T. E. ADAMS.

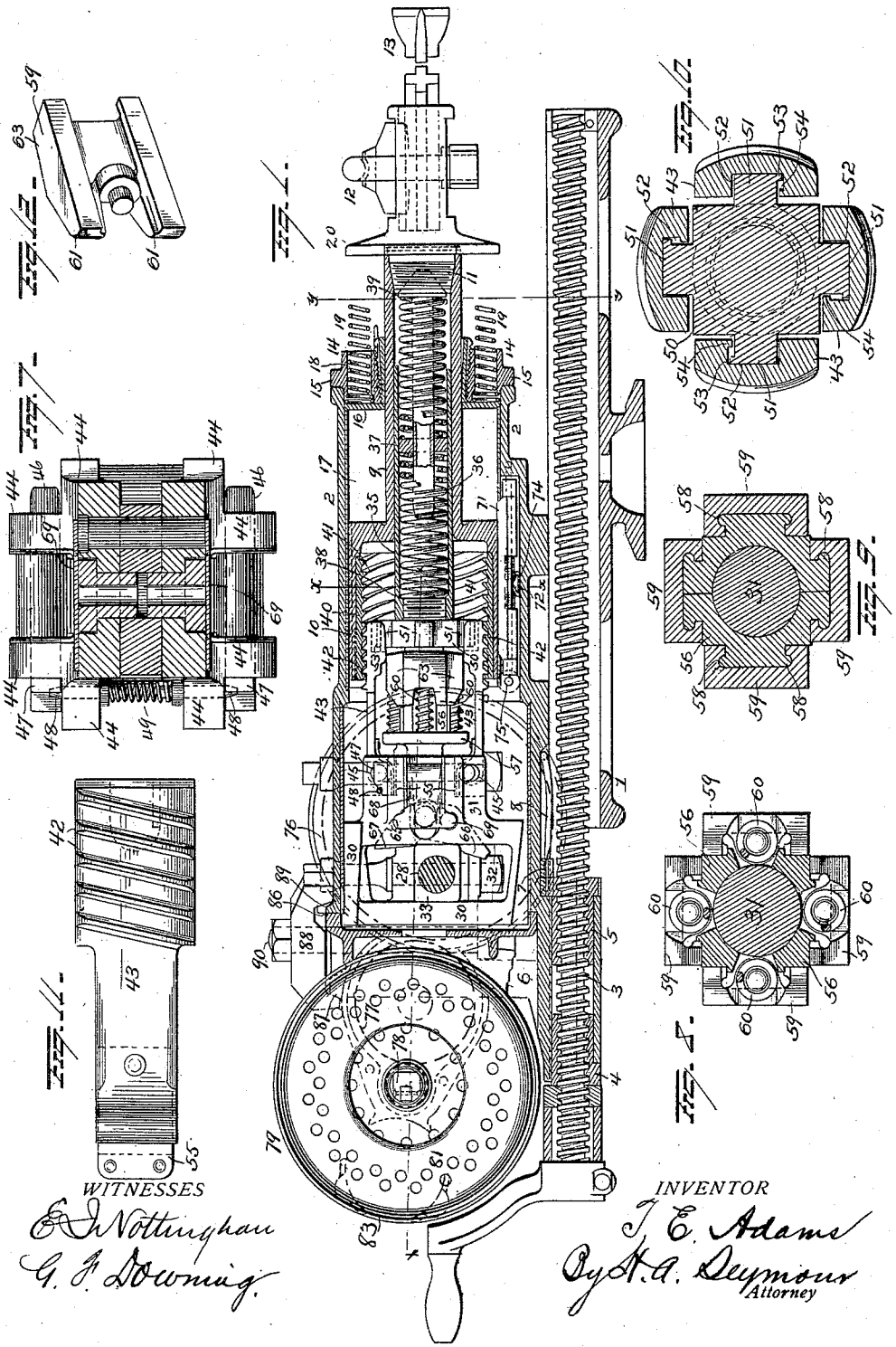
ROCK DRILL.

APPLICATION FILED JULY 15, 1909.

995,210.

Patented June 13, 1911.

5 SHEETS—SHEET 1.



WITNESSES

E. L. Nottingham

G. F. Downing

INVENTOR

T. E. Adams

By A. A. Seymour

Attorney

T. E. ADAMS.

ROCK DRILL.

APPLICATION FILED JULY 15, 1909.

995,210.

Patented June 13, 1911.

5 SHEETS—SHEET 2.

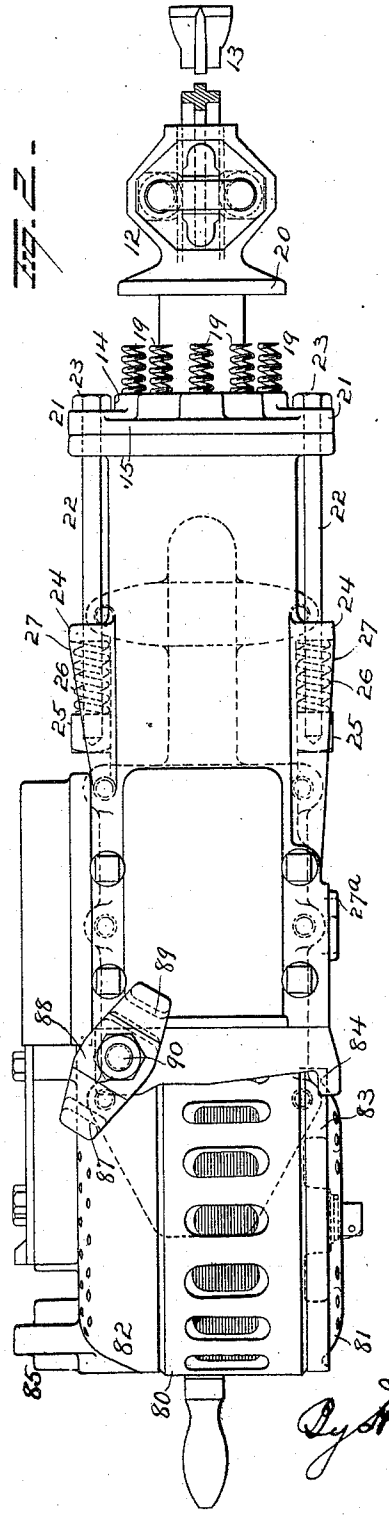


Fig. 2.

WITNESSES

E. L. Nottingham

G. F. Downing

INVENTOR

T. E. Adams

By H. A. Seymour

Attorney

T. E. ADAMS.

ROCK DRILL.

APPLICATION FILED JULY 15, 1909.

995,210.

Patented June 13, 1911.

5 SHEETS—SHEET 3.

Fig. 3.

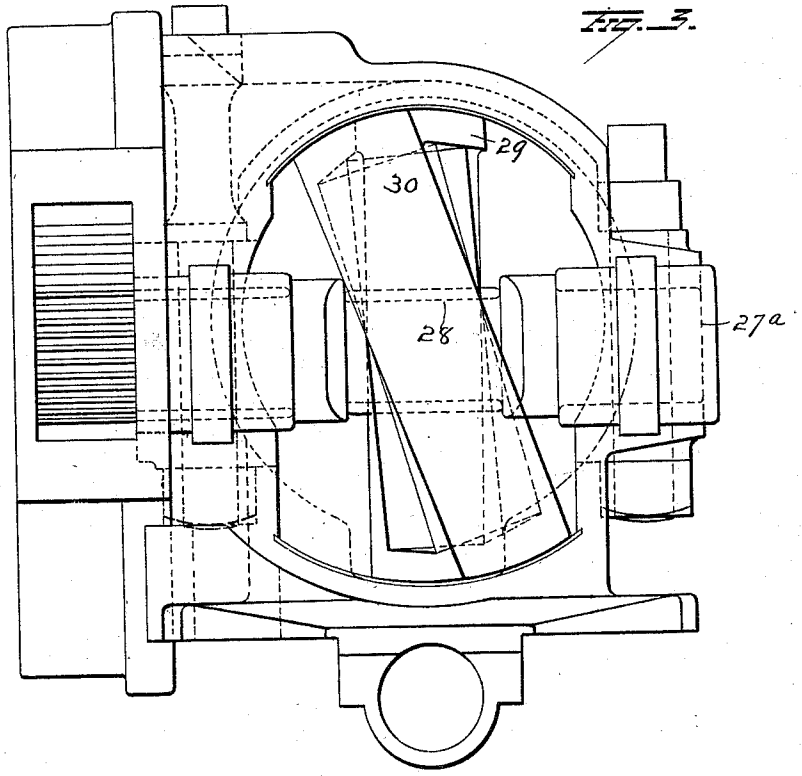
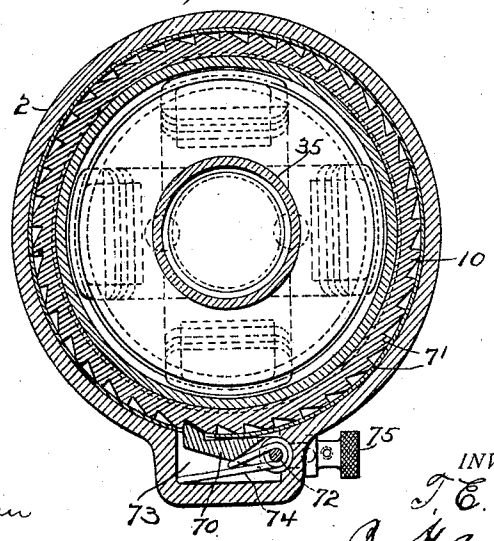


Fig. 4.



WITNESSES

E. L. Nottingham

G. F. Downing

INVENTOR

T. E. Adams

By H. A. Seymour

Attorney

T. E. ADAMS.

ROCK DRILL.

APPLICATION FILED JULY 15, 1909.

995,210. Patented June 13, 1911.

5 SHEETS—SHEET 4.

Fig. 5.

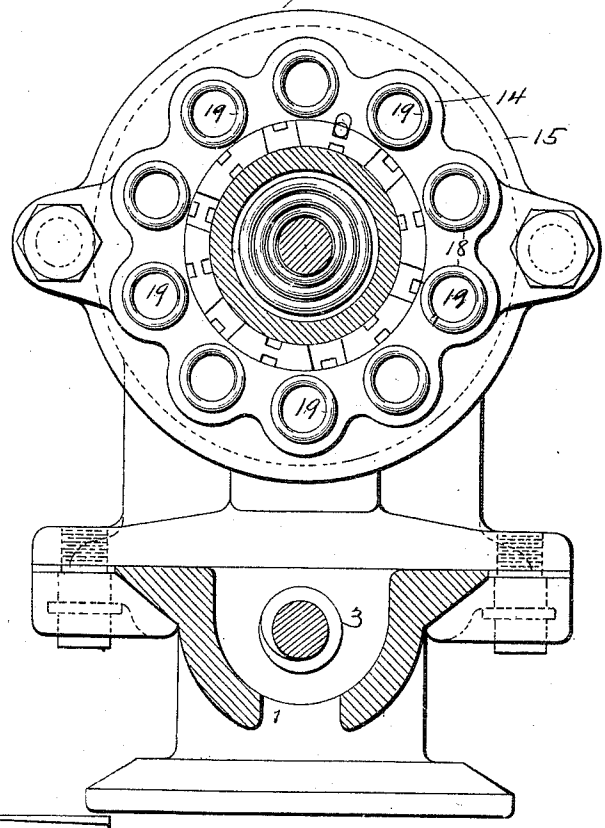
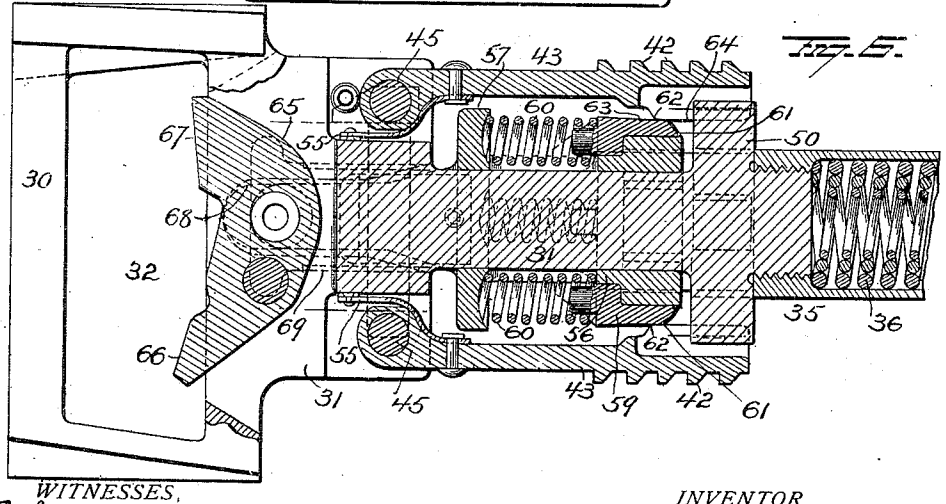


Fig. 6.



WITNESSES,

E. J. Nottingham

G. F. Downing.

INVENTOR

T. E. Adams

By A. G. Seymour

Attorney

T. E. ADAMS.

ROCK DRILL.

APPLICATION FILED JULY 15, 1909.

995,210.

Patented June 13, 1911.

5 SHEETS—SHEET 5.

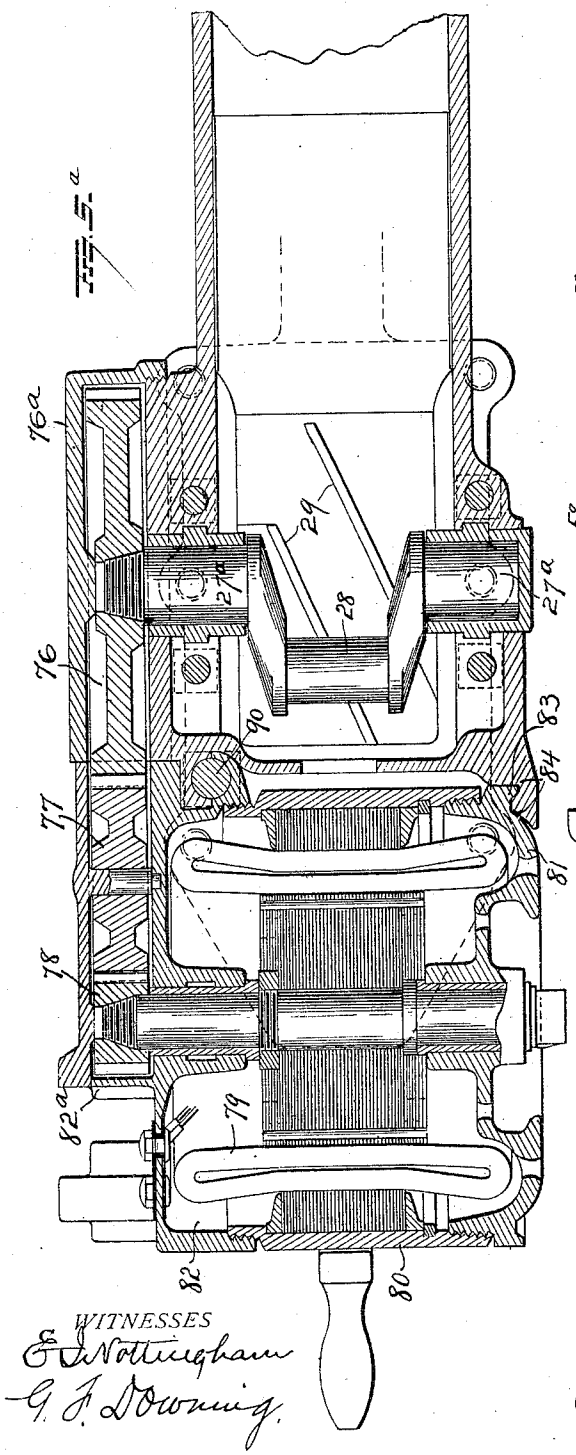


Fig. 5a.

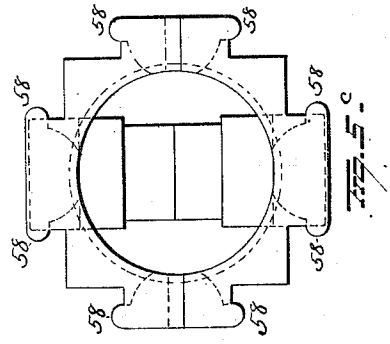


Fig. 5c.

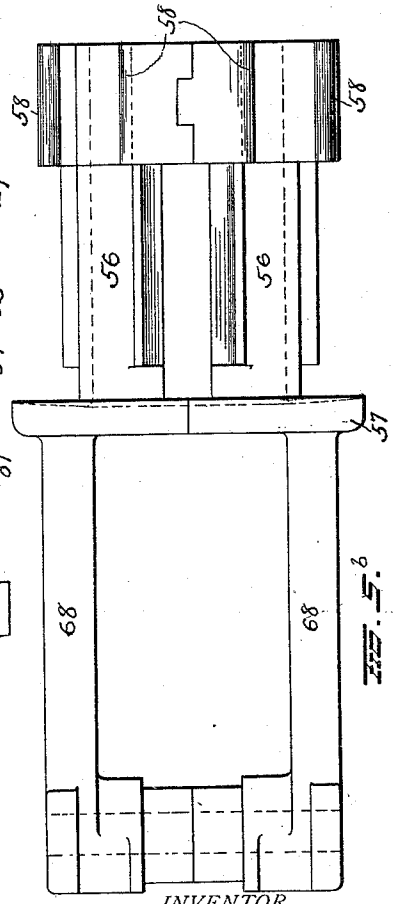


Fig. 5b.

WITNESSES

E. L. Nottingham

G. F. Downing.

INVENTOR

T. E. Adams

By A. A. Seymour

Attorney

UNITED STATES PATENT OFFICE.

THOMAS EDGAR ADAMS, OF CLEVELAND, OHIO.

ROCK-DRILL.

995,210. Specification of Letters Patent. Patented June 13, 1911.

Application filed July 15, 1909. Serial No. 507,859.

To all whom it may concern:

Be it known that I, THOMAS E. ADAMS, a resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Rock-Drills; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to drills and more particularly to improvements in rock drills to the type illustrated by Letters-Patent No. 913,932 granted to me March 2nd, 1909, one object of the present invention being to so construct a rock drill that deep holes may be drilled with a heavy bit without greater damage to the striking springs than in drilling a shallow hole with a light bit.

A further object is to provide a clutch device for withdrawing the drill rod which will operate with equal efficiency with a heavy as with a light bit.

A further object is to provide a rock drill with a clutch device for controlling the operation of the drill rod, which will have such uniform action that the weight of the parts and the speed of the machine will so correspond that the varying of the length of the striking spring in operation will be reduced to a minimum, thereby effecting a blow of maximum force and reducing liability of breakage of the striking or propelling spring.

A further object is to attach the operating motor to the drill body in such manner as to bind the gear case to its seat; the back door or rear end plate of the drill body to its seat; the motor to the drill body, and the motor head rigidly in place so far as jar in operation is concerned, and thus avoid wear and consequent varying of pitch of gears.

A further object is to provide means to avoid danger to the mechanism when the bit is not striking the rock.

A further object is to provide means whereby the operating means can be positively clutched to the drill rod for withdrawing the latter and at the same time accurately turning said drill rod without liability of slipping.

With these and other objects in view, the invention consists in certain novel features of construction and combinations of parts as hereinafter set forth and pointed out in the claims.

In the accompanying drawings, Figure 1 is a longitudinal sectional view, partly in side elevation, of a rock drill embodying my improvements; Fig. 2 is a plan view; Fig. 3 is a rear end view with the motor and rear end plate or back door of the drill body removed; Fig. 4 is a view in section on the line *x*—*x* of Fig. 1; Fig. 5 is a view in section on the line *y*—*y* of Fig. 1; Fig. 5^a is a horizontal section showing the casing and gearing at the rear end of the machine; Fig. 5^b is a detail view showing the parts 56, 57 and 68; Fig. 5^c is an end view of the structure shown in Fig. 5^b; Fig. 6 is an enlarged sectional view showing the clutch devices; Figs. 7, 8, 9 and 10 are enlarged cross sections showing the clutch devices; Fig. 11 is a detail view of one of the clutch jaws; and Fig. 12 is a detail view of one of the sliding blocks of the clutch.

1 represents the guide shell, upon which the drill barrel 2 is mounted to move longitudinally. To effect such movement for feeding the drill toward or away from the rock, a hand operated screw 3 is provided, said screw having a swivel mounting in the fixed framework of the machine and passing through threaded sleeves 4, 5 carried by an apron or extension 6 of the drill barrel. The internally threaded collar 4 is fixed within the extensions 6 while the sleeve 5 is so mounted that it can be turned to compensate for wear. The sleeve 5 is, however, normally locked against rotation by means of a key 7 and a spring 8 serves to hold said key in place.

The drill barrel has a general cylindrical shape and receives a tubular reciprocating drill rod 9. The rear end of the drill rod is provided with an enlarged movable head 10 movable as a piston within the barrel 2 and the forward end of said drill rod projects beyond the forward end of the drill barrel for the reception of the threaded shank 11 of a chuck 12 which receives the tool or bit 13. A nose bushing 14 is provided for the drill rod, at the forward end of the barrel 1. This bushing is movable in the forward end of the drill barrel and is provided with an annular flange 15 to rest against the end of the drill barrel. A plate

or ring 16 located within the barrel 2, bears against the rear end of the nose bushing and forms the forward end wall of the chamber 17 in which the head or piston 10 of the drill rod operates. The bushing 14 is made with an annular series of sockets 18 in which buffing springs 19 are located. The rear ends or bottoms of the sockets 18 are formed by the plate or ring 16, and against this plate or ring, the rear ends of the springs 19 bear, the forward ends of said springs being made to project beyond the forward end of the nose bushing so as to be engaged by the base 20 of the chuck 12 and thus cushion the drill rod and parts carried thereby when the same move rearwardly.

It may some times happen that the drill will not be properly set with respect to the rock, so that the bit will not strike the latter. In order to protect the parts against injury when the drill is thus operated, the cushioning devices now to be explained will be employed.

As before explained, the nose bushing 14 is movable in the forward end of the barrel 1, and it is provided at diametrically opposite points with perforated bosses 21 for the passage of rods 22, the forward ends of which are provided with heads 23. The rods 22 are disposed exteriorly of the drill barrel, and pass loosely through perforated ears 24 on the drill barrel some distance rearwardly from the forward end thereof. The rear ends of the rods 22 are provided with nuts or heads 25 and between the latter and the ears 24, springs 26 are located, said springs being housed in pockets 27 in rear of the ears 24. When the drill rod makes its forward throw and the bit fails to strike the rock, an air cushion will be formed in the forward end of the chamber 17 between the forward end of the head or piston 10 and the plate or ring 16, and the pressure exerted against said plate or ring will cause a slight forward movement of the nose bushing 14, against the resistance of the springs 26. Thus it will be seen that the parts will be relieved of undue strain and shock by the combined effect of the air cushion within the chamber 17 of the drill barrel and the cushioning springs 26.

A shaft 27^a is mounted in the rear end of the drill barrel 2 and provided between its ends with a crank arm 28.

Diametrically opposite walls in the rear portion of the drill body or barrel 2 are provided with spiral grooves or guideways 29 in which the ends of a cross head 30 on a draw bar 31 are adapted to move. The cross head is made with an elongated opening 32 which receives a bearing box 33 mounted sufficiently loose on the crank arm 28 of the shaft 27 to permit the cross head 30 to move in the spiral grooves or guideways 29 when the crank shaft is operated. In this manner, an oscillating as well as a reciprocating motion will be given to the draw bar and both of these motions will be imparted to the drill rod during the rearward movement of the draw bar, provision being made (as presently described) to couple the draw bar with the drill rod during the rearward stroke of said draw bar.

The forward portion of the draw bar is preferably made cylindrical in shape and has secured to its forward end, a tube 35 which enters and has free movement in the tubular drill rod 9. The tube 35 and the tubular drill rod serve to house the propelling springs 36. I prefer to employ two sets of such springs the springs of each set being located one within another. The springs of the two sets bear against an intermediate block 37 located in the tube 35, and the rear ends of the springs of one set bear against a seat 38 at the forward end of the draw bar, while the forward ends of the springs of the other set bear against a block 39 having a conical bearing in the rear end of the shank 11 of the chuck 12. By thus mounting the propelling springs, torsion thereof, when the drill rod is turned, will be reduced to a minimum.

Means are provided for withdrawing the rod and simultaneously turning it, and then releasing it so that said drill rod shall be subjected to the propelling action of the springs 36 and in order that said springs shall exert a propelling power, they must be first compressed so as to store such power. It is desirable that the springs shall be compressed during the forward stroke of the withdrawing means, as in my former Patent No. 913,932, hereinbefore referred to. In view of the fact that the drill rod is turned during its rearward throw, it is desirable that the coupling of the withdrawing means with the drill rod shall be such that the possibility of slipping of the parts comprising this coupling shall be reduced to a minimum. A positive or interlocking clutch rather than a friction clutch will, therefore, be more effectual in the construction of the coupling between the withdrawing means and the drill rod. The clutch should not, however, be such as would subject the engaging parts to excessive strain.

The coupling devices and the means for operating them to connect the withdrawing devices with the drill rod and then releasing the latter, are constructed as follows:—The head or piston 10 is provided interiorly with a removable lining 40 having internal threads 41, preferably six such threads being employed. These threads are to be engaged by ribs 42 disposed diagonally on jaws 43 carried by the draw bar, and in this manner, an interlocking clutch is formed between the draw bar and the drill rod. I

prefer to employ four jaws, each having transversely curved outer faces from which the ribs 42 project in a manner to mesh with the threads in the head or piston 10. The jaws are arranged in pairs disposed at right angles to each other and approximately parallel with the cylindrical portion of the draw bar. For the accommodation of the jaws 43, the draw bar is provided in rear of the cylindrical portions thereof, with lugs or ears 44 arranged in pairs to receive pins 45—46 by means of which said jaws are pivotally connected with the draw bar. The pivot pins 45 terminate at both ends flush with the lugs or ears through which they pass, and the pins 46 are made of greater length so as to overlap the ends of the pins 45 and prevent displacement of the latter. The pins 46 are provided with heads 47 having notches to receive locking pins 48 which pass through two of the lugs or ears 44, said pins 48 being pressed outwardly into engagement with the heads 47 by means of a spring 49. The cylindrical portion of the draw bar 34 is enlarged and made angular as shown at 50 and from this angular enlarged portion, four lugs 51 project and enter recesses 52 in the free ends of the jaws. Each lug 51 is provided with a lip 53 to be engaged by a lip 54 at the end of one wall of the recess 52 in the adjacent jaw to limit the outward movement of the latter when said jaw is moved outwardly to cause the ribs or the threads thereon to mesh with the threads in the head or piston 10. Normally the jaws 43 are pressed inwardly toward the enlargement on the forward end of the draw bar to prevent engagement of the ribs or threads on the jaw with the threads in the head or piston 10, by means of flat-plate springs 55, but said jaws will be moved outwardly against the resistance of said springs to cause the ribs of the jaws to interlock with the threads in the head or piston 10, by means of devices which will now be described. A sleeve 56 is mounted to move longitudinally on the cylindrical portion of the draw bar 31 and provided at its rear end with a head 57. The sleeve 56 is provided exteriorly with guides 58 for the accommodation of blocks 59 which are normally sustained with their forward ends adjacent to the forward end of the sleeve, by means of springs 60 located in grooves in the sleeve and bearing at their rear ends against the head 57. The blocks 59 are thus located between the jaws 43 and the draw bar 31, and provided at their forward ends with slightly rounded shoulders 61 which, when the sleeve 56 is moved forwardly, will engage similar shoulders 62 on the inner faces of the jaws and move said jaws outwardly to cause their ribs to engage the threaded interior of the head or piston 10 of the drill rod. When the jaws shall have been thus operated, they will be maintained interlocked with the threads in the head or piston 10, by the engagement of the flat faces 63 on the blocks with the flat faces 64 on the jaws above the shoulders 62. Should the ribs on any of the jaws engage the edges of the threads in the head 10, instead of entering between said threads, the block 59 which actuates such jaw will yield against the resistance of its spring 60 and the complete throw of the sleeve 56 to operate the other jaws will not be prevented.

When the draw bar and drill rod are coupled with the use of the devices above described, the six separate threads in the head or piston 10 coöperating with the ribs on the jaws will cause the rotative strains to apply at nearly right angles and hence no slip will occur when the drill rod is being withdrawn and simultaneously turned by the turning of the draw bar 31 while the cross head 30 is moving the spiral guideways 29 in the rear portion of the drill body. By providing four jaws hinged at their rear ends to the draw bar and spaced 90° apart around the latter, said jaws may be made alike and interchangeable, but the threads or ribs of either pair of diametrically opposite jaws are preferably one-half thread staggered relatively to the other pair, so that two will always come in easy and full engagement with the piston, although the tops of the threads of the other pair should meet the tops of the threads of the threads in the head or piston 10 and be unable to engage. The springs 60 of the blocks 59 of the other pair will yield as before explained, and avoid any undue strain. The size of the ribs that compose the six threads and the space between them in the head or piston 10, is such that, sometimes, the ribs of all four jaws will engage the threads, but two jaws will be sufficient to withdraw and retain the head or piston and the drill rod carried thereby. The clutch and releasing of the draw bar with the drill rod by means of the devices above described, are accomplished during the forward and rear "dwell" of the draw bar during its operation by the crank shaft, and hence no jerk will occur.

The manipulations of the clutch or coupling devices are accomplished automatically by the movements of the bearing box 33 on the crank of shaft 27^a through the elongated opening 32 of the cross head 30. To this end, a trip lever 65 is pivotally supported between its ends in proximity the cross head 30 and at one side of the longitudinal axis of the draw bar. This trip lever is provided at the free ends of its arms with toes 66 and 67,—one or the other of which will always project into the elongated opening 32 of the cross head 30. One arm of the trip lever is pivotally connected to the rear ends of arms

68 made rigid with and projecting rearwardly from the head 57 of the sleeve 56. The arms 68 are covered by saddles 69 against which the springs 55 of two of the jaws 43 bear.

When the draw bar is moved forwardly by the crank shaft, the bearing box 33 will move in such direction through the elongated opening 32 of the cross head 30 as to engage the toe 66 of the trip lever 65 and turn the latter in a direction to withdraw the sleeve 56, thus moving the blades 59 rearwardly and permitting the jaws 43 to be moved, by the springs 55 toward the draw bar so that said jaws will be permitted to move freely in the head or piston 10 during their forward throw. When the draw bar shall have completed its forward throw, the bearing box 33 will, during the forward "dwell" of said draw bar, engage the toe 67 of the trip lever 65, thus rocking said trip lever to move the sleeve 56 forward and actuate the jaws 43 for causing their threads or ribs to interlock with the threads within the head or piston 10 of the drill rod. During the forward throw of the draw bar, the propelling springs were compressed as previously explained, and as the crank shaft continues to turn, the draw bar will be withdrawn and the drill rod securely coupled thereto, will also be withdrawn, together with the compressed propelling springs, and at the same time, the drill rod will be caused to turn by the turning of the draw bar as the cross head moves in the spiral guideways 29. When the rear "dwell" of the parts is reached, the bearing box 33 of the crank of the operating shaft will engage the toe 66 of the trip lever 65, causing the latter to be rocked and the sleeve 56 to be moved rearwardly to permit the spring-pressed jaws to be released from the threads in the head or piston 10. The drill rod will now be free, and will be projected forwardly by the propelling springs to cause the bit to strike the rock. The draw bar and clutch jaws carried thereby will quickly follow the head 10 of the drill rod and prevent the propelling springs from being fully expanded. By thus keeping the propelling springs under more or less compression when they are in action, the force of the draw bar during its forward throw is added to that of the propelling springs and the force of the blow struck by the bit is amplified.

It is desirable that the turning of the drill rod during its backward throw shall not be greater nor less in degree than the turning of the draw bar. In other words, the drill bit should be turned uniform distances during all return strokes of the same. In order to insure such action, I provide a ratchet plate 70 to engage ratchet teeth 71 on the peripheral face of the head or piston 10, and prevent rotation of the latter during its forward throw, but permit partial rotation of said head or piston during the rearward throw of the same. The ratchet plate 70 is mounted on a rod 72 located in a pocket 73 in the lower portion of the drill barrel and is pressed into engagement with the ratchet teeth on the head or piston 10, by means of a spring 74. The ratchet plate is normally held in place by means of a pin 75, by removing which the said ratchet plate can be removed.

The crank shaft 27^a is provided at one end with a gear wheel 76 inclosed by a casing 76^a and motion is imparted to this gear wheel by a gear wheel 77, the latter receiving motion from a pinion 78 on the rotary shaft of an electric motor 79. The ring or body portion 80 of this motor is threaded at its ends for the reception of heads 81 and 82, the latter being also pinned in place and provided with a gear casing 82^a. The other motor head 81 is easily removable and has an outer rib or rim 83 that engages a groove 84 in the rear end plate of the drill barrel. The rib or rim 83 extends all around the edge of the head 81, serving to strengthen it and also render it interchangeable with different drills. When the head 81 is removed, the rotor of the motor can be lifted out as the bearing in the head 82 is large enough to permit the pinion 78 to pass through it. When the rotor has been removed, access is had to the contact connections on the inside of the head 82. Were the head 82 not pinned on after being screwed in place, any attempt to unscrew it, would damage these connections. Cast integral with the head 82, is the holder 85 for the contact boxes, as well as part of the housing for the pinion 78 and intermediate gear 77. The head 82 is also provided with a strong boss 86 that is machined to a step-by-step surface to engage a like surface on the drill body. The head 82 is also provided with another boss or rib 87 disposed to receive one jaw of a clamping dog 88, the other jaw of which engages a rib 89 on the drill body. A bolt 90 passes down through the dog 88 and through a flange 91 on the rear end piece of the drill body and is screwed into the apron at the rear end of the drill body. To attach the motor, the flanged end motor head 81 will be hooked into the groove in the rear end plate of the drill body. The gear case will then be moved if necessary to cause the gears to properly mesh, and when the joints of the gear cases properly mesh, the larger notched boss of the motor head will rest upon the notched seat made upon the drill body to receive it. The dog 88 will then be placed in position and secured by the bolt 90. By connecting the motor with the drill body as above described, it will be secured in position with the use of a single bolt and can be removed by loosening said bolt.

Various changes might be made in the details of construction of my invention without departing from the spirit thereof or limiting its scope and hence I do not wish to restrict myself to the precise details herein set forth.

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

1. In a drill, the combination with a reciprocating drill rod provided with a head having internal threads, of a draw bar, ribbed jaws carried by said draw bar and adapted to engage the threads in said head, means for operating said jaws, means for reciprocating the draw bar and means for causing said draw bar to turn.

2. In a drill, the combination with a drill rod provided with a head having a series of parallel ribs or threads within the same, of a draw bar, jaws carried by the draw bar and provided with ribs to engage the ribs or threads in said head, means for operating said jaws, and means for recipocating the draw bar.

3. In a drill, the combination with a drill rod provided with a hollow head or piston, of a removable lining within said head or piston and having a series of spiral ribs or threads therein, a reciprocating draw bar, jaws carried by said draw bar and provided with inclined ribs to engage the spiral ribs or threads in the lining of the head or piston of the drill rod, and means for operating said jaws.

4. In a drill, the combination with a drill rod having a hollow head or piston provided interiorly with spiral ribs or threads, of a draw bar, a series of spring-pressed jaws carried by said draw bar and adapted to enter said hollow head or piston, said jaws provided exteriorly with ribs to engage the ribs or threads in the hollow head or piston, and means for moving the jaws outwardly into engagement with the ribs or threads in the hollow head or piston.

5. In a drill, the combination with a drill rod provided with a hollow head having internal threads, and a reciprocating draw bar, of a series of jaws having ribs on their outer faces, carried by the draw bar and adapted to coöperate with the threads in the hollow head, said jaws arranged in pairs with the members of each pair disposed opposite each other, and means for operating said jaws to cause their ribs to engage the ribs in the hollow head.

6. In a drill, the combination with a drill rod provided with a hollow head having internal ribs, and a reciprocating draw bar, of a series of pivoted jaws having ribs, carried by said draw bar, and a series of blocks to engage said jaws and move them into engagement with the ribs in the hollow head, and means for operating said blocks.

7. In a drill, the combination with a drill rod provided with a hollow head, and a reciprocating draw bar, of a series of jaws carried by said draw bar and movable in said hollow head, a series of yielding blocks for operating said jaws, and means for moving said jaws longitudinally to operate the jaws.

8. In a drill, the combination with a drill rod provided with a hollow head, and a reciprocating draw bar, of a series of spring-pressed jaws carried by the draw bar and adapted to enter said hollow head, each of said jaws having a shoulder, a series of blocks adapted to engage the shoulders of the jaws, springs behind said blocks, and means for moving said blocks and their springs to operate the jaws.

9. In a drill, the combination with a drill rod provided with a hollow head and a reciprocating draw bar, of spring pressed jaws pivotally attached to said draw bar and adapted to enter said hollow head, a sleeve mounted to move longitudinally on said draw bar, yielding blocks carried by said sleeve and adapted to engage said jaws for operating the latter and means for moving said sleeve longitudinally.

10. In a drill, the combination with a drill rod provided with a hollow head, and a reciprocating draw bar, of a series of spring-pressed jaws pivotally attached to the draw bar, means for limiting the movements of said jaws, a sleeve movable longitudinally on the draw-bar, a series of yielding blocks carried by said sleeve for operating said jaws and means for moving said sleeve longitudinally.

11. In a drill, the combination with a drill rod provided with a hollow head having internal threads, a crank shaft, a draw bar provided with a cross head having an elongated opening, and a bearing box mounted on the arm of the crank shaft and movable in the elongated opening of the cross head, of a series of spring pressed jaws provided with external ribs, carried by the draw-bar and movable in the hollow head of the draw bar, a sleeve mounted to move longitudinally on the draw bar, blocks carried by said sleeve and adapted to coöperate with the jaws to move them into engagement with the threads in the hollow head, arms projecting from said sleeve, and a trip lever mounted in the draw bar and connected with the arms on the sleeve, said trip lever having toes adapted to project into the elongated opening of the cross head so as to be engaged by the bearing box therein.

12. In a drill, the combination with a drill rod having a hollow head, of a reciprocating draw bar, a plurality of pairs of lugs projecting from the draw bar, a jaw mounted between the lugs of each pair, pivot pins passing through said lugs and jaws, one pair of said pivot pins overlapping the ends

of the other pair and provided with heads at one end, spring-pressed locking pins engaging said heads, springs normally pressing the pairs toward the draw bar, and means located between the draw bar and the jaws for moving the latter into engagement with the hollow head on the drill rod.

13. In a drill, the combination with a drill body, a drill rod, a crank shaft and connections between the crank shaft and drill rod, of a motor and a motor casing comprising a body casing and heads screwed to said body casing and engaging the drill body, a dog engaging one of the motor heads and the drill body, a bolt securing said dog to the drill body and gearing connecting said motor with the crank shaft.

14. In a drill, the combination with a drill body, a drill rod, a crank shaft, and connections between the crank shaft and the drill rod, of a motor and a motor casing having a body ring or casing and heads screwed into said body ring or casing, one of said heads having a head or rib to engage the drill body, and the other head having a stepped engagement with the drill body, and a lug, a lug on the drill body, a dog connecting said lugs, a bolt connecting said dog with the drill body, gearing connecting the motor with the crank shaft and casings inclosing said gearing.

15. In a drill, the combination with a drill rod having a hollow head provided internally with threads or ribs, and a reciprocating draw bar, of two pairs of jaws carried by the draw bar and having ribs to engage the threads or ribs in the drill rod head, the ribs of one pair of jaws being staggered with relation to the ribs on the other pair.

16. In a drill, the combination with a drill rod having a hollow head provided internally with a series of separate threads or spiral ribs and a reciprocating draw bar, of two pairs of interchangeable jaws each having a series of ribs to engage the ribs or threads within the drill rod head, the ribs of one pair of jaws being staggered with the ribs of the other pair, and all of said jaws being interchangeable without interfering with such staggered relation.

In testimony whereof, I have signed this specification in the presence of two subscribing witnesses.

THOMAS EDGAR ADAMS.

Witnesses:
ISADOR LADOFF,
JOHN R. ORPUTT.