Jan. 6, 1942. C. F. OSGOOD 2,268,574

DRILLING APPARATUS

Filed Aug. 3, 1940 3 Sheets-Sheet 1

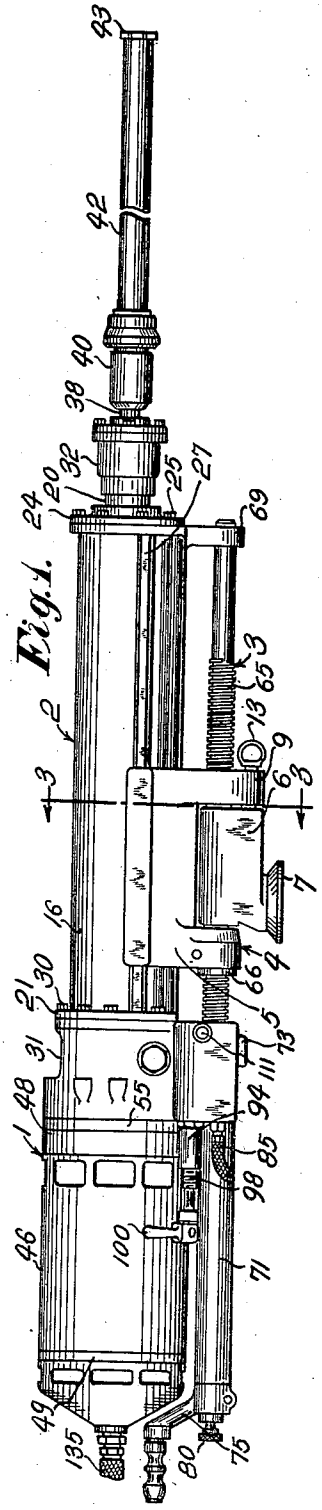


Fig. 1.

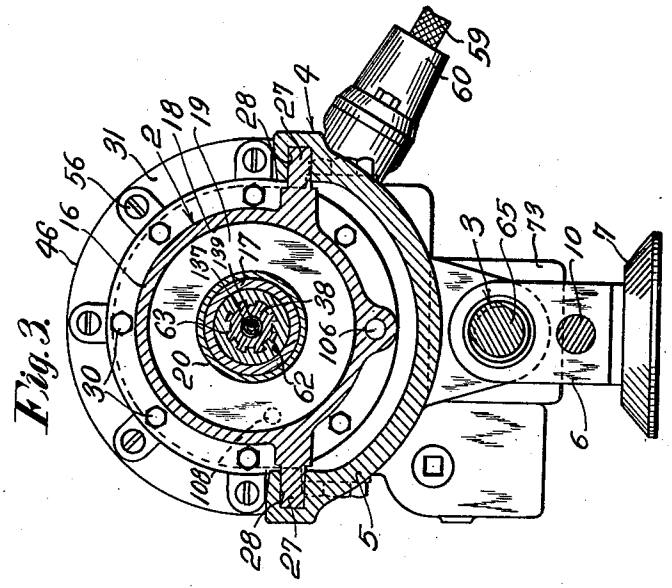


Fig. 3.

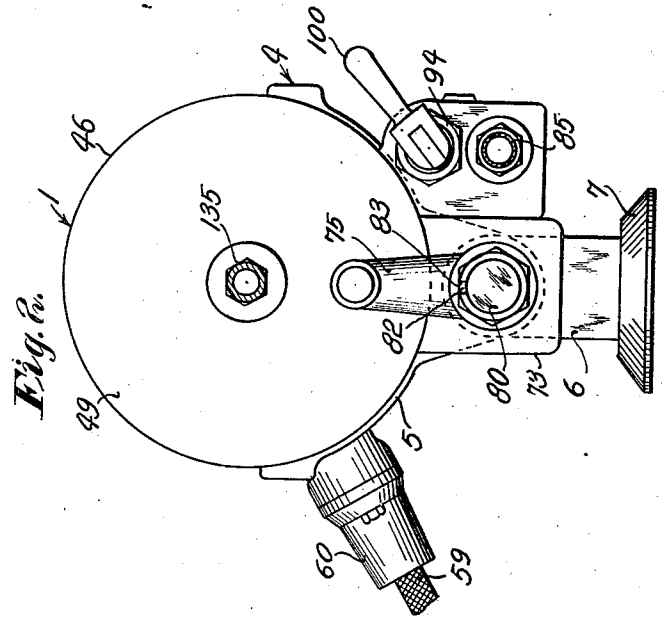


Fig. 2.

Inventor:
Charles F. Osgood.
by
Louis A. Maxson
Atty.

Jan. 6, 1942. C. F. OSGOOD 2,268,574

DRILLING APPARATUS

Filed Aug. 3, 1940 3 Sheets-Sheet 2

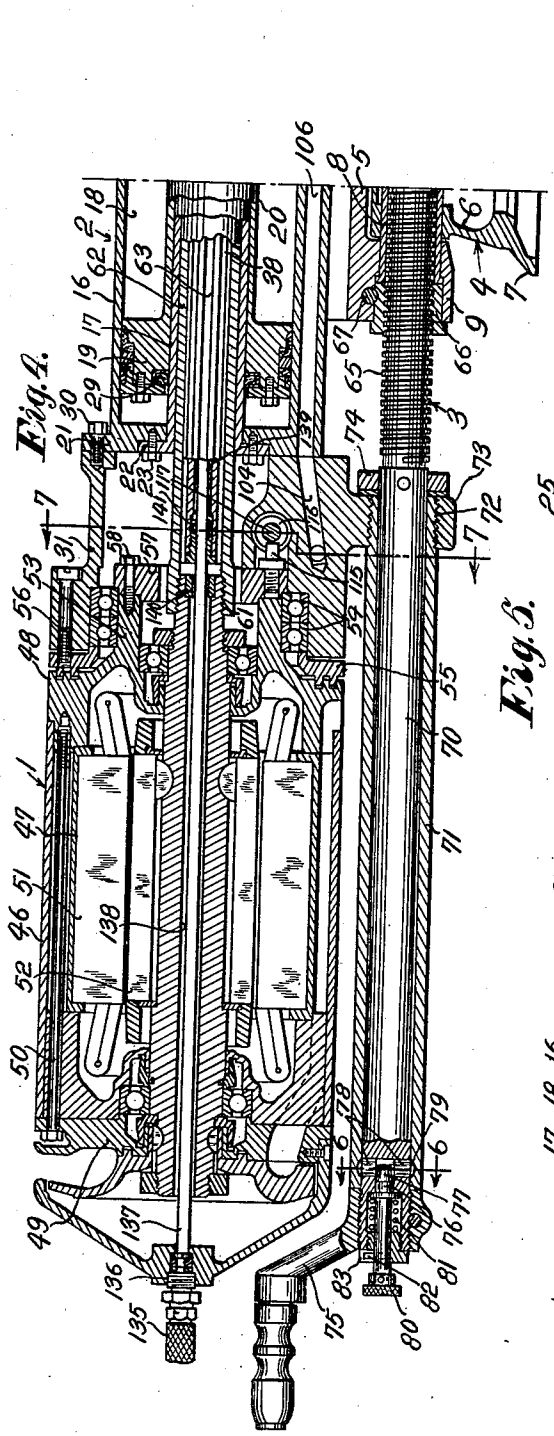


Fig. 4.

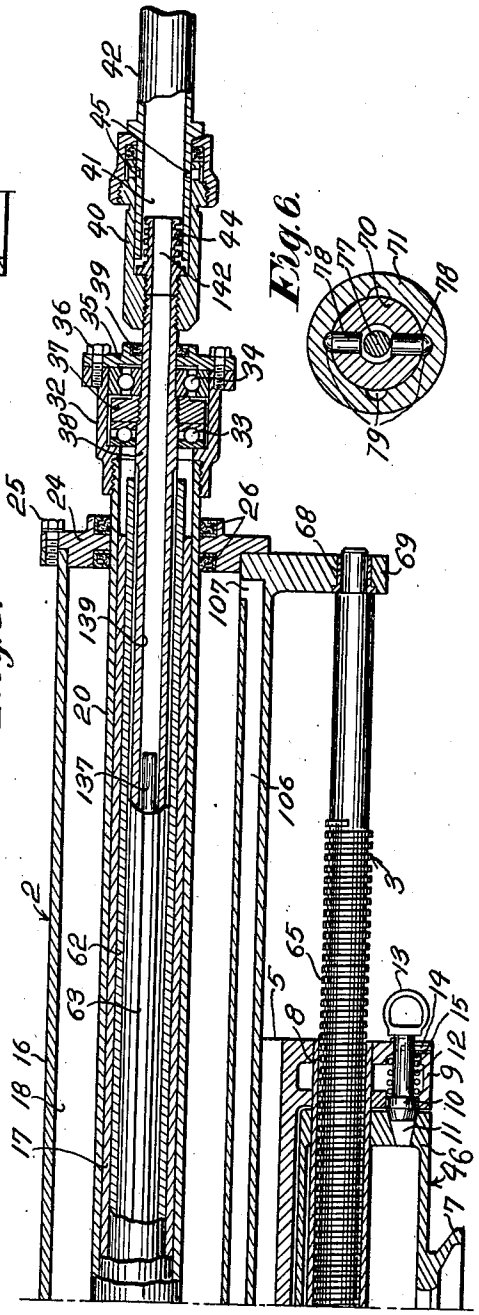


Fig. 5.

Fig. 6.

Inventor:
Charles F. Osgood
by
Louis A. Makosh.
Atty.

Jan. 6, 1942. C. F. OSGOOD 2,268,574

DRILLING APPARATUS

Filed Aug. 3, 1940 3 Sheets-Sheet 3

Fig. 7.

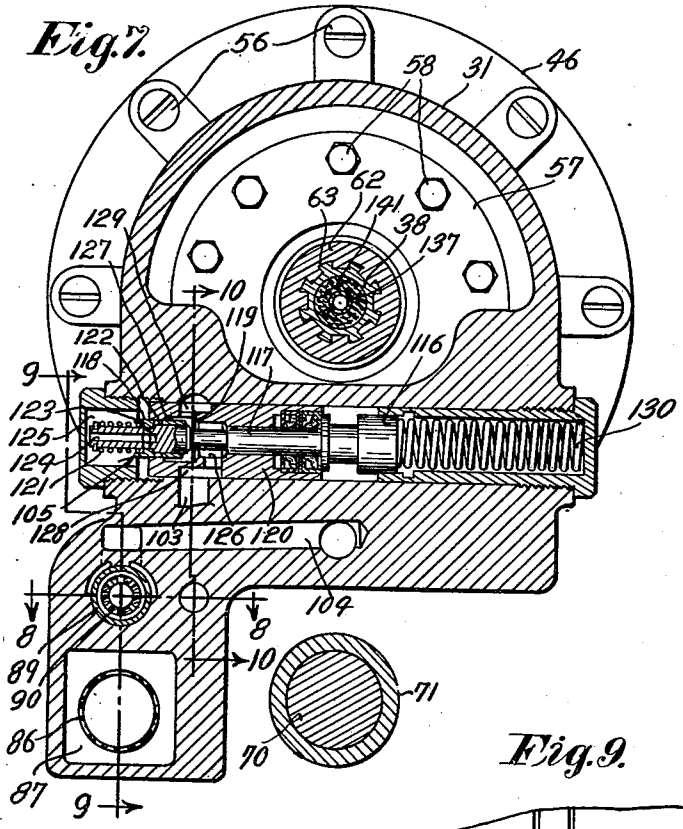


Fig. 8.

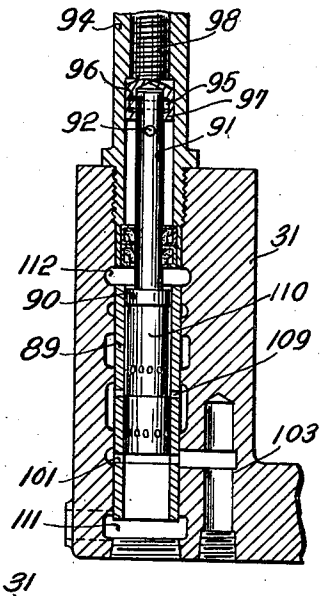


Fig. 9.

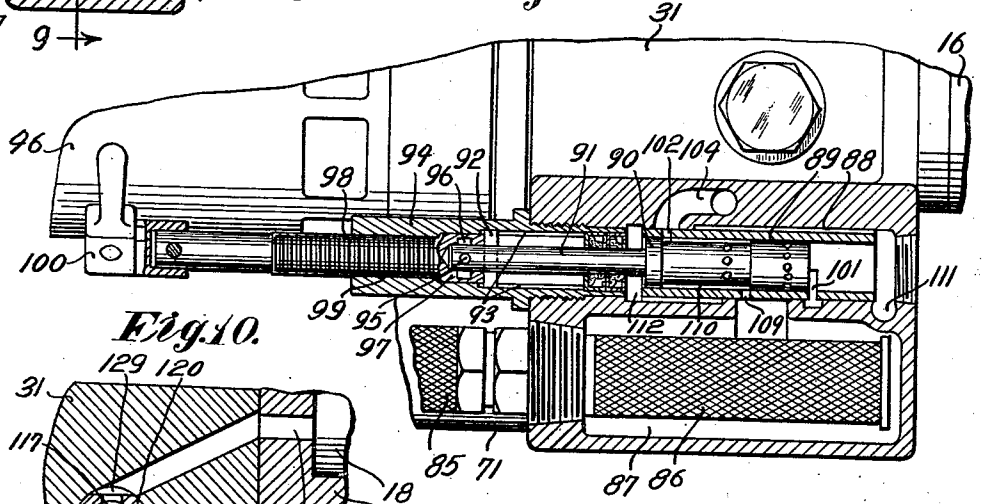
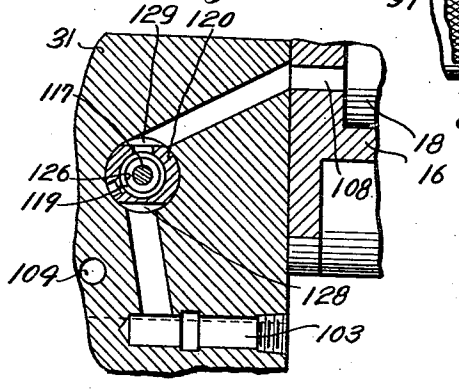


Fig. 10.



Inventor:
Charles F. Osgood.
by
Louis A. Marson.
Atty.

Patented Jan. 6, 1942

2,268,574

UNITED STATES PATENT OFFICE

2,268,574

DRILLING APPARATUS

Charles F. Osgood, Claremont, N. H., assignor to Sullivan Machinery Company, a corporation of Massachusetts

Application August 3, 1940, Serial No. 350,438

20 Claims. (Cl. 255—47)

This invention relates to drilling apparatus, and more particularly to improvements in high speed rotary drills especially designed for use in boring blast holes in relatively hard materials, such as hard rock or the like.

An object of the present invention is to provide an improved drilling apparatus. Another object is to provide an improved portable drilling apparatus of the high speed rotary type especially designed for use with abrasive type bits commonly known as diamond bits. A further object is to provide an improved drilling apparatus having improved feeding means for feeding the drill bit toward and from the work. Still another object is to provide an improved arrangement of the feeding means with respect to the bit-rotating means whereby not only more powerful bit rotation is obtained but also the drilling apparatus is nicely balanced. A still further object is to provide an improved supporting and guiding structure for the bit-rotating motor whereby the latter is supported and guided in a novel manner. Yet another object is to provide an improved automatic feeding means for the bit-rotating motor and having associated therewith an improved manual feeding means. Still another object is to provide an improved portable rotary drilling apparatus of the high speed type having novel and extremely compact arrangements and combinations of parts. Other uses and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there is shown, for purposes of illustration, one form which the invention may assume in practice.

In these drawings:

Fig. 1 is a side elevational view of a drilling apparatus constructed in accordance with an illustrative embodiment of the invention.

Fig. 2 is an enlarged rear end elevational view of the drilling apparatus shown in Fig. 1.

Fig. 3 is an enlarged cross sectional view taken substantially on line 3—3 of Fig. 1.

Fig. 4 is an enlarged view in longitudinal vertical section through the rearward portion of the drilling apparatus.

Fig. 5 is an enlarged view in longitudinal vertical section through the forward portion of the drilling apparatus.

Fig. 6 is an enlarged cross sectional view taken on line 6—6 of Fig. 4.

Fig. 7 is an enlarged cross sectional view taken substantially on line 7—7 of Fig. 4.

Fig. 8 is a detail horizontal sectional view taken on line 8—8 of Fig. 7.

Fig. 9 is a fragmentary view in longitudinal vertical section taken substantially on line 9—9 of Fig. 7.

Fig. 10 is a fragmentary vertical sectional view taken substantially on line 10—10 of Fig. 7.

In this illustrative embodiment of the invention there is shown a portable rotary drilling apparatus of the high speed type especially designed for use in drilling blast holes in relatively hard materials, such as hard rock or the like, and adapted to use with core or plug type abrasive bits commonly known as diamond bits. Various features of the invention may, however, be incorporated in drilling apparatus of other types. The weight and size of the drilling apparatus disclosed may be commensurate with those of a conventional hammer rock drill of the mounted drifter type.

The drilling apparatus as a whole comprises bit-rotating means, generally designated 1, automatic feeding means, generally designated 2, manual feeding means, generally designated 3, and supporting and guiding means, generally designated 4.

The supporting and guiding means 4 comprises a guide frame 5 mounted on a trunnion support 6 having a swivel plate 7 adapted to be secured in the saddle mounting of a conventional rock drill support. The drill support 6 has a longitudinal bore which receives a cylindric pivot tube 8 (Figs. 4 and 5), the latter having its end portions secured within alined bores within lugs 9 integral with the guide frame 5. The tube 8 provides a pivotal mounting for the guide frame whereby the latter may be swung laterally to one side or the other of the trunnion support, thereby to enable movement of the bit rotating and feeding means to one side of the drill hole to facilitate changing of drill rods and bits in a manner well known to those skilled in the art. As shown in Fig. 5, a plunger lock 10 carried by the guide frame is insertable in a locking aperture 11 in the trunnion support for locking the guide frame in its centrally located position. The plunger lock is guided within a bore within the front lug 9, and a coil spring 12 constantly urges the lock towards its innermost locking position. The lock has a handle 13 whereby the lock may be released, and a pin 14 secured to the lock is engageable with an abutment on the front face of the front lug 9 to hold the lock against the tension of the spring in its released position, and the lug is notched at 15 to receive the pin when the lock is in its locking position.

The automatic feeding means 2 comprises a

feed cylinder 16 having a cylindric tube 17 extending centrally therethrough to provide an annular piston chamber 18. Contained in the piston chamber is a reciprocable feed piston 19 having a tubular piston rod 20 extending centrally forwardly through the cylinder. The piston rod surrounds and has telescopic relation with the tube 17. As shown in Fig. 4, the feed cylinder has a rear head 21 to which the flanged rear end 22 of the tube 17 is secured, as by screws 23. The feed cylinder has a front head 24 (Fig. 5) detachably secured thereto, as by screws 25, and packings 26 carried by this head sealingly engage the exterior periphery of the piston rod 20, in the manner shown in Fig. 5. The feed cylinder is slidably guided on the guide frame 5 and has integral lateral guides 27 slidingly received in longitudinal guideways 28 on the guide frame 5. A packing 29, carried by the feed piston (Fig. 4) sealingly engages the exterior periphery of the tube 17. The feed cylinder has its flanged rear end secured, as by screws 30, to a control head 31, and the latter is wholly supported by the feed cylinder for movement with the latter. The feed piston rod 20 projects forwardly through the front head 24 of the feed cylinder and has threadedly secured thereto a thrust head casing 32 having a chamber receiving antifriction thrust bearings 33 and 34 which are retained in the head casing chamber by a detachable cap plate 35 held in position, as by screws 36. A thrust collar 37 threaded on a drive shaft 38 is interposed between the thrust bearings, and the forward portion of this shaft projects forwardly through an axial opening in the cap plate. A packing 39 carried by the cap plate sealingly engages the exterior periphery of the drive shaft to prevent access of foreign matter to the thrust bearings. Threadedly secured to the outer projecting end of the drive shaft 38 in advance of the thrust head is a chuck casing 40 having a socket 41 for receiving the shank of a conventional drill rod 42. As shown in Fig. 1, the drill rod carries a conventional drill bit 43 of the core or plug abrasive type known as a diamond bit. The chuck has a threaded rod coupling 44 secured to the chuck casing, and rod locking pins 45 whereby either a drill rod carrying a starting bit or one carrying a conventional core barrel may be secured within the chuck socket.

Now referring to the bit-rotating means 1, it will be noted that a rotary motor 46, herein preferably a high speed electric motor, has its stator casing 47 mounted on the control head 31, and the motor is wholly supported by the feed cylinder through the control head. The motor casing has detachable front and rear heads 48 and 49 held in position on the stator casing by tie bolts 50. The motor has a usual field 51 and an armature rotor 52, and the shaft of the rotor is journaled in bearings suitably supported within the casing heads. The front motor head 48 has an integral forward cylindric projection 53 mounted for limited rotary movement in bearings 54 supported within a bore in the control head 31, as shown in Fig. 4. The bearings are retained in position within the control head bore by a retaining ring 55 secured, as by screws 56, to the control head, and the cylindric projection 53 is held against axial displacement with respect to its bearings by an end plate 57 secured, as by screws 58, to the projection. Electric energy may be conducted to the motor from any convenient source through a conductor cable 59 and a conventional connector plug 60 mounted on the control head 31. The shaft of the armature rotor 52 is coupled at 61 to a tubular shaft 62 telescopically arranged within the tube 17, and the drive shaft 38 has telescopic relation with and is splined at 63 to the outer tubular shaft 62. It will thus be seen that the shaft 38 may be driven by the shaft 62 through the spline connection irrespective of the relative axial positions of the shafts.

Associated with the automatic feeding means 2 is the manual feeding means 3 whereby the feed cylinder 16 may be manually fed along its guideways relative to the guide frame 5. This manual feeding means comprises a rotatable feed screw 65 extending centrally through the pivot tube 8 and coacting with a non-rotatable feed nut 66 secured at 67 within the rear lug 9 on the guide frame 5. The forward end of the feed screw is journaled at 68 within a bushing supported by a depending bracket 69, preferably integral with the front end of the feed cylinder 16. The feed screw has a rearward shaft portion 70 supported within a tube 71, the latter being secured at 72 within a depending bracket 73 integral with the control head 31. A thrust collar 74 is fixed by a pin to the screw shaft. Fixed to the rear end of the screw shaft is a hand crank 75 conveniently located near the rear end of the motor 46. Arranged within an axial bore in the rear end of the screw shaft 70 is a locking plunger 76 having a wedge 77 engageable with locking pins 78, the latter in turn being engageable with appropriately located locking recesses 79 in the walls of the bore of the tube 71. The locking plunger has a control knob 80 conveniently located in adjacency to the hand crank 75, and a spring 81 urges the wedge 77 towards its innermost position. A pin 82 is secured to the plunger so that when the wedge is released the pin may engage an abutment at the rear end of the screw shaft to hold the wedge released. The screw shaft is slotted at 83 to receive the pin when the locking plunger is in its locking position. This lock holds the feed screw against rotation during operation of the automatic feeding means and may be readily released to permit hand feed.

The automatic feeding means 2 is preferably operated by liquid under pressure, and the means for controlling the liquid supply thereto may be similar to that described in a copending application of one Win W. Paget, Serial No. 322,267, filed Mar. 5, 1940. The liquid supply means comprises a supply hose 85 (Figs. 1 and 9) through which liquid may be conducted from any suitable source through a strainer 86 to a supply chamber 87 formed in the control head 31. Also formed in the control head is a longitudinal bore 88 having arranged therein a ported valve bushing 89 in which a slide valve 90 is reciprocably mounted. As shown in Figs. 8 and 9, this slide valve has a stem 91, and a pin 92 fixed to the stem and engaging longitudinal guide slots 93 holds the valve against rotation. The slots 93 are formed in a member 94 secured to the control head. Also fixed to the valve stem is a pin 95 having its ends projecting within an annular groove 96 in a rotatable member 97 also mounted in the member 94. The member 97 has an integral valve-adjusting screw 98 threadedly engaging a non-rotatable nut 99 integral with the member 94. The screw 98 has a pivoted operating handle 100 (Figs. 1, 2 and 9). It is accordingly evident that when the screw is rotated the slide valve may be slid back and

forth in the valve bushing as desired. The valve bushing has longitudinally spaced slots 101 and 102 respectively communicating with a forward feed passage 103 and a reverse feed passage 104, the liquid flowing through the forward feed passage 103 being under the control of an automatic torque controlled valve means, generally designated 105, which is the invention of the above mentioned Win W. Paget. As shown in Figs. 4 and 5, the reverse feed passage 104 is connected by a passage 106 and a port 107 with the forward end of the piston chamber 18 at the forward side of the feed piston 19. The forward feed passage 103, as shown in Fig. 10, is connected by a passage 108 with the rear end of the piston chamber at the rear side of the feed piston. The valve bushing is slotted at 109 intermediate the slots 101 and 102, and this slot communicates with the supply chamber 87, and the valve has an external annular groove 110 for connecting either of the forward and reverse feed slots 101 and 102 with the supply slot 109. Communicating with the valve bushing bore are exhaust chambers 111 and 112. When the slide valve is in the position shown in Fig. 9, the reverse feed slot 102 is connected to the supply chamber while the forward feed slot 101 is connected to the exhaust chamber 111. When the valve is shifted axially into its reverse position, the forward feed slot is connected to the supply chamber and the reverse feed slot is connected to the exhaust chamber 112. It will thus be seen that under the control of the slide valve, liquid under pressure may be supplied to the piston chamber 18 within the feed cylinder at either side of the feed piston 19 to effect forward or reverse feed as desired. The manner in which the forward feed is influenced by the torque controlled valve means 105 will now be briefly described.

As clearly described in the copending Paget application above referred to, the torque on the bit-rotating motor 46 automatically regulates the flow of liquid under pressure through the forward feed passage under the control of the torque controlled valve means 105, and the latter also has a venting function whereby the forward feeding pressure in the piston chamber may be vented when the motor torque exceeds a predetermined amount. As shown in Fig. 4, a torque pin 115 secured to the end plate 57 is engageable within a groove on a reciprocable tappet 116 (Fig. 7). Secured to the tappet is a valve stem 117, and an end-seating sleeve valve 118 has a tight sliding fit with the valve stem and is engageable with a valve seat 119 on a valve sleeve 120. The valve sleeve 120 is arranged in a transverse bore in the control head 31, and the ends of the bore are closed by suitable screw plugs. The valve 118 is yieldingly held against a shoulder on the valve stem by a coil spring 121. The valve has ports 122 communicable with ports 123 in the valve stem, and the latter has an axial passage 124 connecting the ports 123 with an exhaust chamber 125. At the opposite sides of the valve seat 119 are bores 126 and 127 connected by ports to grooves 128 and 129 respectively, and these grooves communicate with portions of the forward feed passage 103 (Fig. 10). As shown in Fig. 7, interposed between the screw plug closing the right-hand end of the valve sleeve receiving bore and the tappet 116 is a relatively heavy coil spring 130 which constantly urges the tappet toward the left. In Fig. 7 the sleeve valve is shown in open position with the vent closed, and when the load on the bit-rotating motor 46 reaches a predetermined amount, the motor stator rotates slightly relative to the control head 31, moving the torque pin 115 and tappet 116 to the right as viewed in Fig. 7, against the pressure of the spring 130, and as a result the sleeve valve 118 is moved toward its seat or completely seated, partially to close or completely to cut off flow of liquid through the forward feed passage 103 to the rear end of the piston chamber 18 at the rear side of the feed piston 19. As the load on the motor becomes even greater, the motor stator will rotate slightly further relative to the control head 31, moving the tappet 116 further towards the right, moving the valve stem 117 relative to the seated valve 118, to connect the valve ports 122 with the stem ports 123, thereby to vent the liquid in the piston chamber at the rear side of the feed piston to exhaust through the axial stem passage 124 and exhaust chamber 125.

Manual feed by the hand crank 75 of the feed screw 65 may take place during flow of liquid through the forward feed passage 103 to the rear end of the piston chamber to effect forward feed. For instance, when the feed piston 19 reaches its limit of forward feeding travel within the feed cylinder 16, the latter may be fed forwardly along its guideways relative to the guide frame 5 into a new feeding position, and in the event of excessive loading of the bit rotating motor 46 during the manual feeding operation, the flow of liquid under pressure to the rear end of the piston chamber at the rear side of the feed piston will be cut off and the rear end of the piston chamber will be vented, to permit such forward movement of the feed cylinder relative to the then stationary feed piston, all in the manner clearly described in the Paget application above referred to. As is also described in the Paget application, the drill may be manually fed with respect to the working face during operation of the starting bit and during coupling and uncoupling of the drill rods since automatic feed is frequently too rapid for these operations. Of course, at that time the feed piston is usually disposed against the rear head of the feed cylinder, although if desired liquid may be trapped in the rear end of the feed cylinder under the control of the slide valve 90, so that the feed piston is held against movement with respect to the feed cylinder during manual feed.

Liquid under pressure may be conducted through the drill rod 42 to the drill bit 43 to cool the latter and to wash away the cuttings at the bottom of the drill hole. As shown in Fig. 4, a liquid supply hose 135 is connected within a threaded bore 136 in the rear motor head 49, and also secured within this bore is a liquid conducting tube 137 extending centrally through an axial bore 138 in the motor rotor shaft and terminating at its forward end within an axial bore 139 in the drive shaft 38, as shown in Fig. 5. The tube is guided by a bushing 140 (Fig. 4) secured within the forward end of the motor rotor shaft, and a packing 141 (Figs. 4 and 7) carried within the rearward portion of the drive shaft 38 sealingly engages the exterior periphery of the tube to prevent leakage. Liquid under pressure is discharged from the tube 137 within the bore 139 of the drive shaft 38, and the shaft bore 139 communicates with a bore 142 in the coupling member 44, and the coupling bore communicates with the drill rod bore. The supply hose 135

may have a suitable control valve, and the liquid may be utilized to control a conventional motor starting switch, in the manner described in my copending application Serial No. 347,716, filed July 26, 1940, so that the bit-rotating motor may be started after the flow of liquid to the drill bit and the building up of a predetermined pressure within the rod line have taken place.

The general mode of operation of the improved drilling apparatus is as follows. The apparatus may be set up in proper drilling position with respect to the working face with the swivel plate 7 of the trunnion support 6 suitably secured in the saddle mounting of a conventional rock drill support. The drill rod 42, by which the drill bit 43 is carried, is coupled by the chuck to the drive shaft 38. A starting hole is preferably made in the working face, and the operator may then manipulate the control handle 100 of the slide valve 90 to move the latter to a position to effect supply of liquid under pressure to the forward feed passage 103 to effect forward movement of the feed piston 19 within the then stationary feed cylinder 16, thereby to feed the drill bit forwardly to bring the latter within the starting hole at the working face. Thereafter, the slide valve may be moved into a position to cut off flow of liquid under pressure to the forward feed passage. The operator may then effect a supply of cooling liquid through the hose 135 and conducting tube 137 to the drill bit, and when liquid has reached the bottom of the drill hole the operator may start the bit-rotating motor 46, so that the drill bit is rapidly rotated. Upon further manipulation of the slide valve 90 liquid under pressure may be supplied to the forward feed passage 103, again to effect forward movement of the feed piston 19 within the then stationary feed cylinder 16, to feed the drill bit forwardly while the latter is rapidly rotated, thereby to effect drilling. The forward feeding pressure on the drill bit is sufficient to overload the bit-rotating motor 46 in the event of any change in drilling conditions increasing above normal the torque requirements, and in the event of initiation of overloading of the motor due to an excessive motor torque, the torque controlled valve means 105 is actuated partially or completely to close the sleeve valve 118, thereby to reduce or completely cut off the flow of liquid through the forward feed passage 103 to slow down or stop forward feed and preclude serious overloading of the motor. When the motor again operates at its normal load rating, forward feed is automatically resumed or brought back to its desired rate, as the case may be. Thus the actual feeding pressure on the drill bit will always be kept at or near, as an upper limit, that required to keep the bit-rotating motor 46 working at its normal load rating, although the feeding pressure obviously may be greatly reduced or even entirely removed, if conditions of drilling increase in difficulty. Since the mode of operation of the torque controlled valve means 105 is clearly described in the above mentioned Paget application, further detailed description thereof is herein unnecessary.

The bit-rotating motor 46 may be fed manually simply by manipulating the hand crank 75 to rotate the feed screw 65 relative to the non-rotatable feed nut 66, thereby to move the feed cylinder 16 forwardly along its guideways on the guide frame 5, and the feed cylinder may be moved forwardly relative to the feed piston 19 while drilling is uninterrupted. As is the case with the earlier Paget invention, when the feed piston has reached its limit of forward feeding travel relative to the feed cylinder, the slide valve 90 may be positioned to effect supply of liquid under pressure to the reverse feed passage 104 to effect retraction of the feed piston, and the feed cylinder may then be manually fed forwardly along its guideways on the guide frame 5 into a new feeding position, and thereafter forward feeding movement of the feed piston, under the actuation of liquid under pressure, may be resumed. Also, if desired, the drill bit may be fed either forwardly or rearwardly solely by the hand crank of the feed screw, wholly independently of the flow of liquid under pressure to the feed cylinder. In coordination with the manual feed, the torque controlled valve means 105, due to its venting function, makes it possible for the drill bit to be fed forwardly during the drilling operation while the flow of liquid under pressure through the forward feed passage 103 to the rear end of the feed cylinder is uninterrupted. If during forward feeding of the drill bit by liquid acting on the rear pressure area of the feed piston it is desired to feed the feed cylinder 16 forwardly along the guideways relative to the guide frame 5 by means of the hand crank of the feed screw and so to move the feed cylinder forwardly relative to the feed piston, the operator simply needs to turn the hand crank of the feed screw so as to advance the feed cylinder at a rate greater than the rate of penetration of the drill bit. This will obviously cause the normal feeding pressure on the drill bit to be increased, and as a result the torque on the bit-rotating motor 46 to become excessive, so that the torque controlled valve means 105 would move to the right as viewed in Fig. 7, not only to seat the sleeve valve 118 but also to move the valve stem 117 relative to the seated valve, thereby to open the vent ports in the valve stem; and as a result the liquid in the rear end of the piston chamber at the rear side of the feed piston can be forced out, as heretofore described, through ports 122, 123, axial passage 124 and the exhaust chamber 125. The venting of liquid from the rear end of the piston chamber at the rear side of the feed piston enables manual advancing of the feed cylinder along its guideways relative to the guide frame 5 by means of the hand crank of the feed screw. This venting function is at all times under torque control, so that varying rates of venting adapted to different rates of cylinder movement are obtained, and if the feed exhaust passages are of sufficient capacity the rate at which the operator manually feeds the feed cylinder forwardly has no substantial effect on the load on the bit-rotating motor. This feeding operation enables the drill bit to be fed forwardly the combined distances of travel of the feed piston in the feed cylinder and the feed cylinder relative to the guide frame 5, without interrupting the flow of liquid under pressure to the automatic feeding means, thereby to enable reduction in the time consumed during drilling and eliminating the necessity of the operator's feeding the drill bit through a series of definite steps. It is accordingly evident that the drill bit may be fed forwardly or rearwardly by the automatic feeding means under the control of the slide valve, and that the load on the bit-rotating motor automatically effects control of the forward feeding pressure. During the automatic feeding operation the feed screw may be locked by means of the locking plunger 78, and during manual feed these locking plungers are, of course, released.

As a result of this invention it will be noted that an improved drilling apparatus of the high speed rotary type is provided whereby blast holes may be bored in relatively hard material, such as hard rock or the like, relatively quickly and efficiently. It will further be evident that by the provision of the improved arrangement of the feeding means with respect to the bit-rotating means not only is powerful bit rotation obtained, but also the drilling apparatus is nicely balanced. It will also be evident that by the provision of the automatic feed controlling means embodying a venting function, manual feeding of the drill bit at substantially any time during the drilling operation may be caused to supersede the automatic feed, thereby to facilitate and expedite feeding of the drill. It will also be evident that by the provision of the novel driving means for the drill bit and its novel arrangement with respect to the feeding means, not only is the drill bit driven in an improved manner but also the drilling apparatus is rendered extremely compact and well balanced. Other uses and advantages of the invention will be clearly apparent to those skilled in the art.

While I have in this application specifically described one form which my invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration only and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a drilling apparatus, the combination comprising a rearwardly located motor, fluid actuated feeding means including relatively reciprocable feed cylinder and piston elements coaxial with said motor in advance of the latter, and driving connections between the front end of said motor and a drill bit to be fed including telescopic driving elements extending centrally forwardly through said cylinder and piston elements.

2. In a drilling apparatus, the combination comprising a guide frame, fluid actuated feeding means including relatively reciprocable feed cylinder and piston elements, said cylinder element being slidably guided on said guide frame for longitudinal adjustment relative thereto, a motor mounted on the rear end of said feed cylinder element in coaxial relation with said feeding means, and driving connections between the front end of said motor and a drill bit to be fed including telescopic driving elements extending centrally through said cylinder and piston elements.

3. In a drilling apparatus, the combination comprising a guide frame, fluid actuated feeding means including relatively reciprocable feed cylinder and piston elements, said cylinder element being slidably guided on said guide frame for longitudinal adjustment relative thereto, a motor mounted on the rear end of said feed cylinder element in coaxial relation with said feeding means, driving connections between the front end of said motor and a drill bit to be fed including telescopic driving elements extending centrally through said cylinder and piston elements, and means for feeding said cylinder element longitudinally relative to said guide frame and for holding said cylinder element in its different adjusted positions.

4. In a drilling apparatus, the combination comprising a guide frame, fluid actuated feeding means including relatively reciprocable feed cylinder and piston elements, said cylinder element being slidably guided on said guide frame for longitudinal adjustment relative thereto, a motor mounted on the rear end of said feed cylinder element in coaxial relation with said feeding means, driving connections between said motor and a drill bit to be fed including telescopic driving elements extending centrally through said cylinder and piston elements, and means for feeding said cylinder element longitudinally relative to said guide frame and for holding said cylinder element in its different adjusted positions including a feeding element extending rearwardly along one side of said motor.

5. In a drilling apparatus, the combination comprising a motor, fluid actuated feeding means coaxial with said motor and including relatively reciprocable feed cylinder and piston elements, said motor being arranged at the rear end of said feeding means and supported solely by said cylinder element, and said piston element being operatively connected to a drill bit to be fed, and driving connections between the front end of said motor and the drill bit including telescopic driving elements extending centrally through said cylinder and piston elements.

6. In a drilling apparatus, the combination comprising a motor, fluid actuated feeding means coaxial with said motor and including relatively reciprocable feed cylinder and piston elements, said piston element having a tubular piston rod extending forwardly through said cylinder element, said motor being arranged at the rear end of said feeding means and supported solely by said cylinder element, and said piston element being operatively connected to a drill bit to be fed, driving connections between the front end of said motor and the drill bit including telescopic driving elements extending centrally through said cylinder and piston elements and said tubular piston rod, and means for operatively connecting said piston element to the drill bit including a thrust head carried by said piston element at the forward end thereof in advance of said feeding means, one of said telescopic driving elements being operatively connected to said thrust head.

7. In a drilling apparatus, the combination comprising a motor, fluid actuated feeding means coaxial with said motor and including relatively reciprocable feed cylinder and piston elements, said motor being arranged at the rear end of said feeding means and supported solely by said cylinder element, and said piston element being operatively connected to a drill bit to be fed, driving connections between the front end of said motor and the drill bit including telescopic driving elements extending centrally through said cylinder and piston elements, said cylinder element having longitudinal guides, and a guide frame having longitudinal guideways for slidingly receiving said cylinder guides.

8. In a drilling apparatus, the combination comprising a motor, a feed cylinder coaxial with said motor in advance thereof, a tube extending centrally through said cylinder, an annular feed piston reciprocable in said cylinder and having a tubular piston rod surrounding and telescopically arranged with said tube, front and rear heads for said cylinder respectively cooperating with said tube and said piston rod to provide an annular piston chamber for receiving said piston, and driving connections between said motor and a drill bit to be fed including telescopic driving

elements extending centrally through said tube and said piston rod.

9. In a drilling apparatus, the combination comprising a motor, a feed cylinder coaxial with said motor in advance thereof, a tube extending centrally through said cylinder, an annular feed piston reciprocable in said cylinder and having a tubular piston rod surrounding and telescopically arranged with said tube, front and rear heads for said cylinder respectively cooperating with said tube and said piston rod to provide an annular piston chamber for receiving said piston, driving connections between said motor and a drill bit to be fed including telescopic driving elements extending centrally through said tube and said piston rod, and a thrust head carried by said piston rod at the forward end thereof, one of said driving elements being operatively connected to said thrust head.

10. In a drilling apparatus, the combination comprising a motor, a feed cylinder coaxial with said motor in advance thereof, a tube extending centrally through said cylinder, an annular feed piston reciprocable in said cylinder and having a tubular piston rod surrounding and telescopically arranged with said tube, front and rear heads for said cylinder respectively cooperating with said tube and said piston rod to provide an annular piston chamber for receiving said piston, driving connections between said motor and a drill bit to be fed including telescopic driving elements extending centrally through said tube and said piston rod, a thrust head carried by said piston rod at the forward end thereof, one of said driving elements being operatively connected to said thrust head, and a drill rod chuck carried by said latter one of said driving elements in advance of said thrust head.

11. In a drilling apparatus, the combination comprising a rearwardly located motor, hydraulic feeding means coaxial with said motor in advance of the latter, and driving connections between the front end of said motor and a drill bit to be fed including telescopic driving elements having a sliding splined connection and extending centrally through said feeding means.

12. In a drilling apparatus, the combination comprising a rearwardly located motor, hydraulic feeding means coaxial with said motor in advance of the latter, driving connections between the front end of said motor and a drill bit to be fed including telescopic driving elements having a sliding splined connection and extending centrally through said feeding means, said feeding means including a reciprocable feeding element, and a thrust head carried at the forward end of said reciprocable feeding element and to which one of said telescopic driving elements is operatively connected.

13. In a drilling apparatus, the combination comprising a guide support, fluid actuated feeding means including relatively reciprocable feed cylinder and piston elements, said feed cylinder element being slidably guided on said support for longitudinal adjustment relative thereto, and said feed piston element being operatively connected to a drill bit to be fed, a motor mounted on said feed cylinder element at the rear end of the latter and arranged in coaxial relation with said feeding means, and driving connections between said motor and the drill bit including extensible driving means disposed wholly in advance of said motor and extending centrally through said cylinder and piston elements.

14. In a drilling apparatus, the combination comprising a guide support, fluid actuated feeding means including relatively reciprocable feed cylinder and piston elements, said feed cylinder element being slidably guided on said support for longitudinal adjustment relative thereto, and said feed piston element being operatively connected to a drill bit to be fed, a motor mounted on said feed cylinder element at the rear end of the latter and arranged in coaxial relation with said feeding means, driving connections between said motor and the drill bit including extensible driving means disposed wholly in advance of said motor and extending centrally through said cylinder and piston elements, and means for operatively connecting the drill bit to be fed to said feed piston element including a thrust head carried by the latter in advance of said feed cylinder element, one of the elements of said extensible driving means being operatively connected to said thrust head.

15. In a drilling apparatus, the combination comprising fluid actuated bit feeding means including relatively reciprocable feed cylinder and piston elements, a rearwardly located bit-rotating motor carried by one of said elements in coaxial relation with said feeding means, said feed cylinder element having lateral guides extending longitudinally along the sides thereof, and a guide frame by which said feeding means is supported and having longitudinal guideways slidably receiving said lateral guides of said cylinder element.

16. In a drilling apparatus, the combination comprising a guide support, fluid actuated bit feeding means including relatively reciprocable feed cylinder and piston elements, said feed cylinder element being slidably guided on said support, a bit-rotating motor carried by one of said cylinder and piston elements in coaxial relation with said feeding means and arranged at the rear end of said feeding means, and means for manually feeding said cylinder element relative to said support including a rotatable feeding element arranged parallel with said feed cylinder element, a coacting feeding element on said support, means for rotatably supporting said rotatable feeding element including a bearing bracket depending from the front end of said cylinder element, and an operating member for rotating said rotatable feeding element, said operating member arranged at the rear end of said bit rotating member.

17. In a drilling apparatus, the combination comprising a guide support, fluid actuated bit feeding means including relatively reciprocable feed cylinder and piston elements, said feed cylinder element being slidably guided on said support, a bit-rotating motor carried by one of said cylinder and piston elements in coaxial relation with said feeding means and arranged at the rear end of said feeding means, and means for manually feeding said cylinder element relative to said support including a rotatable feeding element arranged parallel with said feed cylinder element, a coacting feeding element on said support, means for rotatably supporting said rotatable feeding element including a bearing bracket depending from the front end of said cylinder element, a support on the rear end of said cylinder element and a guide tube secured to said latter support and extending rearwardly alongside said bit rotating motor and through which the rearward portion of said rotatable element extends, and an operating member for said

rotatable element located at the rear end of said guide tube.

18. In a drilling apparatus, the combination comprising a support, fluid actuated bit feeding means including relatively reciprocable cylinder and piston elements, said cylinder element being mounted on said support, a control head secured to the rear end of said cylinder element, a bit-rotating motor carried by said control head at the rear end of said feeding means in coaxial relation with the latter, driving connections between said motor and a drill bit to be fed including extensible driving means extending centrally through said cylinder and piston elements, and valve means carried by said control head for controlling the flow of fluid to said feeding means.

19. In a drilling apparatus, the combination comprising a bit-rotating motor having a power shaft, feeding means arranged coaxially with and in advance of said motor, and driving connections between the forward end of said motor power shaft and a drill bit to be fed including extensible driving means disposed in advance of said motor and extending centrally through said feeding means.

20. In a drilling apparatus, the combination comprising a bit-rotating motor, feeding means arranged coaxially with and in advance of said motor, driving connections between the front end of said motor and a drill bit to be fed including extensible driving means extending centrally through said feeding means, and means for supplying cleansing fluid to the drill bit including a fluid-conducting element stationary with respect to said motor and extending centrally through the latter and within said extensible driving means.

CHARLES F. OSGOOD.