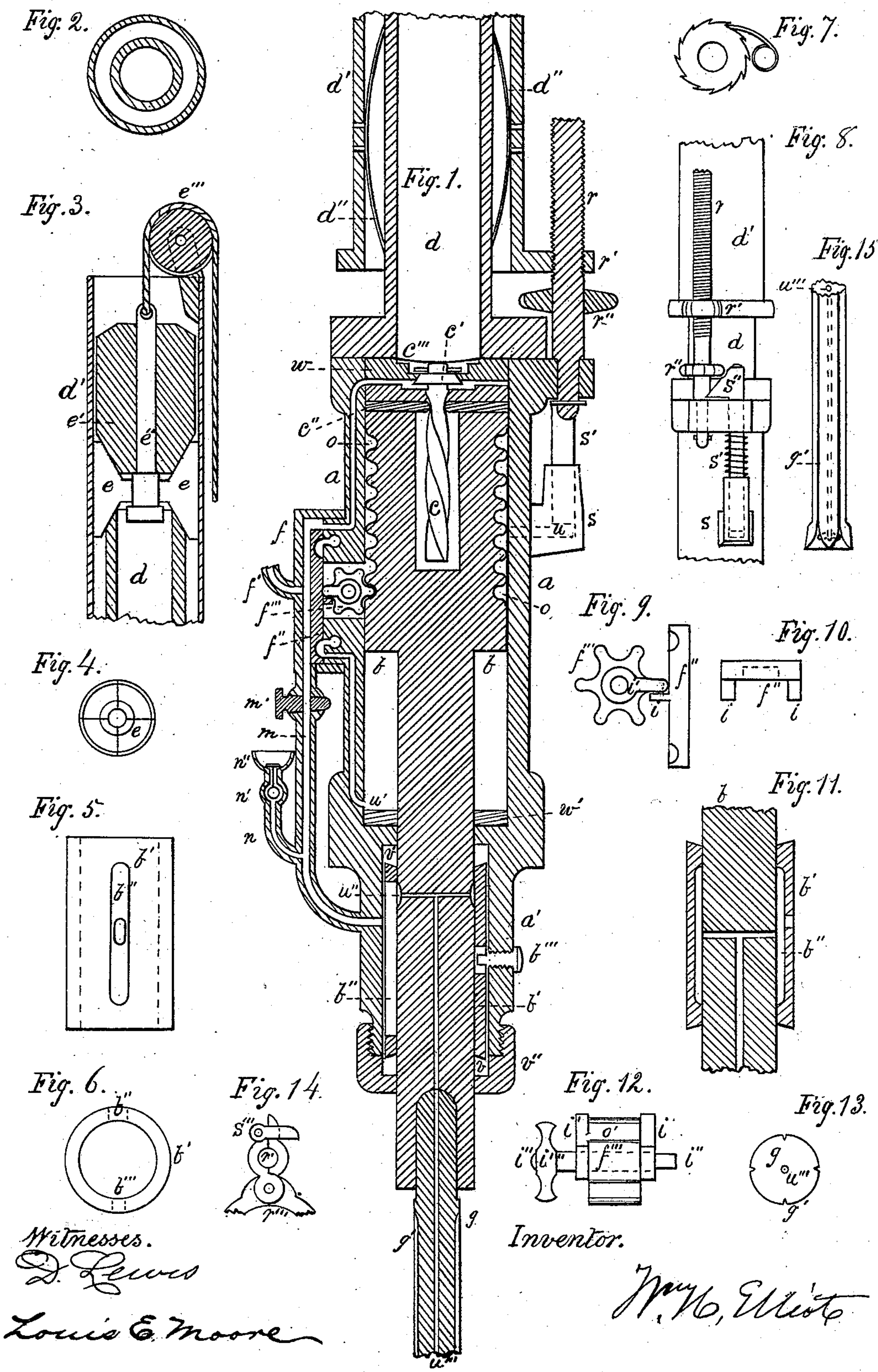
W. H. ELLIOT.
Rock-Drills.

No. 202,338. Patented April 16, 1878.



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IMPROVEMENT IN ROCK-DRILLS.

Specification forming part of Letters Patent No. **202,338,** dated April 16, 1878; application filed March 4, 1878.

To all whom it may concern:

Be it known that I, WM. H. ELLIOT, of the city and State of New York, have invented a new and Improved Rock-Drill, of which the following is a specification:

The object and nature of my invention are described as follows:

The object of my invention is to provide a more simple and durable rock-drill, and a more practical method of supporting the same, than any now in use, and also to provide improved means of removing the rock-cuttings from the hole; and the nature of my invention consists in the use of certain appliances and methods to further the above object, which are fully set forth in the following specification and claims.

Figure 1 is a vertical section of my improved rock-drill. Fig. 2 is a horizontal section of the vertical shaft and shank of the rock-drill. Fig. 3 is a vertical section of the upper end of the vertical shaft, showing the means of resisting the recoil of the rock-drill. Fig. 4 is a bottom view of the sectional wedge. Fig. 5 is an elevation of the sleeve. Fig. 6 is a plan of the same. Fig. 7 is an elevation of the feeding-ratchet and diagonal pawl. Fig. 8 is an elevation of the feeding devices. Fig. 9 is an elevation of the pinion and slide-valve. Fig. 10 is a plan of the slide-valve. Fig. 11 is a vertical section of the sleeve and a portion of the piston-rod or drill-carrier, showing a modification of that portion of the invention. Fig. 12 is an elevation of the pinion. Fig. 13 is a view of the bit end of the drill-blank. Fig. 14 is a plan of a sectional feed-nut. Fig. 15 is an elevation of the bit end of a drill-tool.

a is the cylinder; *a′*, the elongated portion or neck of the same; *b*, the piston and piston-rod; *b′*, sleeve; *b″*, slot or chamber in the sleeve; *b‴*, screw for holding the sleeve in position; *c*, spiral revolving rod; *c′*, friction-clutch or disk on the same; *c″*, pins, which work in the grooves of the rod *c* and cause the piston to revolve; *c‴*, spring; *d*, shank of the rock-drill; *d′*, vertical shaft; *d″*, elliptical springs within the vertical shaft and between it and the shank of the rock-drill; *e*, annular sectional wedge, Figs. 3 and 4; *e′*, weight; *e″*, bolt for lifting the weight and wedge; *e‴*, pulley and rope; *f*, chest; *f′*, induction-pipe; *f″*, slide-valve; *f‴*, pinion; *g*, drill-tool blank; *g′*, grooves in the surface of the blank; *i*, projections on the under side of the slide-valve; *i′*, arms on the pinion-shaft *i″*; *i‴*, cross-handle on the same; *m*, passage from chest *f* to the neck of the cylinder; *m′*, stop-cock controlling the same; *n*, water-passage from funnel or reservoir *n″* to the passage *m*; *n′*, check-valve in the same; *o*, grooves turned in the surface of the piston, which operate as a rack to turn the pinion; *r*, feeding device; *r′*, nut attached to the vertical shaft; *r″*, ratchet on the feed-screw or feeding device; *r‴*, joint of the sectional nut; *s*, small cylinder on the side of the main cylinder; *s′*, Figs. 1 and 8, piston-rod and spring of the same; *s″*, diagonal pawl; *s‴*, lock of the sectional nut; *u*, passage from main cylinder *a* to auxiliary cylinder *s*; *u′*, passage or port between the chest *f* and the cylinder *a*; *u″*, passage through the piston-rod; *u‴*, passage through the drill-tool; *v* and *v′*, upper and lower stuffing-box; *v″*, screw-cap or gland; *w*, disk-seat; *w′*, cushion.

I have shown in this application a rock-drill which is intended to be operated by compressed air. It is obvious, however, that the devices herein shown will work with equal facility in connection with steam or any other medium of force.

My improved rock-drill is supported upon a vertical shaft by means of a shank, as shown in my patent of May 29, 1877. To avoid strain and injury to the piston and cylinder by the glancing of the drill-tool, I place within the lower ends of the vertical shaft, and between it and the shank of the rock-drill, elliptical springs *d″*, between which the shank slides in the process of feeding. They may therefore be described as a flexible guideway. These springs or flexible guideway allow a little lateral movement to the rock-drill as the drill-tool glances from inclined surfaces in starting a hole.

To prevent the rock-drill from rising by the recoil, and thereby losing power and doing injury to the feeding devices, I employ within the vertical shaft, and upon the end of shank *d*, wedge *e* and weight *e′*. This wedge, as shown in Figs. 3 and 4, is divided vertically into four sections, and so shaped as to fit upon the conical ends of the shank *d* and weight *e'*,

The angle of these cones should be so proportioned that, where the rock-drill is fed down by the feeding devices, the wedge and weight will readily follow down and rest upon the shank. When the recoil takes place the conical end of the shank, by its action from below, and of the weight, by its action above, tend to throw the wedge outward against the inner surface of the vertical shaft, and so prevent it, by friction, from moving at all. When it becomes necessary to take up the feed of the rock-drill, the weight is raised by the cord and pulley *e'''*. This operation may be greatly facilitated by the use of a small windlass. By the action of the cord on bolt *e''* the weight is first raised sufficiently to free the wedge, when the head on the lower end of the bolt brings the wedge up after it. The wedge may be made heavy enough to serve the purpose of weight and wedge. In that case the advantage of one cone only would be obtained.

The feeding of the rock-drill downward automatically is effected by the auxiliary cylinder and piston *s* and *s*. As the hole which is being drilled in the rock deepens the main piston *b* falls lower and lower in the cylinder *a*, until it finally uncovers or falls below the passage *u*, which leads from the main cylinder to the auxiliary cylinder, when the steam rushes through the passage *u* and forces out the piston *s'*, giving it a longitudinal or vertical movement, which carries the diagonal pawl *s''* against the teeth of the ratchet *r''*, causing the feeding device or screw *r* to revolve and feed the rock-drill down. When this operation has been continued till the piston *b* ceases to fall below the passage *u*, the feeding also ceases. The spiral spring at *s'* not only forces the piston back into the cylinder *s*, but it tends to revolve the piston, so as to hold the diagonal pawl upon the ratchet. By the use of an angular lever between the piston *s* and the ratchet *r''*, a direct-acting pawl may be employed instead of the diagonal one shown.

The nut *r'* should be made sectional, as represented in Fig. 14, so that it may be thrown open and the feed of the rock-drill taken up by means of the pulley and rope *e'''* with the help of a windlass. To do this it would be necessary that the bolt *e''* should take up not only the weight *e'* and the wedge *e*, but it should also be attached to the shank *d*, so that after the wedge and weight have been raised a little it will bring up the rock-drill also. When by these means the rock-drill has been raised to the proper height, the sectional nut may be closed and the weight and wedge let down upon the shank *d*.

I give the necessary revolving movement to the drill-tool by means of the spiral rods *c* and the friction-clutch *c'*. This clutch is fitted to the seat *w*, and acts as a valve to prevent the escape of the air within the cylinder. The angle of the clutch-seat should be such that the disk will slip around when any very great strain is thrown upon it.

While the piston is making its downward movement the pressure in the upper end of the cylinder causes the clutch to become stationary in its seat, where the inner end of the pins *c''*, following the grooves in the spiral bar, give to the piston and drill-tool a spiral or revolving movement. When the piston rises, the pressure being removed, the spring *c'''* throws the clutch down sufficiently to release it from its seat, when the spiral bar, revolving freely, gives no movement to the piston. This revolving device works easily, and continues to act during the whole downward movement of the drill-tool, is free to turn in any direction when the rock-drill is not in operation, and will slip before it will break while the rock-drill is in operation.

I operate the slide-valve in my improved rock-drill by means of pinion *f'''*, which communicates the movement of the piston to the valve by means of the projections *i* on the under side of the valve and the arms *i'*, one at each side of the pinion.

The outer surface of the piston has a series of grooves, *o*, turned in it, which serve as a rack to give motion to the pinion. The pinion is so proportioned to the length of the stroke that it makes one complete revolution for each movement of the piston. The arms *i'* on the pinion-shaft *i''*, coming around against the projections *i* on the slide-valve, give to the valve the necessary movement at the moment the piston reaches the upper or lower limit of its motion. The projections *i* first come in contact with the arms *i'* near their center of motion, and lastly at the extremity of the arm. This gives to the valve an increasing velocity in its movement.

It will be observed by reference to Fig. 12 that the shaft *i''* of the pinion passes entirely through the chest, and has a cross-handle, *i'''*, upon one end. The object of this is to enable the drill-tender to slide the valve by hand in case anything should prevent the piston from falling low enough to trip the valve automatically. For this purpose, while the arms *i'* should be rigidly fastened to the shaft *i''*, the pinion should have a free movement upon the shaft of about a quarter-turn. This extra movement should be provided for in the length of the rack.

In Figs. 1 and 13 I have represented a drill-tool blank having a central hole, *u'''*, through its entire length, and also having four sharp longitudinal grooves, *g'*, running nearly its whole length, and dividing its outer surface into four equal parts. The object of the central hole is to provide a passage for water and air or steam through the drill-tool to the bottom of the hole in the rock. The object of the parallel grooves is to render the drill-sharpener assistance in the prosecution of his work, and to secure the accuracy of the same.

Drills are made from these blanks by first fitting the head of the drill to the piston-rod, and then by splitting them to the center at the bit end, and drawing each lip to an edge, when, by the use of a proper die, the end of the drill is upset, which not only increases the diameter of the end of the blank, so as to form a cutting-bit, but it closes up the central hole at the extreme end.

The use of the die gives to the cutting-edge the form of a cross. Small holes are then punched between the lips of the bit into the central hole, as seen in Fig. 15, which completes the drill ready for hardening. These blanks are rolled hollow in the same manner that gun-barrels are made, and the grooves are also rolled into the blanks by four suitably-constructed rolls.

Blanks with three grooves may have three lips formed upon them; but four is the most practical number.

These drill-tool blanks cannot be made practically by hand, and to manufacture them by machinery requires a large outlay for the necessary appliances. They can therefore go into use only by being furnished to the public as articles of manufacture and trade. The head of the drill-tool blank which goes into the piston-rod need not necessarily be reduced in size to meet the requirements of the consumer.

One of the most important features of the invention herein shown is the method employed of removing the rock-cuttings or rock-mud from the hole by the use of air in connection with water, and the devices employed for that purpose.

It is necessary, for the sake of economy, that the flow of the medium of force should be under the control of the drill-tender. I therefore take it from the chest *f*, where the pressure is constant, by means of the passage or pipe *m* into the chamber b'' in the sleeve b', from whence it passes into the passages u'' and u''', which conduct it through the piston-rod and drill-tool. If steam be used in the cylinder *a*, compressed air may be brought to the chamber b'' from some other reservoir. In the passage *m* I place the stop-cock m', and in connection with these I use the water-pipe *n*, provided with a check-valve, n', and tunnel or reservoir n''.

When it becomes necessary to free the hole in the rock from the rock cuttings and mud, the passages *n m* u'' u''' and chamber b'' are first filled with water from the tunnel n''. The stop-cock m' is then opened, when the pressure within the chest or reservoir is communicated to the column of water within the several passages. By this pressure a recurrent flow of water is produced within the passage *n*, which closes the check-valve n', and the water in the several spaces below is blown through the drill-tool, carrying with it any rock mud or chip that may have collected therein. Following this, the compressed air is blown through the drill-tool into the bottom of the hole in the rock in such quantities that the rock-mud is blown out at the top. Cold air being used instead of steam as a medium of force, no condensation of it takes place. On the contrary, the compressed air, being relieved of a large portion of the pressure, on passing out at the end of the drill-tool, suddenly expands upward, carrying out of the hole before it the rock-mud and water.

The air or steam pressure, in connection with the column of water in the several passages, operates effectually in removing the rock-mud which becomes packed into the openings in the lower end of the drill-tool. After the water has been allowed to flow into the several spaces below the check-valve n', the chamber b'' will be found to contain air only above the lower end of the passage *m*; and as the openings at u'' in the piston-rod in their movements rise above that point they must take in air and water alternately, or steam and water alternately if steam be used, until the water in the chamber b'' has all been blown out. The result of this alternate action of air and water pressure is to jar and break up any rock-mud that may have become packed in or around the openings at u'''.

The introduction of steam and water in small quantities into the passage u'' is still more effectual, as on the instant that steam is followed into the passage by water the steam is condensed, and consequently produces upon all parts of the passages u'' and u''' a heavy pressure and almost a perfect vacuum alternately about four times a second.

The use of steam as a medium of force in connection with water in other respects for removing débris from the hole in the rock has the disadvantage of being condensed for a considerable time by the rock-mud around the drill-tool before the temperature of the mud is raised sufficiently so that the steam can act upon it as a blast to blow it out of the hole.

The chamber b'' (shown in Figs. 1, 5, and 6) is formed by cutting a slot in the side of the sleeve b' and by turning a groove in the piston-rod at u'', from the bottom of which the passages u'' and u''' continue through the piston-rod and drill-tool. The passage *m* opens into the chamber b'', the sleeve being held stationary by the screw b'''. Fig. 11 shows a modification of the form of the chamber b''. This is an annular chamber, formed by cutting away the inner surface of the sleeve and dispensing with the groove in the piston-rod. (Shown in Fig. 1.) This chamber may have any suitable form. It need not necessarily be in the sleeve. The chamber b'' is placed between the stationary and moving parts of the rock-drill, into which the stationary passage *m* empties, and from which its contents pass into the moving passage u'' in the piston-rod or moving portion of the machine, whereby direct and continuous passages, which are at all times under the control of the drill-tender, are provided from the chest *f* or other reservoir, and from the tunnel n'' to the bottom of the hole of the rock while the rock-drill is in operation.

By the arrangement of the chamber b'' within the neck of the cylinder, I place it in direct connection with the piston-rod, through which the medium of force has to be conducted to the drill-tool. This arrangement creates the necessity for two stuffing-boxes, one above the chamber, between it and the main cylinder, and one below it, the principal office of the sleeve being to communicate the pressure of the gland v'' through the stuffing in box v to the stuffing in box v'.

By connecting the pipe m with the cylinder a at a point a little above the port u, an intermitting and alternating flow of live and exhaust steam or air through the drill-tool would be obtained, which would still be under the control of the drill-tender; and the chamber b'' may be formed in the piston, or in the cylinder opposite the piston, or between any other stationary and moving parts of the rock-drill; but it is desirable that it be as far as possible removed from the cylinder, so that the steam in the cylinder may not be condensed by the pressure of cold water.

Having described my invention, what I desire to have secured to me by Letters Patent of the United States is—

1. The combination, in a rock-drill, of the flexible guideway or spring d'' with the shank d and the vertical shaft d', substantially as shown and described.

2. The combination, in a rock-drill, of wedge e and weight e' with the shank d and vertical shaft d', substantially as and for the purpose set forth.

3. The combination, in a rock-drill, of pinion f''', having arms i', with piston b, having groove o, and slide-valve f'', having arms i, operating substantially as and for the purpose set forth.

4. The combination, in a rock-drill, of passage m, provided with stop-cock m', chamber b'', and passages u'' and u''', for conducting the steam, air, or gas to the bottom of the hole in the rock, substantially as specified.

5. The combination, in a rock-drill, of water-passage n, provided with check-valve n', with the passage m, substantially as and for the purpose specified.

6. The combination, in a rock-drill, of passage m, having stop-cock m', passage n, having check-valve n', with chamber b'' and passages u'' and u''', substantially as specified, whereby water and steam or air may be conducted alternately to the bottom of the hole in the rock, for the purpose set forth.

7. The combination, in a rock-drill, of sleeve b' with the two stuffing-boxes v and v', the piston-rod b, and the screw-cap v'', substantially as set forth.

8. In rock-drills, the combination of the chamber b'' with the neck of the cylinder, the connection m, and the passage u'' in the piston-rod, whereby the latter passage is at all times in connection with the chamber b'', as and for the purpose set forth.

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