July 12, 1938. A. H. KATTERJOHN 2,123,364

AUTOMATIC FEED FOR ROCK DRILLS

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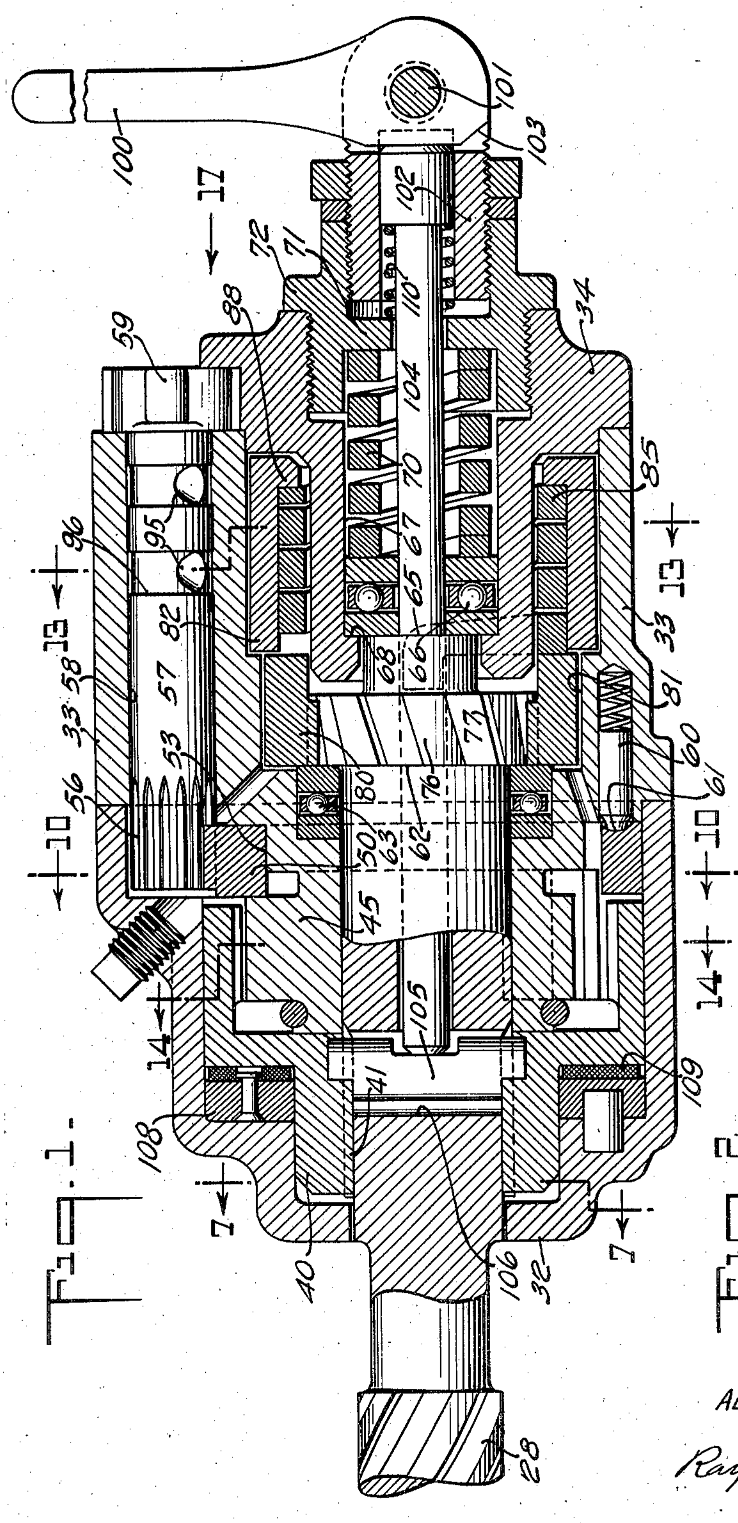


Fig. 1.

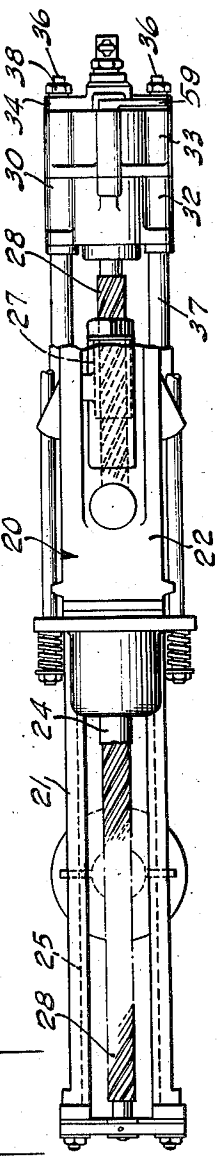


Fig. 2.

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Fig. 3.

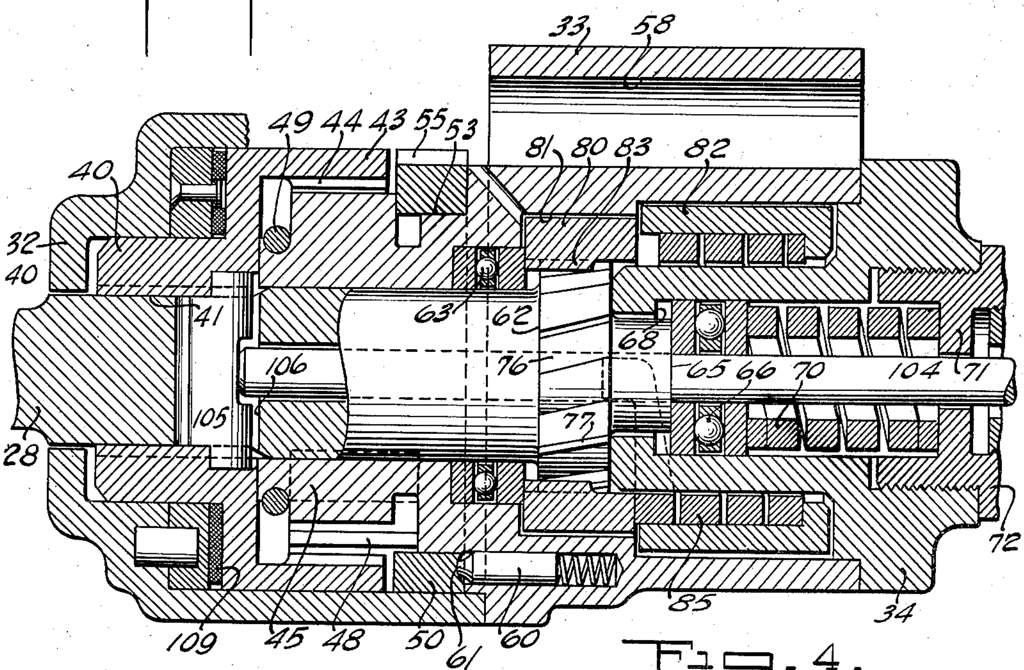
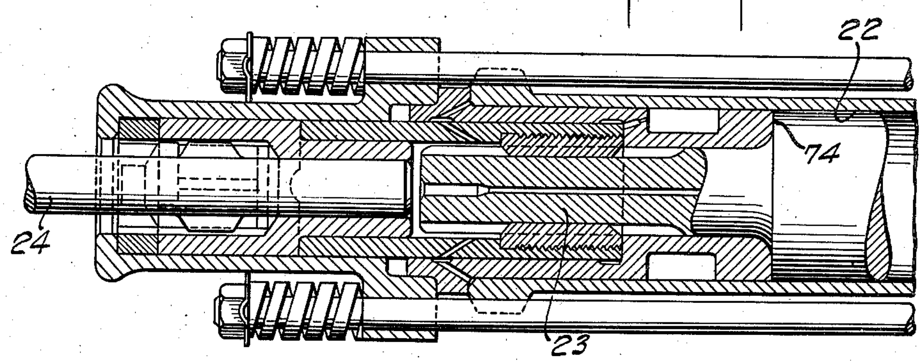



Fig. 4.



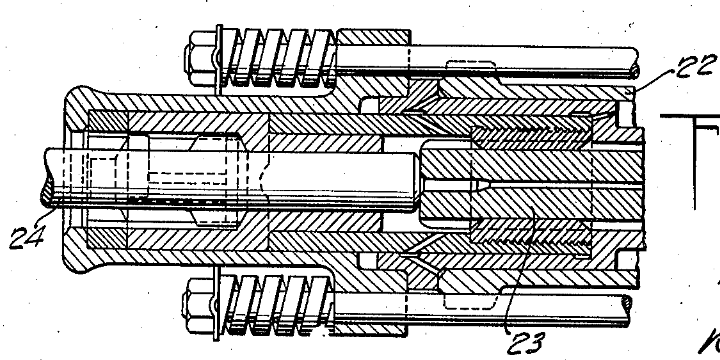




Fig. 5.

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FIG. 6.

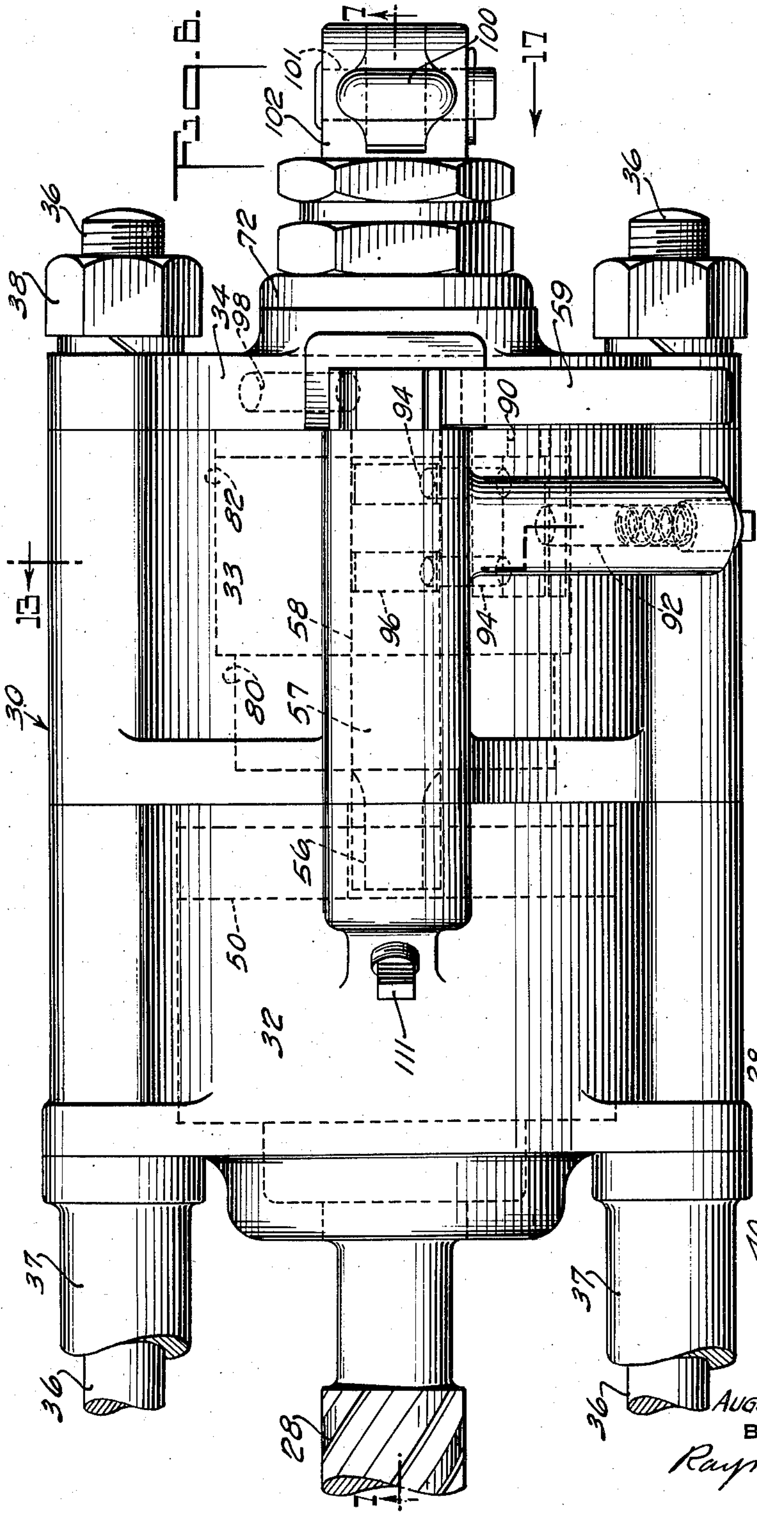



FIG. 8.

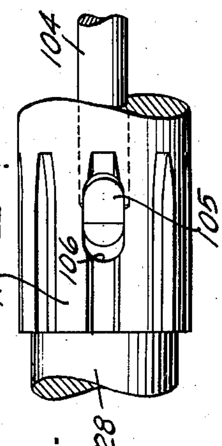
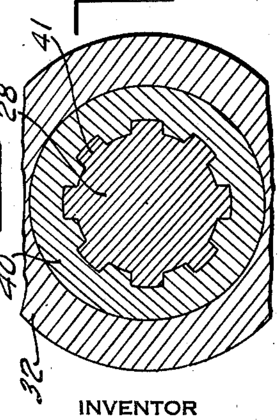



FIG. 7.

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AUTOMATIC FEED FOR ROCK DRILLS

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Fig. 10.

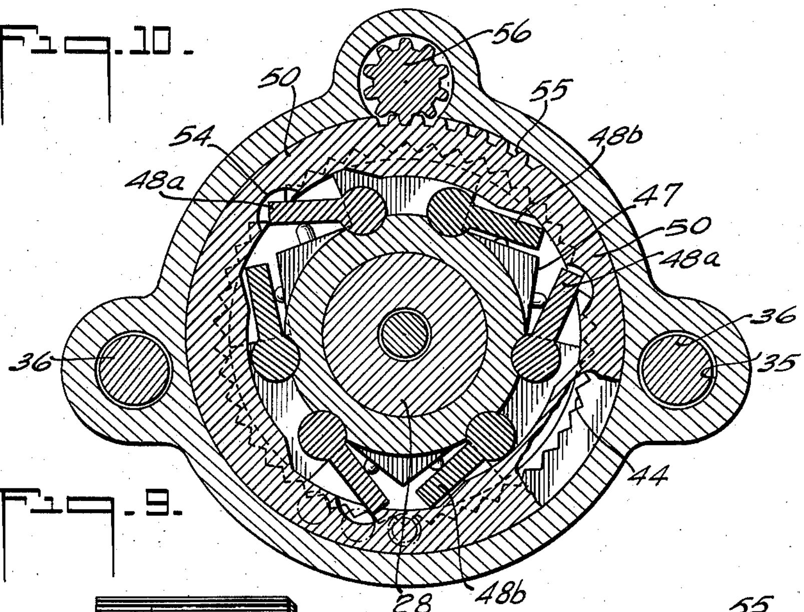



Fig. 9.

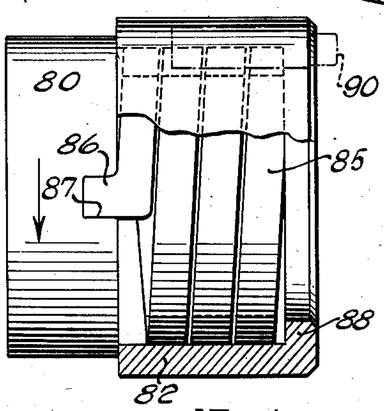
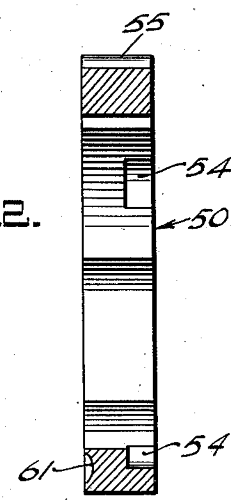



Fig. 12.



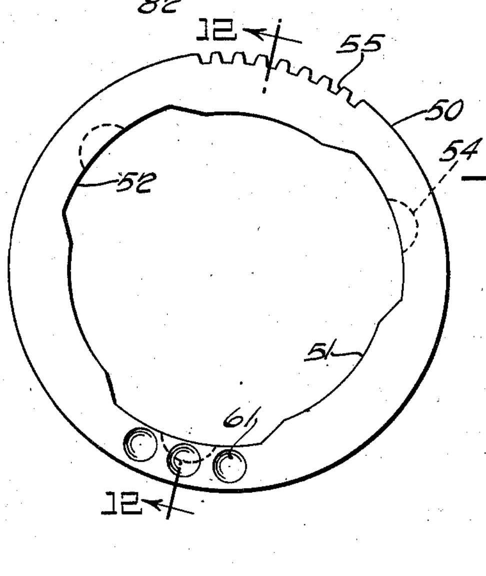




Fig. 11.

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Fig. 13.

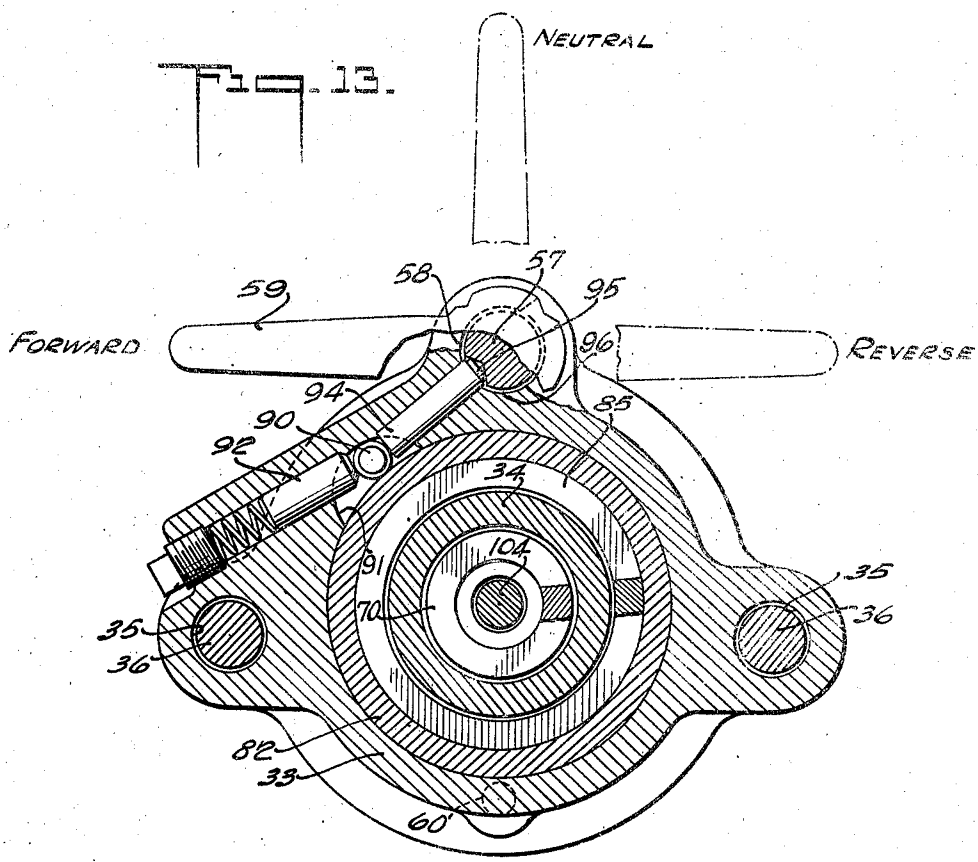


Fig. 14.

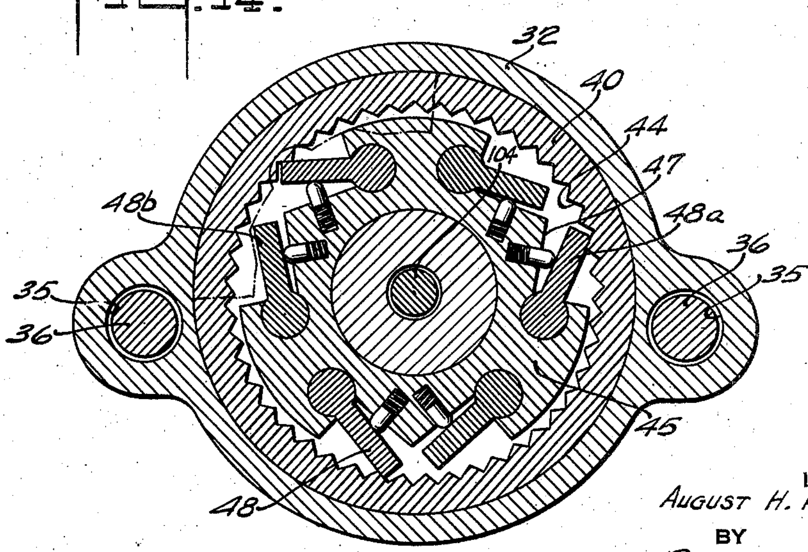


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Fig. 15.

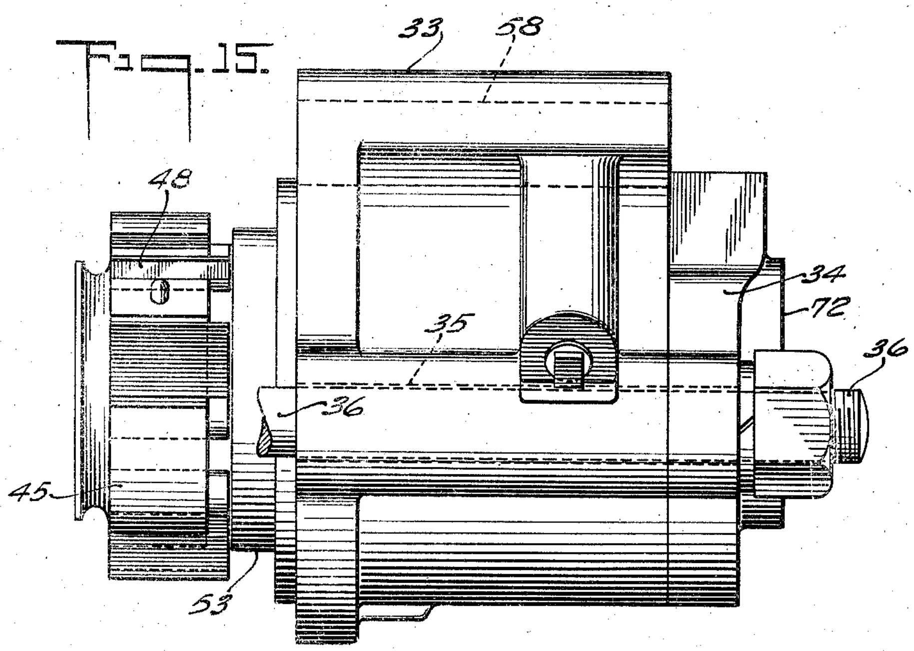


Fig. 16.

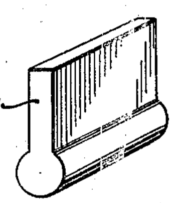


Fig. 17.

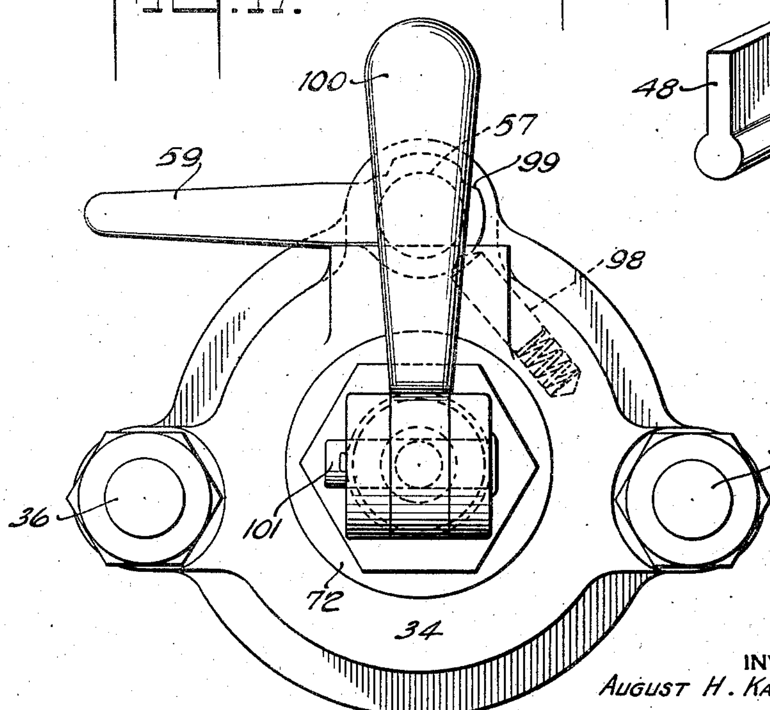


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Fig. 18.

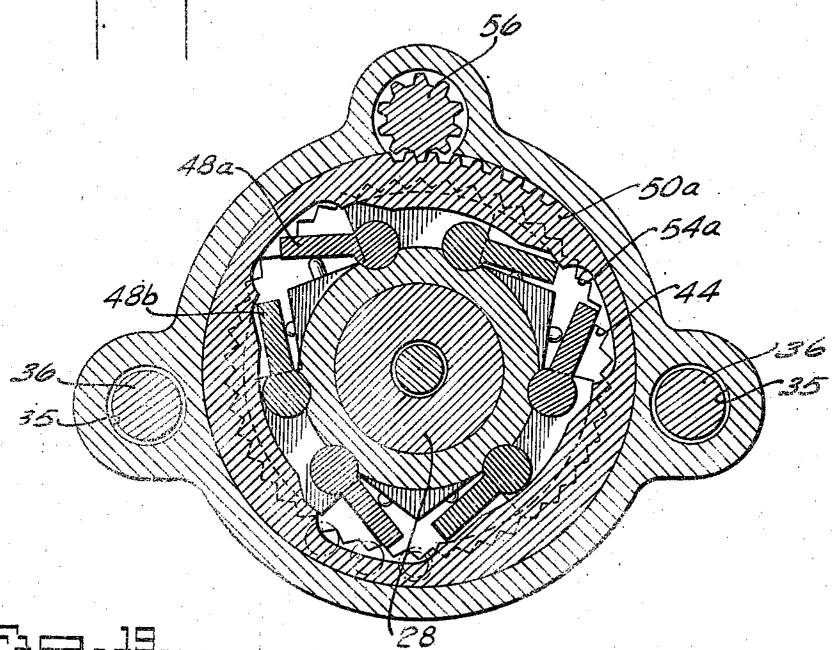



Fig. 19.

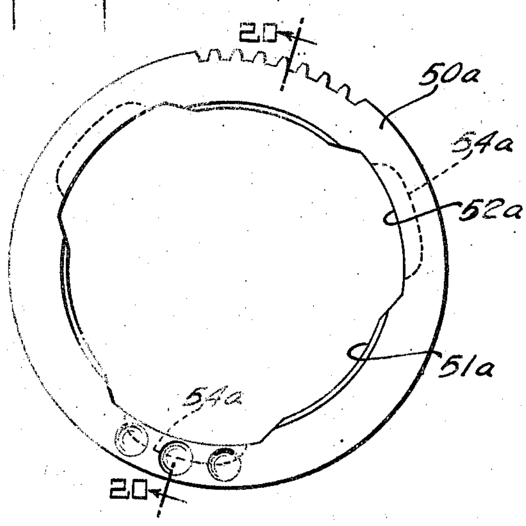
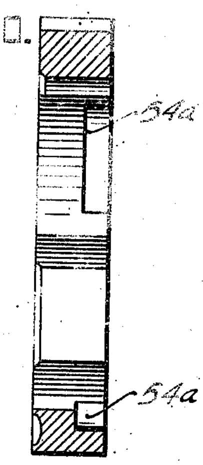



Fig. 20.

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Patented July 12, 1938 2,123,364

# UNITED STATES PATENT OFFICE

2,123,364

## AUTOMATIC FEED FOR ROCK DRILLS

August H. Katterjohn, Detroit, Mich., assignor to Chicago Pneumatic Tool Company, New York, N. Y., a corporation of New Jersey

Application September 1, 1934, Serial No. 742,372

35 Claims. (Cl. 255—45)

This invention relates to feeding devices for percussive tools and more particularly to an automatic feed for rock drills. The general object of the invention is the provision of an improved recoil or jump feed for rock drill drifters in which the position of the drill on its support is so controlled as to enable the drill to operate with maximum efficiency and speed of penetration.

One of the well-known types of automatic feeds for rock drills is known as the jump feed which operates in response to the longitudinal vibrations of the drilling machine, a ratchet arrangement being provided to permit the machine to move step-by-step in one direction only. While the jump or recoil type has many advantages over other feeding devices, its commercial success has been retarded due to failure heretofore to maintain the desired relation between the drilling machine and the rock. One serious objection to the conventional type of feed that depends upon the forward and backward jumping of the machine to accomplish the feeding, is the fact that before any forward jumping of the machine can be obtained, the piston hammer of the drifter must run into the front cushion chamber sufficiently hard to drive the machine forward. While this feature is not objectionable while the machine is being moved backward or forward rapidly, or to and from its working position, it is objectionable during that time when the machine is in its actual drilling position against the shank of the drill steel. When this position is assumed, the full force of the forward movement of the piston should be applied to the end of the drill steel instead of part of that energy being used to jump the machine forward. There can be no forward force applied to the machine itself until the piston hammer has passed its most effective striking position in relation to the shank of the drill steel. The result is not only a loss in drilling efficiency, but also increased strains are placed upon the various parts of the entire drill and mounting.

To prevent this loss of efficiency and to overcome other disadvantages in conventional jump feeds, the present invention is designed automatically to continue the feeding of the drilling machine during the time that there is no forward blow imparted by the piston to the cylinder. The desired object is accomplished by the use of a novel mechanism responsive to the backward jump of the machine to rotate the feed screw in the direction that will feed the machine forward so that when the machine is actually drilling and is in working relation to the end of drill steel, all the force of the hammer or piston blow is delivered to the drill steel.

In the illustrative embodiment of the invention the mechanism for converting the rearward recoil of the machine into a forward feeding movement comprises a feed screw having limited axial movement on the support and rotation devices adapted to convert reciprocating into rotary motion for advancing the drill.

Another object of the invention is to combine two feeding mechanisms for operation upon the same screw, one mechanism being adapted to feed the machine rapidly and the other slowly, the former becoming ineffective after the machine has been advanced into working relation with respect to the rock. In accordance with this invention the conversion from rapid to slow feeding is effected automatically at the proper time and without any attention on the part of the operator. The two feeding mechanisms are so arranged that they do not interfere with each other or with the operation of the drilling machine at any time. In operation, briefly, the drilling machine is advanced rapidly and step-by-step with each forward impulse delivered to the cylinder by the piston until the machine reaches a position where the forward blow is taken by the drill steel instead of the machine. The slow feeding mechanism becomes effective at this point and advances the machine in response to impulses due to the piston striking the rear end of the cylinder.

A feature of this invention resides in an automatic control whereby the operator may permit automatic feeding either rearwardly and rapidly or forwardly at automatically controlled speeds, or may disable the automatic feeding mechanisms entirely to permit the machine to be pushed by hand.

Another feature of this invention resides in a brake for the feed screw which is designed to retard rotation of the latter while permitting limited axial movement of the screw with respect to its support.

Other objects and features of the invention will appear more clearly from the following description. In the drawings:

Fig. 1 is a central vertical section of a feeding device incorporating the present invention;

Fig. 2 is a plan view on a reduced scale, showing the invention applied to a rock drill drifter;

Fig. 3 is a fragmentary view similar to Fig. 1 but showing the feed screw shifted rearwardly;

Fig. 4 is a horizontal section of the front end of a conventional rock drill showing the piston delivering its forward blow to the front head of the cylinder;

Fig. 5 is a view similar to Fig. 4 but showing the piston delivering its forward blow to the drill steel;

Fig. 6 is a plan view of the device shown in Fig. 1;

Fig. 7 is a section taken along the line 7—7 of Fig. 1;

Fig. 8 is a fragmentary top view of the feed screw, brake key and brake rod;

Fig. 9 is a side view partly in elevation and partly in section showing the clutch case, clutch spring and rotation collar;

Fig. 10 is a section along the line 10—10 of Fig. 1 and showing reversible ratchet means for controlling the direction of the rapid feeding mechanism;

Fig. 11 is an elevational view of the ratchet control ring looking forwardly with respect to the drilling machine;

Fig. 12 is a section indicated by the arrows 12—12 in Fig. 11;

Fig. 13 is a section along the broken line 13—13 of Fig. 1 illustrating the means for selectively permitting or preventing rotation of the clutch case in one direction;

Fig. 14 is a section taken along the broken line 14—14 of Fig. 1;

Fig. 15 is a side elevation showing the intermediate housing, rear housing and pawls mounted in an extension of the intermediate housing;

Fig. 16 is a detail view of one of the pawls shown in Fig. 15;

Fig. 17 is an elevational view of the rear end of the device shown in Fig. 1;

Fig. 18 is a section, similar to Fig. 10, of a modified reversible ratchet means;

Fig. 19 is an elevational view of the modified ratchet control or shifter ring; and

Fig. 20 is a section indicated by the arrows 20—20 in Fig. 19.

Referring more particularly to the drawings, the percussive motor is illustrated as a rock drill 20 mounted slidably on a support 21 (Fig. 2) illustrated as being a rock drill shell. The rock drill 20 comprises the usual cylinder 22, wherein is disposed a reciprocating hammer piston 23 (Figs. 4 and 5) arranged to deliver blows of impact against a working implement, such as a drill steel 24. The support or shell has the usual guide ways 25 to slidably receive ribs (not shown) carried by the cylinder 22 of the motor.

The means for feeding the rock drill longitudinally of the shell comprises a feed nut 27 affixed to the drill and a feeding screw 28 received by said nut and extending parallel to the guide ways 25 and supported by the shell in a manner to be described presently. The connection between the nut 27 and the screw 28 and the lead of the threads of these elements are such that when the motor 20 is moved longitudinally of its support, the screw 28 will be freely rotated by the motor in either a clockwise or counter-clockwise direction depending upon the direction in which it is desired to move the motor.

As best shown in Figs. 2 and 6 the apparatus for supporting the feed screw 28 and for controlling its movement is contained in a housing 30 mounted at the rear end of the support or shell 21. The component parts of the housing may be designated for convenience as the front housing 32, the intermediate housing 33, and the rear housing 34, these three parts being telescoped, or nested, one within another. The three housing members are provided at their sides with alined apertures 35 to receive the through bolts 36 supported in the usual manner by the shell 21. Spacing sleeves 37 and nuts 38 cooperate with the through bolts to hold the housing 30 securely to the support 21 as will be understood by those skilled in the art. The housing 30 encloses two automatic feed mechanisms, one of which feeds the rock drill in the same direction as the piston impulse which actuates the feeding movement, and the other of which is responsive to a rearward impulse for feeding the drill forwardly.

*Forward impulse—forward feed*

The automatic feeding mechanism which feeds the rock drill in the direction of the jars by the piston comprises a ratchet ring 40 rotatably mounted in the front housing 32 and having splines 41 receiving cooperating splines on the exterior of the feed screw 28 adapted to lock the fed screw rotatably to the ratchet ring while permitting axial movement of the screw.

For controlling the direction of rotation of the ratchet ring and consequently of the feed screw, the ratchet ring has an annular flange 43, the inner surface of which is provided with teeth 44 to form an internal ratchet. The toothed ratchet surrounds a projection 45 integral with the intermediate housing 33 and having its free end abutting a portion of the ratchet ring 40. The periphery of the projection 45 is provided with two sets of oppositely inclined slots 47 (see Fig. 14) extending lengthwise of the projection and adapted to receive two sets of pawls 48. As shown in Fig. 16 each pawl has the shape of a key hole slot in cross section. The slots 47 are shaped to provide bearings for the pawls and to permit them to move into or out of engagement with the ratchet teeth 44. A split ring 49 received in a groove in the projection retains the pawls in the slots. The slots are so arranged that one set of pawls 48*a* may lock the ratchet ring 40 against clockwise movement while the other 48*b* may lock the ratchet ring against counter-clockwise movement.

Any suitable reversing control means may be provided for selecting a set of pawls to permit the ratchet to rotate in the desired direction. As shown, it comprises a shifter ring 50 (shown best in Fig. 11) having an internal bearing surface 51 interrupted by three recesses 52 corresponding to the number of pawls in each set. Bearing surface 51 is rotatably mounted on a cylindrical neck 53 at the rear end of projection 45. The shifter ring is placed in position on the neck in the manner of a bayonet joint by moving the ring axially over the projection prior to the insertion of the pawls with the bearing surfaces registering with the slots 47 and then rotating the ring. The recesses 52 are in communication with notches 54 which may extend throughout a portion of the thickness of the ring, as illustrated in Fig. 12. These notches are of sufficient axial and radial depth to receive the outer corners of the pawls 48 and to permit only one set of pawls at a time to engage the ratchet teeth 44. The shifter ring is adapted to be rotated through a limited arc by virtue of peripheral teeth 55 meshing with an actuating pinion 56 formed on a control shaft 57 supported within a bore 58 in the intermediate housing 33. The shifter ring 50 is operated by a control handle 59. A spring pressed detent 60 cooperates with any one of three depressions 61 to lock the shifter ring yieldingly in either extreme or in an intermediate position, in which last-named position both sets of pawls are rendered ineffective.

Movement of the feed screw 28 along its axis in a forward direction is positively limited by a shoulder 62 abutting a thrust bearing 63 mounted in a recess in the intermediate housing 33. Rearward axial movement is resisted by an engagement between the free end 65 of the screw and a thrust bearing 66 situated in a bore 67 in the rear housing 34 and normally held against a flanged shoulder 68 at the end of said bore. A recoil spring 70 also mounted in said bore exerts pressure against the thrust bearing 66 at one end and at its other end against a flange 71 formed on a cap 72 threaded into the rear housing 34.

The operation of the forward-jump, forward-feed mechanism just described is as follows: Movement of the rock drill 20 along the guide ways 21 in a forward direction is effected by rotating the feed screw 28 in a counter-clockwise direction from the view point of the operator. When the control handle 59 is thrown to forward position, as indicated in Figs. 13 and 17, the shifter ring 50 is turned to disengage the set of pawls 48*b* and permit pawls 48*a* to engage the ratchet teeth 44. These pawls lock the ratchet ring 40 and consequently the feed screw 28 against clockwise movement while permitting counter-clockwise rotation of the screw to advance the drill forwardly. Operation of the drilling motor, prior to the time that the drill steel engages the rock, causes the piston 23 to reciprocate rapidly and to deliver cushioned blows to both the front head and the back head of the cylinder. These blows, or vibrations, are transmitted to the feed nut 27. The pitch of the screw and nut is such that on the forward blow the feed nut moves forwardly turning the feed screw in a counter-clockwise direction. When a rearwardly directed jar is delivered by the piston the nut cannot move rearwardly because the pawls 48*a* prevent the feed screw 28 from turning in a clockwise direction. As a result the vibrations of the drill 20 impart to the feed screw a series of rotary movements in the counter-clockwise direction for feeding the drill forwardly just as long as the piston delivers to the front head of the cylinder, blows of sufficient force to cause the feed nut to rotate the screw.

The intensity of the forwardly directed jar imparted to the rock drill is determined by the position of the drill steel. When the steel 24 is out of engagement with the rock it occupies a position forwardly of the piston, as shown approximately in Fig. 4. In this position of the steel, the piston strikes a cushioned blow against a shoulder, such as 74, on the front head. As long as the front head absorbs most of the momentum of the piston, this forward impulse or jar is sufficient to feed the drill forwardly by means of the apparatus described above and referred to as the forward-jump, forward-feed mechanism.

This mechanism by itself will not function efficiently, however, after the actual drilling is commenced. When the steel 24 reaches its operative position and begins to drill the rock, the inner end of the steel moves in towards the piston chamber and approaches the position shown in Fig. 5, in which position the major portion of the momentum of the piston is absorbed by the steel and not by the front head. In prior devices, employing but a single feed, it has been found that the drill will not feed forward sufficiently to permit the steel to occupy the Fig. 5 position. Since these prior or conventional feed mechanisms depend for their operation upon impulses delivered to the front head of the cylinder, they do not feed with the full force of the piston imparted to the steel. As a result there is a lag between the position of the steel and the position of the drill, which causes or permits the front head to absorb a part of the shock that should be transmitted to the steel, the latter occupying a position intermediate the Fig. 4 and Fig. 5 positions.

It has been found that when the piston dissipates a large part of its energy against the front head instead of the steel, there is a loss of efficiency, a reduction in drill speed, and frequent breakage of the parts of the drill. The present invention overcomes these disadvantages and eliminates troubles of this character by controlling the feed so that the steel will be in position to operate with maximum efficiency. The ideal position is approximately as shown in Fig. 5 with the drill so advanced as to cause the steel to project inwardly toward the piston chamber without forcing the steel too hard against the rock. Accordingly, there is provided a secondary feed mechanism which automatically comes into operation when the feeding device, first described, has ceased to become effective.

*Rearward impulse—forward feed*

The mechanism for feeding the drill forwardly in response to impulses in the opposite direction is believed to embody a novel principle. Briefly described, it consists in converting axial reciprocation of the feed screw into rotary movement by absorbing a rearward impulse, storing the energy thus absorbed and then turning the screw in the forward feeding direction after the impulse or jar has been delivered. It should be noted that while maximum efficiency requires the elimination of shock against the front head of the cylinder, the piston on its return stroke may deliver a jar to the back head without impairing the performance of the drill. This backward impulse is transmitted to the feed nut carried by the drill. The pawls 48*a* prevent the nut from turning the screw when the latter is thrust rearwardly and, as a result, the screw and nut move backward as a unit in the direction of the feed screw axis. Rearward axial movement of the screw causes the end shoulder 65 to force the thrust bearing 66 against the recoil spring and compresses the latter which absorbs the rearward thrust of the piston. The recoil spring stores the energy thus received and releases it to restore the feed screw to normal position after the impulse has been delivered and while the piston is moving forwardly.

The rotation mechanism for converting axial reciprocations of the feed screw into step-by-step rotary movement comprises a head 76 on the feed screw having spiral flutes 77, the head having limited axial movement between the thrust bearing 63 and the inner end of the rear housing 34. A rotation collar 80 surrounding the splined head 76 is mounted in a counterbore 81 in the intermediate housing 33 and loosely held between the thrust bearing 63 and the end of a clutch case 82. A portion of the internal surface of the rotation collar is provided with splines 83 meshing with the splines 77 on the screw head 76. The splines are illustrated as left hand or opposite to the right hand threads at the forward end of the feed screw 28. The reciprocation of the feed screw with respect to the rotation collar **80** causes one of these splined elements to rotate with respect to the other.

Means are provided to permit the rotation collar to turn during rearward movement of the feed screw and to lock the rotation collar and compel the feed screw to rotate during forward movement of the latter. This means comprises the clutch case **82** and a clutch spring **85** enclosed therein. One end of the clutch spring has a tang **86** that engages a slot **87** in the end of the rotation collar **80**. The other end of the spring rests against a flange **88** on the clutch case. The inside of the clutch case and the outside of the clutch spring are ground to a close fit. The spring is made a trifle longer than the space it is to occupy so that when assembled, the periphery of the spring will be in close contact with the inside surface of the clutch case **82**. Referring to Fig. 9 it will be understood that when the clutch case **82** is locked against rotation, the rotation collar **80** is rotatable only counter-clockwise (in the direction of the arrow). The spring is so coiled that any tendency of the rotation collar **80** to rotate clockwise relative to the clutch case expands the spring radially against the inner surface of the clutch case **82**. This action of the spring prevents the rotation collar **80** from rotating clockwise if the clutch case is held stationary, but will not prevent counter-clockwise rotation of the collar which exerts a pulling action on the end **86** of the spring, tending to contract the latter.

The operation of the rearward jump—forward feed mechanism is as follows: Assume that the clutch case **82** is locked, by mechanism to be described, against clockwise movement and that the drill steel **24** is in operative position against the rock with its shank projecting into the piston chamber, as indicated in Fig. 5. The rock drill piston reciprocates within the cylinder striking the drill steel **24** on one stroke and the cylinder back head on the other, thereby transmitting to the feed nut **27** a series of rearwardly directed blows. Since the feed screw **28** is locked by the pawls **48*a*** against clockwise movement, the screw is thrust rearwardly together with the feed nut, there being no turning movement of the screw during the rearward movement. The rearward recoil of the screw causes the splines on the feed screw head **76** to ride along the splines **83** on the rotation collar. Since the feed screw cannot rotate clockwise, it reciprocates without turning but causes the rotation collar to rotate in the opposite direction, the clutch spring **85** permitting the end **86** of the spring to be pulled counter-clockwise. The longitudinal thrust of the feed screw compresses the recoil spring **70**.

After the rearward longitudinal thrust ceases the recoil spring **70** moves the feed screw forwardly. During this forward movement, the rotation collar **80** is prevented from turning clockwise and the feed screw is therefore compelled to rotate counter-clockwise due to the inclination of the splines **77** and **83**. This turning movement of the feed screw advances the rock drill toward the rock.

*Rate of feed*

The rate of feed produced by the rearward jump—forward feed mechanism is controlled by the amplitude of the axial vibrations of the feed screw **28**. Any tendency of the feed mechanism to jam or force the drill too tight against the steel automatically shortens the stroke of the axial movements by increasing the mean tension on the recoil spring **70** and causes the feed screw head **76** to move from the Fig. 3 position to a position intermediate those shown in Figs. 3 and 1 respectively. Conversely, when the drill tends to lag behind the steel, the stroke is automatically lengthened. The maximum amplitude of reciprocating movement of the feed screw head **76** and the pitch of the splines on the head are selected to produce the extreme maximum feed anticipated in free cutting rock, for example, thirty inches per minute. Thus the drill is adapted to operate with maximum efficiency on any kind of rock and the feed mechanism exerts the desired pressure against the steel for all drilling speeds from zero to the maximum.

It is desirable that the threads on the forward end of the feed screw have longer lead than the splines on head **76** so that the free running feed may be several times as fast as the maximum drilling speed. Satisfactory results are obtained by the use of threads having, for example, one turn in two inches, as compared with one turn in twenty inches for the splines. Observations of a device so constructed show that it will feed both rearwardly and forwardly when free from the rock at the rate of twenty-four inches in four seconds and will drill at speeds ranging from one-quarter inch per minute in mass copper to eighteen inches per minute in free cutting rock with the machine continuously held firm against the drill steel shank and without crowding the steel.

During the free running movement of the drill the axial reciprocations of the screw, which are permitted by the recoil spring **70**, do not hamper the operation of the forward jump—forward feed mechanism. On the rearward stroke of the piston the spring **70**, which may have an initial tension of say five hundred pounds, permits the screw to move a limited distance with the feed nut **27**, but on the forward stroke the thrust bearing **63** positively holds the screw head in normal position while the nut moves axially over the screw, turning the latter to advance the drill.

*Reverse and neutral control*

The control handle **59** which selects the sets of pawls **48*a*** and **48*b*** for determining the direction of the free running or forward jump—forward feed mechanism is also effective to disable the other feed mechanism in both the neutral and reverse positions. The means for controlling the rearward impulse feed mechanism comprises a lock pin **90** (see Fig. 13) engaging the outer wall of the clutch case **82** and confined within a cam shaped recess **91** in the intermediate housing **33**. A spring-pressed plunger **92** urges the lock pin toward the upper end of the recess. When plunger **92** is effective, the clutch case **82** and rotation collar **80** are locked against clockwise movement thereby compelling the feed screw to rotate counter-clockwise when it moves forwardly. A pair of disabling plungers **94** engage the opposite side of the lock pin **90** and are adapted to be forced upwardly into recesses **95** in the control shaft **57** when the control handle **59** is in forward position to permit lock pin **90** to operate. When the control handle **59** is moved away from the normal position, the plungers **94** are forced out of the recesses **95** and lie in shallow annular grooves **96**, which grooves serve to lock the control rod **57** yieldingly against axial separation. Movement of the plungers **94** out of recesses 95 forces the lock pin 90 to occupy a position at the center of the half-moon recesses 91, which permits the clutch case 82 to turn freely in either direction. Upon movement of the control handle from forward to reverse position, the shifter ring 50 is turned counterclockwise and away from the Fig. 10 position to disable pawls 48a and permit pawls 48b to engage the ratchet teeth 44. Ratchet ring 40 then permits the feed screw 28 to feed in reverse direction only and the rearward impulses delivered by the piston move the drill away from the rock. At the same time the disabling of the lock pin 90 permits the clutch case 82, clutch spring 85 and rotation collar 80 to rotate with the feed screw.

With the control handle 59 in neutral position, the lock pin 90 and both sets of pawls 48a and 48b are disabled to permit the ratchet ring and rotation collar to turn freely in either direction. The drill may then be moved by hand to the desired position.

A spring-pressed detent 98 mounted in the rear housing 34 cooperates with notches 99 in the handle to lock the latter yieldingly in selected position.

*Brake*

A brake device is provided to retard or stop the feeding of the drill when desired. It comprises a brake lever 100 pivoted at 101 to the slotted end portion of a hollow plug 102 screwed into the cap 72. The brake lever carries a cam 103 adapted to engage the end of a brake rod 104. The other end of the rod telescopes with the feed screw and engages a brake key 105 which is mounted in a slot 106 in the screw and is held in the ratchet ring 40. A brake washer 108, keyed to the front housing 32, carries brake lining 109 with which the ratchet ring 40 is adapted to engage. When the brake handle 100 is pulled rearwardly the cam 103 acts through the rod 104 and key 105 to force the ratchet ring 40 against the brake lining. The brake rod 104 is normally urged toward releasing position by the spring 110. The threaded connection between the yoke 102 and the cap 72 provides means for adjusting the brake.

Oil plug 111 is provided in the front head 32 to permit filling the entire mechanism with a light oil.

*Modified ratchet control*

If desired, the brake may be eliminated and replaced by a lock adapted to hold the feed screw positively against rotation in either direction. A suitable locking device for the feed screw, as illustrated in Figs. 18, 19 and 20, may be obtained by substituting a modified shifter ring 50a for the ring 50. Shifter ring 50 is provided with internal bearing surfaces 51a separated by reduced portions 52a. Elongated recesses 54a are provided to receive the ends of the pawls 48a and 48b. These recesses differ from the half-moon recesses 54 of Fig. 11 in that they are of sufficient circumferential length to receive both sets of pawls at the same time. When the control handle 59 is adjusted to neutral position, both sets of pawls 48a and 48b are permitted to engage the ratchet teeth 44 to lock the feed screw for both directions of rotation.

From the above description it is seen that the illustrative embodiments of the invention comprise two distinct feeding mechanisms cooperating with each other to maintain at all times the proper rate of feed and feed pressure. Although the two feed mechanisms produce the best results when in combination with each other, it would be possible to make either one operate without the other. Furthermore, many modifications of the present disclosure may be made without departing from the spirit of the invention.

What is claimed is:

1. A rock drilling device comprising a fixed support having longitudinally extending guideways, a drill mounted thereon and adapted to reciprocate in said guideways, said drill having a reciprocating hammer piston therein adapted to impart to the drill longitudinal jars in opposite directions, a longitudinally extending feed member for said drill, means for coupling the feed member to the drill to adapt the feed member to vibrate in unison with the drill, one end of the feed member being supported on said support by means permitting limited longitudinal movement of the feed member relative to the support and means carried by the support and responsive to longitudinal vibrations of the feed member for moving said feed member in a direction to advance the drill.

2. In rock drill feeding mechanism, a support, a drilling machine mounted thereon for longitudinal sliding movement and being subject to longitudinal vibrations, a pair of cooperating threaded feed elements, one carried by the machine and the other carried by the support with limited longitudinal movement relative to the latter, ratchet mechanism carried by the support limiting rotation of the associated feed element to one direction only and rotation mechanism carried by the support for converting longitudinal movement of the associated feed member to rotary movement in said one direction.

3. In feeding means for rock drills, in combination, a shell, a drill casing slidably mounted in said shell, a rotatable feed member, means mounting said feed member on said shell and permitting limited movement of the feed member with respect to the shell, connections between the feed member and the drill casing responsive to rotation of the feed member for advancing the drill casing, said connections being sufficiently rigid whereby vibration of the drill casing is transmitted to the feed member, and means comprising cooperating elements on the feed member and shell respectively for rotating the feed member in response to vibratory movements of the member with respect to the shell.

4. In feeding means for percussive tools, in combination, a shell, a drill casing slidably mounted in said shell, a rotatable feed screw mounted on said shell and passing through a feed nut carried by the drill casing, said drill casing being subject to vibrations lengthwise of said screw, the means mounting the screw on the shell being yieldable to permit limited lengthwise movement of the screw in response to said vibrations, and means responsive to axial movement of the screw with respect to the shell for rotating said screw.

5. A rock drilling device comprising a support, a drill casing mounted on said support for longitudinal movement, a rotatable feed member, connections between the feed member and the drill casing so constructed and arranged to move the casing along the support in response to rotation of the feed member, means mounting the feed member on the support and permitting limited longitudinal movement with respect thereto, a rock drill connected to said casing and adapted to transmit longitudinal vibrations to said feed

member, and means supported by the support and responsive to reciprocation of the feed member relative to the support for rotating the feed member.

6. In combination, a drilling machine subject to longitudinal vibrations in both directions, a support having means including guideways for supporting said machine and permitting longitudinal movement of the latter, a longitudinally extending feed screw having connections with both the machine and the support, said connections comprising a nut carried by the drilling machine and receiving the screw, the lead angle of the screw and nut being such that axial movement of the nut member relative to the screw causes the screw to rotate, ratchet mechanism carried by the support for preventing rotation of the feed screw in the rearward feeding direction, the connection between the screw and support being yieldable to permit longitudinal movement of the feed screw together with the nut in a rearward direction, and means responsive to such longitudinal rearward movement for rotating the screw in the forward feeding direction.

7. A rock drill assembly comprising a cylinder, a piston reciprocating therein, a drill steel projecting into said cylinder, said piston being adapted to strike the rear end of the cylinder on its rearward stroke and to strike the drill steel on its forward stroke, whereby force of recoil of the drill is greatest in the rearward direction, a support for the drill, and means for feeding the drill forwardly on said support, said means comprising a feed member reciprocating forward and backward in response to vibrations of the drill, mechanism responsive to the reciprocations of the feed member for feeding the drill forwardly, and a spring interposed between the feed member and support adapted to move said feed member forwardly, said spring being yieldable in response to the rearward recoil of the drill.

8. A feed arrangement comprising a support, a percussive tool mounted thereon for longitudinal movement, said tool being subjected to vibrations in a forward and rearward direction, a pair of elements having a splined connection with each other adapted to convert relative longitudinal movement thereof into relative rotation thereof, one of said elements being associated with the tool and adapted to vibrate in unison therewith and the other, or second-mentioned element, being carried by the support, a spring mounted on the support normally urging the first-mentioned element forwardly, ratchet mechanism preventing rotation of the first-mentioned element during its rearward movement, and means preventing rotation in one direction of the element carried by the support to compel rotation of the first-mentioned element during forward movement actuated by the spring.

9. A drilling mechanism comprising a support having longitudinal guideways, a percussive drill movably supported in said guideways, an elongated member connected to said drill, means mounting said member for limited longitudinal movement on the support, an element having threaded connection with the member and held against longitudinal movement on the support, ratchet mechanism preventing rotation of the element in one direction only and ratchet mechanism preventing rotation of the member in the opposite direction only, whereby reciprocation of the member with respect to the element imparts step-by-step rotary movement to the member.

10. A drilling mechanism comprising a support having longitudinal guideways, a percussive drill movably supported in said guideways, an elongated member connected to said drill, means mounting said member for limited longitudinal movement on the support, an element having threaded connection with the member and held against longitudinal movement on the support, ratchet mechanism preventing rotation of the element in one direction only and ratchet mechanism preventing rotation of the member in the opposite direction only, whereby reciprocation of the member with respect to the element imparts step-by-step rotary movement to the member, the connections between the member and drill being so constructed and arranged that rotation of the member moves the drill longitudinally in said guideways.

11. A rock drilling device comprising a support having longitudinal guideways, a rock drill slidably mounted therein, a drill steel actuated by said drill and projecting into the drill and engaging a stop limiting inward movement of the steel, a feed screw having a floating connection with the support, limit stops carried by the support and engageable with stops on the screw for positively limiting longitudinal movement of the screw with respect to the support, a spring normally holding the screw against the forward limit stop, said feed screw having threaded connection with the drill whereby the pressure of reaction of the steel against its associated limit stop is transmitted through the feed screw to overcome the spring and move the screw away from the forward limit stop, means for rotating the screw to feed the drill and means responsive to the reaction pressure transmitted from the drill steel for reducing the rate of feed.

12. In a rock drill feeding device, a support, a rock drill slidably mounted thereon, a feed nut fixed to the drill, a feed screw having a threaded connection with the feed nut and subjected to limited axial movements relative to the support in response to the vibrations of the drill, an element carried by the support and having a splined connection with the feed screw, stop means resisting axial movement of the element relative to the support whereby to cause limited axial movements of the screw relative to the element in opposite directions in response to the vibrations of the drill, said splined connection being adapted to convert such movements into relative rotative movements in opposite directions, and means carried by the support for preventing rotation of the element in one direction only.

13. A rock drilling device comprising a support, a percussive drill slidably mounted thereon, a feed screw extending parallel to the direction of movement of the drill, said screw having two longitudinally spaced sets of threads, one set being received within a nut carried by the drill and the other within a nut carried by the support, both sets of threads having a large lead angle whereby movement of the drill with respect to the screw or longitudinal movement of the screw with respect to the support causes rotation of the screw, and yieldable means for resisting longitudinal movement of the screw with respect to the support.

14. A rock drilling device according to claim 13 in which one of the nuts is rigidly connected to the drill while the other is connected to the support by means preventing rotation of the nut except in one direction.

15. In a rock drilling device comprising a per-

cussive drill supported on a fixed support for longitudinal feeding movement and subject to vibrations longitudinally of the drill, means for automatically feeding said drill in response to said vibrations and comprising a feed screw having longitudinally spaced thereon screw threads having a large lead angle, a nut carried by the drill and receiving one set of said threads, a nut carried by the support and receiving the other set of threads, whereby longitudinal movement of either nut over the screw causes relative rotation thereof, ratchet mechanism operatively connected to the screw for preventing rotation thereof except in one direction, a recoil spring carried by the support and resisting relative movement between the screw and the nut carried by the support, said spring being yieldable responsive to a predetermined longitudinal force transmitted through the feed screw and being adapted to restore the feed screw to normal position, whereby the feed screw moves in two directions in response to the recoil of the drill in one direction.

16. A rock drilling device comprising a guide shell having longitudinal guideways, a rock drill movably mounted in said guideways, and subject to longitudinal jars imparted by a piston, a plurality of feed mechanisms supported by said guide shell, one of said feed mechanisms being actuated by forward jars transmitted to it from the rock drill for feeding the drill forwardly, the other feed mechanism being actuated by rearward jars transmitted to it by the drill for feeding the drill forwardly.

17. A rock drilling device comprising a guide shell having longitudinal guideways, a rock drill movably mounted in said guideways, and subject to longitudinal jars imparted by a piston, a plurality of feed mechanisms supported by said guide shell, one of said feed mechanisms being actuated by forward jars transmitted to it from the rock drill for feeding the drill forwardly, the other feed mechanism being actuated by rearward jars transmitted to it by the drill for feeding the drill forwardly, the first-named feed mechanism being adapted to feed the drill a greater distance than the other feed mechanism responsive to a jar of like intensity.

18. A rock drilling device comprising a shell having guideways, a rock drill movably mounted in said guideways, a piston reciprocable in said cylinder and adapted to impart a jar to the rear end of the cylinder on one stroke and on its other stroke to strike either the front end of the cylinder or a drill steel depending upon the position of the steel and the drill, a feed mechanism carried by the shell and adapted to receive forwardly directed jars from the drill to feed the drill forward rapidly, and other feed mechanism for feeding the drill forward slowly, said other feed mechanism operating independently of said forwardly directed jars.

19. A rock drilling device comprising a shell having guideways, a rock drill movably mounted in said guideways, a piston reciprocable in said cylinder and adapted to impart a jar to the rear end of the cylinder on one stroke and on its other stroke to strike either the front end of the cylinder or a drill steel depending upon the position of the steel and the drill, a feed mechanism carried by the shell and adapted to receive forwardly directed jars from the drill to feed the drill forward rapidly, and other feed mechanism for feeding the drill forward slowly, said other feed mechanism operating independently of said forwardly directed jars, said drill having a fixed stop limiting movement of the steel into the drill and said other feed mechanism being responsive to the mean pressure of said stop against the steel to control the rate of feed.

20. In a rock drilling device, a support having guideways, a drill mounted on said support and engaging said guideways, a feed screw operatively connected to the drill for feeding the latter, a nut carried by the support and having threaded connection with the screw, a plurality of ratchet mechanisms and a control device carried by the support, said ratchet mechanisms being adapted in one position of the control device to restrict rotation of the screw to one direction only and to restrict rotation of the nut to the opposite direction only and being adapted in another position of the control device to restrict rotation of the screw to the opposite direction and to release the nut for rotation with the screw.

21. A reversible ratchet mechanism comprising a pawl carrier slotted to receive two sets of pawls inclined from radial positions in opposite directions, a ratchet ring encircling said carrier and having one end of the ring in a plane intermediate the ends of the pawls, springs tending to move both sets of pawls into engagement with the ratchet ring, a shifter ring adjacent the ratchet ring and surrounding the pawls near one end thereof, said shifter ring having cam surfaces separated by recesses adapted in one extreme position to disable one set of pawls and permit the other set to engage the ratchet ring and being rotatable to another extreme position in which the first set of pawls are permitted to engage the ratchet ring and the second set disabled, said recesses being of limited circumferential extent whereby in an intermediate position of the shifter ring both sets of pawls are disabled.

22. In a rock drilling device, a shell having guideways, a rock drill movably supported therein, a feed screw operatively connected to a feed nut carried by the drill, a stationary member carried by the shell and apertured to receive one end of the feed screw, a sleeve non-rotatively mounted on the screw for limited axial movement, said sleeve and stationary member having spaced annular surfaces, and means for moving said sleeve against said stationary member whereby said surfaces cooperate to form a brake for retarding or stopping rotation of the feed screw.

23. A rock drilling device according to claim 22 in which the means for moving the sleeve comprises a brake rod telescoping within the feed screw and engaging a brake key, the brake key being connected to the sleeve and being movable axially within a radial slot in the screw.

24. A rock drill device comprising a fixed support, a rock drill mounted thereon for longitudinal movement, said drill having a cylinder with a fluid pressure operated piston reciprocating therein, said cylinder having longitudinal impulses imparted to it upon reversal of the direction of the piston, and mechanism for moving the drill forwardly step-by-step with respect to the support, said mechanism comprising an energy storing means mounted on a fixed part of the support and adapted to receive an impulse from the cylinder in the rearward direction, store said impulse, and utilize the stored energy to move the drill forwardly after cessation of the rearward impulse.

25. A rock drill device comprising a fixed support having longitudinally extending guideways,

a drill mounted to slide in said guideways in a forward and rearward direction, said drill having a cylinder with a piston therein, said cylinder being subjected to successive jars in a rearward direction upon reversal of the direction of the piston, a feed device adapted to move the drill step-by-step and forwardly with respect to the support, means responsive to the jarring movement of the cylinder relative to the support in a rearward direction for causing the feed device to move the drill a step forwardly, and means for disabling the feed device, said disabling means being operated by a manipulative member carried by a fixed part of the support.

26. A rock drilling device according to claim 25 which comprises positive means for preventing movement of the feed device oppositely to the forward feeding direction.

27. A rock drill device comprising a fixed support having longitudinally extending guideways, a drill mounted to slide in said guideways in a forward and rearward direction, said drill having a cylinder with a piston therein, said cylinder being subjected to successive jars in a rearward direction upon reversal of the direction of the piston, a feeding device adapted to move the drill step-by-step and forwardly with respect to the support, and means including a spring responsive to jarring movement of the cylinder relative to the support in a rearward direction for causing the feeding device to move the drill a step forwardly, said spring being arranged to be placed under tension by the drill when the latter is jarred rearwardly and being operatively connected to the feeding device to operate the latter upon cessation of the jar, said spring being carried by the support and the feeding device being adapted to reciprocate relative to the support under control of the spring and in response to the vibrations of the drill.

28. A rock drill device comprising a fixed support, a drill mounted thereon for relative movement in a forward and rearward direction, said drill having a cylinder with a piston therein, said cylinder being subjected to successive jars in a rearward direction upon reversal of the direction of the piston, a feed nut carried by the drill and receiving a longitudinally extending feed screw carried by the support, and mechanism for operating the feed screw to move the drill step-by-step forwardly, said mechanism comprising means responsive to jarring movement of the cylinder rearwardly relative to the support for causing the feed screw to rotate to move the drill a step forwardly.

29. A rock drill device comprising a fixed support, a drill mounted thereon for relative movement in a forward and rearward direction, said drill having a cylinder with a piston therein, said cylinder being subjected to successive jars in a rearward direction upon reversal of the direction of the piston, a feed nut carried by the drill and receiving a longitudinal extending feed screw carried by the support, and mechanism for operating the feed screw to move the drill step-by-step forwardly, said mechanism comprising a spring adapted to be placed under tension by the jarring movement of the cylinder in a rearward direction, and adapted upon cessation of the jarring movement to rotate the feed screw to move the drill a step forwardly.

30. In a rock drill, the combination with a hammer motor within which longitudinal vibrations occur during the operation thereof, and a guide along which the hammer motor is movable, of automatic feeding means for feeding the hammer motor along said guide comprising a rotatable feed screw mounted on said guide for rotary and longitudinal movements, a non-rotatable feed nut carried by said hammer motor and engaging said feed screw, and means operated by the longitudinal movement of said feed screw caused by the vibratory action of the hammer motor for effecting rotation of said screw.

31. In a rock drill, the combination with a hammer motor within which longitudinal vibrations occur during operation thereof and a guide along which said hammer motor is guided, of automatic feeding means for feeding said hammer motor along said guide including relatively rotatable co-acting feed screw and nut feeding elements, said nut element fixed against rotation relative to said screw element and said rotatable screw element mounted for axial reciprocation, a yielding mounting for said screw element permitting axial reciprocation of the screw, and means operated by the axial reciprocation of said feed screw element for rotating the latter relative to said non-rotatable nut element.

32. In a rock drill, the combination with a hammer motor within which longitudinal vibrations occur during operation thereof, and a guide on which said hammer motor is movably mounted, of automatic feeding means for feeding the hammer motor relative to said guide comprising a feed screw mounted on said guide for rotary and longitudinal movements, a non-rotatable feed nut carried by the hammer motor and engaging said feed screw, longitudinal movement of said feed screw in opposite directions being effected by the longitudinal vibratory movements in opposite directions of the hammer motor, and means operated by the opposite longitudinal movements of said feed screw for rotating the latter in one direction.

33. In a rock drill, the combination with a hammer motor within which longitudinal vibrations occur during operation thereof, and a guide on which said hammer motor is movably mounted, of automatic feeding means for feeding the hammer motor relative to said guide comprising a feed screw mounted on said guide for rotary and longitudinal movements, a non-rotatable feed nut carried by the hammer motor and engaging said feed screw, longitudinal movement of said feed screw in opposite directions being effected by the longitudinal vibratory movements in opposite directions of the hammer motor, and means operated by the opposite longitudinal movements of said feed screw for rotating the latter in one direction and having embodied therein means for effecting reversal of the direction of rotation of the feed screw at will.

34. In a rock drill, the combination with a guide shell and a hammer motor guided on said guide shell and within which longitudinal vibrations occur during the operation thereof, of means controlled automatically by the vibratory action of said hammer motor for feeding the latter along said guide shell including a feed screw mounted on said guide shell for axial reciprocation, a non-rotatable feed nut engaging said screw and mounted for movement with said hammer motor, and means associated with said screw and actuated by the reciprocatory movement thereof for positively effecting rotation of said screw relative to said non-rotatable nut, the axial movements of said screw in opposite directions effecting rotation of said screw in only one direction.

35. In a rock drill, the combination with a guide

shell and a hammer motor guided on said guide shell and within which longitudinal vibrations occur during the operation thereof, of means controlled automatically by the vibratory action of said hammer motor for feeding the latter along said guide shell including a feed screw mounted on said guide shell for axial reciprocation, a non-rotatable feed nut engaging said screw and mounted for movement with said hammer motor, means associated with said screw and actuated by the reciprocatory movement thereof for positively effecting rotation of said screw relative to said non-rotatable nut, the axial movements of said screw in opposite directions effecting rotation of said screw always in only one direction, and means for reversing the direction of rotation of said screw.

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