *k* and *k′*, said heads being so adjusted with relation to the cylinder ports or passages *m n* that a smaller opening is formed for the admission than for the discharge of the air, substantially as herein described.

12. The flat plates or valves *o o′*, placed in the passages *m n*, which are constructed to allow the passage of air in one direction, as shown, in combination with the passages *m m′ n n′*, the main piston L L′, and the valve consisting of the heads *k k′*, united by the stem *d*, and moving in a chamber having the ingress-port H′ and the egress-ports Q Q′, substantially as herein described.

13. The valve-chest D′, having a cylindrical bore of a length equal to that of the main cylinder to receive the valve, consisting of the heads *k k′* and uniting-stem *d*, and provided with the ports *m m′ n n′*, said valve-chest being bolted upon the cylinder, so that the plates *o o′* may be introduced at the point of junction and be accessible, substantially as herein described.

14. The valve-chest D′, having the cylindrical bore adapted to receive a valve, consisting of the heads *k k′*, united in pairs at each end of the cylinder by the stem *d*, in combination with a steel bushing, *d′*, fitted to each end of the bore at the points where the double heads travel, substantially as herein described.

In witness whereof I have hereunto set my hand.

HENRY RICHMANN.

Witnesses:
CHAS. G. YALE,
FRANK A. BROOKS.