

June 22, 1943.

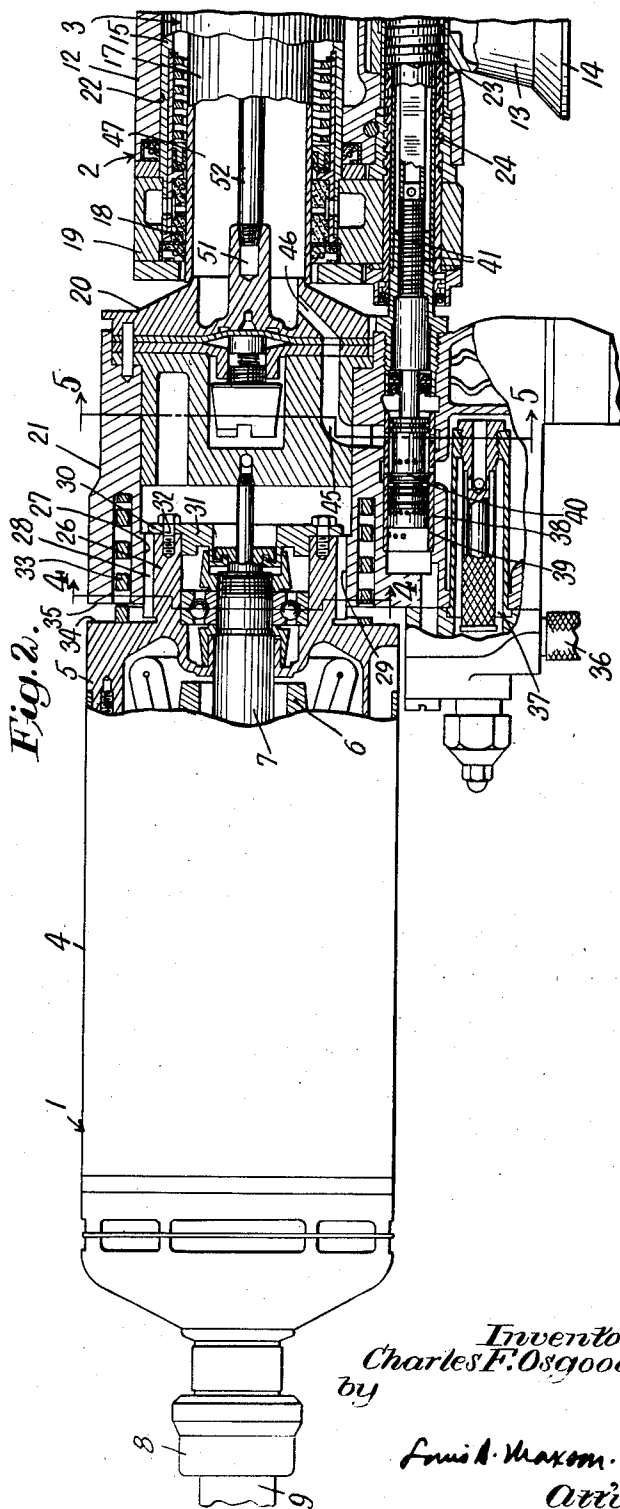
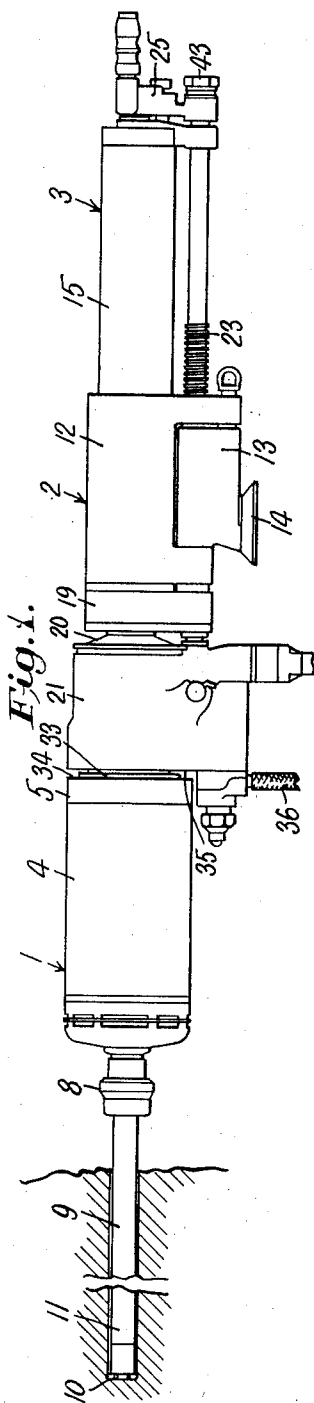
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2,322,741

DRILLING APPARATUS

Filed Aug. 2, 1940

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

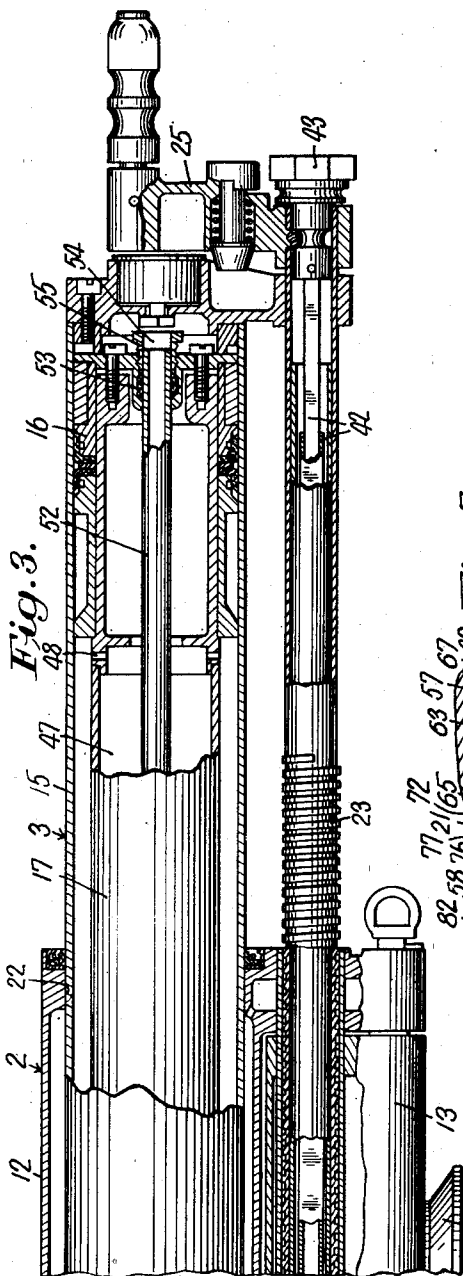


Fig. 7.

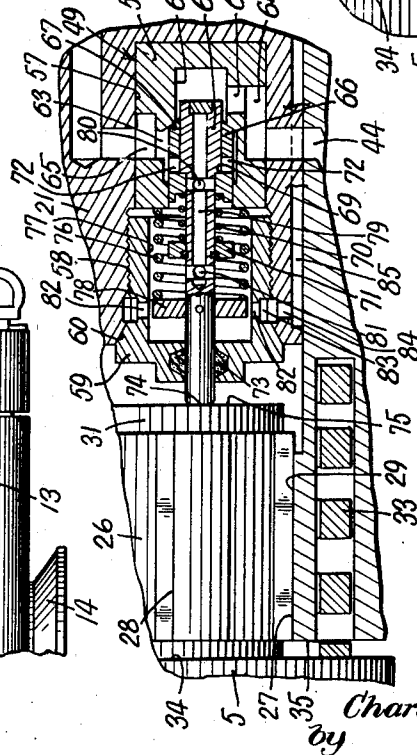
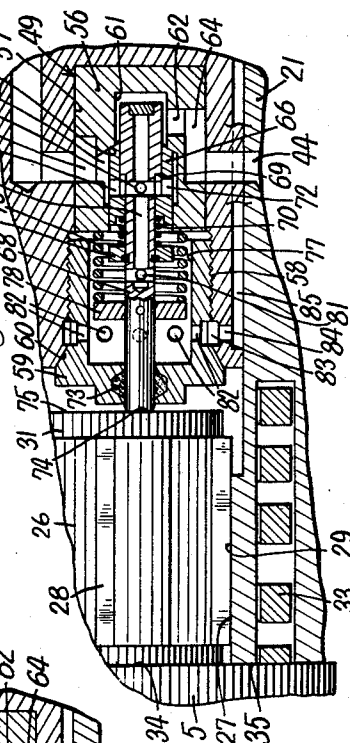


Fig. 8.



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Fig. 4.

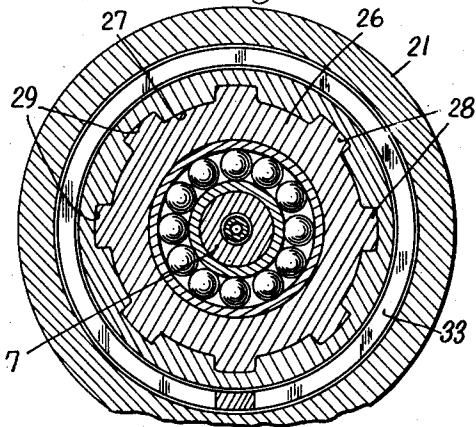


Fig. 5.

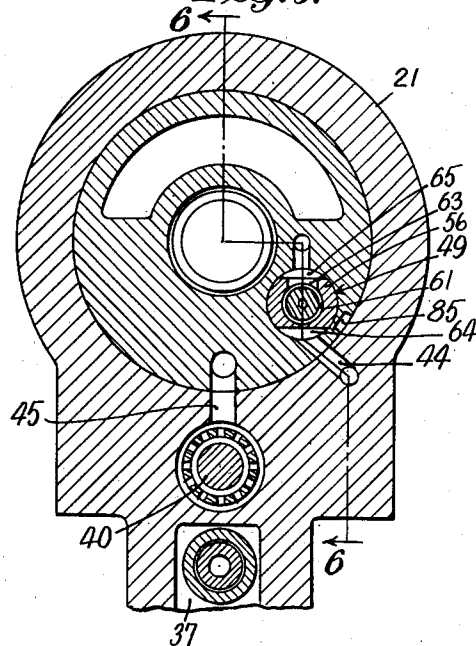
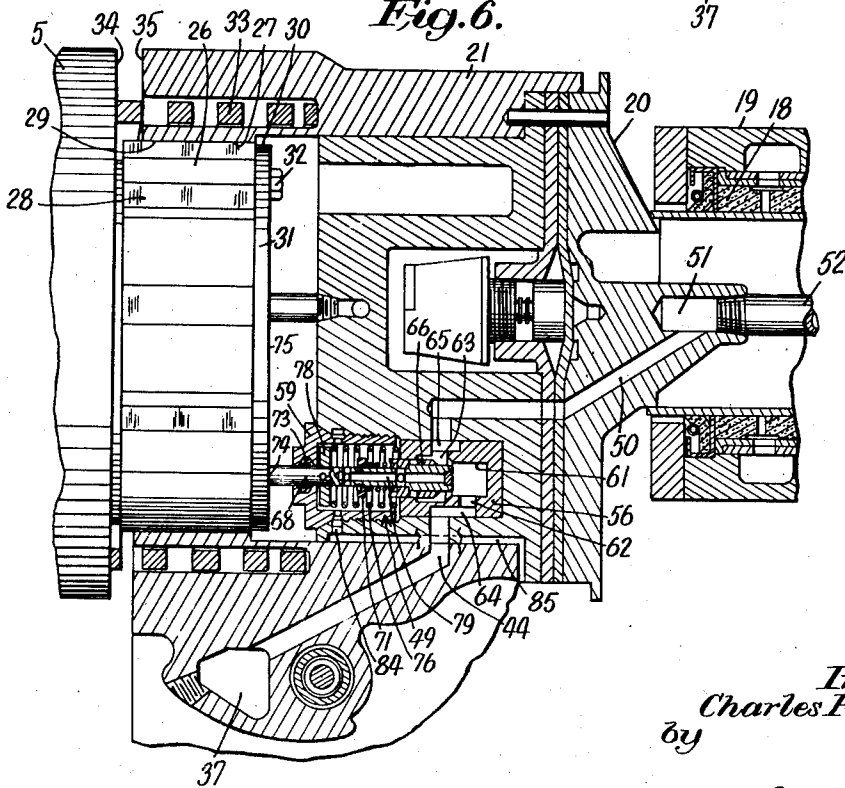


Fig. 6.



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UNITED STATES PATENT OFFICE

2,322,741

DRILLING APPARATUS

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Application August 2, 1940, Serial No. 349,647

24 Claims. (Cl. 255—45)

This invention relates to drilling apparatus, and more particularly, but not exclusively, to improvements in core drilling apparatus of the high speed rotary type.

An object of the present invention is to provide an improved drilling apparatus. Another object is to provide an improved drilling apparatus of the high speed, rotary core type especially adapted to use with diamond core bits. A further object is to provide an improved feeding means having improved means for automatically regulating the feeding pressure on the drill bit during the drilling operation. Still another object is to provide an improved feed controlling means automatically responsive to variations in the resistance to drill bit penetration whereby the feeding pressure on the drill bit is controlled in accordance with the nature of the drilling encountered. A still further object is to provide an improved feed controlling means for automatically interrupting the forward feed when the resistance to drill bit penetration reaches a predetermined degree and embodying means for automatically venting the forward feeding pressure when said predetermined degree is exceeded. Yet another object is to provide an improved valve means for controlling the feeding means, the valve means being controlled by axial non-rotative relative movement between the drilling motor and the control head on which the drilling motor is supported and guided. Other objects of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there is shown for illustrative purposes 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 view in longitudinal vertical section taken through the motor and control head of the drilling apparatus shown in Fig. 1, with parts shown in full to facilitate illustration.

Fig. 3 is an enlarged view in longitudinal vertical section taken in the plane of Fig. 2, showing the feeding means of the drilling apparatus shown in Fig. 1.

Fig. 4 is an enlarged cross sectional view taken on line 4—4 of Fig. 2.

Fig. 5 is an enlarged cross sectional view taken on line 5—5 of Fig. 2.

Fig. 6 is an enlarged developed sectional view taken substantially on line 6—6 of Fig. 5.

Figs. 7 and 8 are enlarged fragmentary sectional views taken in the plane of Fig. 6, showing parts in different positions.

In this illustrative embodiment of the invention there is shown a drilling apparatus of the high speed, rotary core type which may be generally similar to that disclosed in a copending application of one Win. W. Paget, Serial No. 322,267, filed March 5, 1940, (now U. S. Patent No. 2,288,543 dated June 30, 1942) although in the present invention the torque changes on the motor are not employed to effect control of the feed. It will be evident, however, that the invention may be employed in drilling apparatus of various other types. The drilling apparatus disclosed herein generally comprises a bit rotating means, generally designated 1, supporting and guiding means, generally designated 2, and bit feeding means, generally designated 3.

The bit rotating means comprises a rotary motor 4, herein preferably of the high speed electric type, comprising a casing 5 and an armature rotor 6, the latter being keyed to a motor shaft 7 suitably journaled within the motor casing. The motor shaft carries a chuck 8 for receiving the shank of a drill rod 9 by which a drill bit 10 is carried. The drill bit is preferably of the annular abrasive type, herein known as a diamond core bit, and a core barrel 11 is coupled between the bit and drill rod for receiving the core cut by the bit, in the manner well known to those skilled in the art.

The supporting and guiding means 2 comprises a guide member 12 mounted on a trunnion support 13 having a swivel plate 14 adapted to be clamped in the saddle mounting of a conventional drill support.

The feeding means 3 comprises a hydraulic feed cylinder 15 containing a reciprocable feed piston 16 having a piston rod 17 extending forwardly through packings 18 carried within the forward portion of the feed cylinder and a front cylinder head 19. The piston rod 17 carries at its forward end a plate 20 supporting a control head 21, the latter in turn carrying the drilling motor 4, in a manner to be later explained. The feed cylinder 15 is guided for longitudinal axial movement in a bore 22 in the guide member 12 and may be adjusted within the guide member bore into different feed-effecting positions by means of a rotatable feed screw 23 engaging a non-rotatable feed nut 24 and provided with a hand crank 25. The feed screw is rotatably mounted within the front and rear cylinder heads and is suitably held against longitudinal axial

movement with respect to the cylinder heads so that when the feed screw is rotated by the hand crank, the feed cylinder 15 may be moved axially relative to the guide member. The feed screw may also be employed at certain times to effect feed of the drilling motor during the drilling operation. This feeding means is more fully described in the above mentioned Paget application.

In the present construction, the drilling motor has a cylindric portion 26 formed integral with the rear head of the motor casing, and this cylindric portion extends rearwardly within a bore 27 in the control head 21 and is guided for limited axial movement in the control head bore. Rotative movement of the motor casing with respect to the control head is precluded by splines 28 on the cylindric portion 26 engaging splineways 29 within the walls of the control head bore 27, and forward axial movement of the motor casing is limited by a flange 30 on a plate member 31 secured, as by screws 32, to the cylindric portion 26. Interposed between the control head 21 and the motor casing is a heavy coil spring 33 which urges the motor into its foremost position relative to the control head. Rearward axial movement of the motor casing relative to the control head is limited by a surface 34 on the motor casing engageable with an abutment surface 35 on the control head. It will thus be seen that the motor casing has limited axial movement relative to the control head while rotative movement thereof is precluded, and the axial movement is controlled by the heavy coil spring 33. The purpose of this sliding motor mounting will later be explained.

Liquid under pressure may be supplied to the feed cylinder 15 through a supply hose 36 connected to a supply chamber 37 in the control head 21. Arranged in a bore 38 in the control head is a ported valve bushing 39 containing a conventional slide valve 40. The slide valve may be manually operated through a screw and nut device 41 by a telescopic operating rod connection 42 extending centrally through the tubular feed screw 23, the rod connection 42 having an operating handle 43 located in adjacency to the hand crank 25. The slide valve may be manually operated to control the flow of liquid from the chamber 37 through forward and reverse feed passages 44 and 45 respectively communicable with the opposite ends of the feed cylinder. The passages 44 and 45 are formed in the control head 21, and the reverse feed passage 45, as shown in Fig. 2, is connected by a passage 46 formed in the piston rod plate 20 to a chamber 47 in the feed piston rod 17. As shown in Fig. 3, the chamber 47 is connected by a port 48 with the feed cylinder bore at the forward side of the feed piston. The forward feed passage 44 is controlled by an automatic feed controlling valve means, generally designated 49, and leads from the supply chamber 37 past the slide valve 40 to a passage 50 in the piston rod plate 20. The passage 50 communicates with a recess 51 connected by a conduit 52 to the feed cylinder bore at the rear side of the feed piston. As shown in Fig. 3, the conduit 52 extends rearwardly through the piston rod chamber 47 and has its rearward portion extending through a packing 53 within the feed piston, so that leakage past the exterior of the conduit is substantially prevented. The conduit 52 communicates with the rear end of the feed cylinder bore through a bore 54 in a packing-adjusting plug 55.

The automatic feed controlling valve means 49 may assume various forms, but, as shown in Figs. 6, 7 and 8, herein comprises a valve sleeve 56 fitted in a longitudinal bore 57 in the control head 21. Threaded within the bore 57 at 58 is a plug 59 having a tapered head tightly engaging a conical seat 60 on the control head. The sleeve 56 has a bore 61 connected by ports 62 and 63 with grooves 64 and 65 respectively, formed in the valve sleeve 56, and the forward feed passage 44 communicates with groove 64 so that the flow of liquid through the forward feed passages passes through the sleeve bore. A sleeve valve 66 is adapted to seat at 67 to cut off the flow of fluid through the sleeve bore, thereby to interrupt the forward feed, and by variably adjusting the sleeve valve with respect to its seat, the flow of liquid to the forward feed may be varied. A valve stem 68 has a tight sliding fit with the bore of the sleeve valve, and the latter is tightly held against a shoulder 69 on the valve stem by a coil spring 70 interposed between the sleeve valve and a washer 71 attached to the valve stem. The sleeve valve has ports 72 connecting its bore with the bore of the valve sleeve 56. The valve stem projects forwardly through a packing 73 in the plug 59 and abuttingly engages at 74 the rear face 75 of the plate member 31 secured to the rear head of the motor casing, in the manner shown in Fig. 6. A spring 76 is interposed between one end of the valve sleeve 56 and a collar 78 secured to the valve stem, and this spring urges the valve stem into its foremost position against the plate member 31. Formed in the valve stem is an axial passage 79 communicable through ports 80 with the bore of the sleeve valve 66. Ports 81 connect the axial passage 79 with the plug bore 77, and the latter is connected by ports 82, annular groove 83 and port 84 to a vent groove 85 leading to atmosphere, in the manner shown in Fig. 6. When the sleeve valve 66 is held against the shoulder 69 on the valve stem, the ports 80 are closed, but when the valve stem is moved axially within the sleeve valve the ports 80 are brought into communication with the ports 72 in the sleeve valve.

The pressure exerted by the heavy coil spring 33 is sufficient to hold the control head against axial movement relative to the bit rotating motor during normal full feeding pressure on the drill bit, but when the pressure on the bit becomes excessive, i. e. when the resistance to penetration of the work becomes too high, the heavy coil spring is compressed, permitting axial movement by the control head relative to the motor casing, and as a result the sleeve valve 66 is moved onto its seat 67 to cut off fluid flow through the forward feed passages to the rear end of the feed cylinder bore. When the resistance to penetration becomes even greater, the heavy coil spring is further compressed, permitting further relative movement between the control head and motor casing, moving the valve stem relative to the sleeve valve 66 to open the ports 80, thereby to connect the forward feed passage 50 to exhaust through the ports and passages communicating with the vent groove 85. It is accordingly evident that variations in the feeding pressure on the drill bit, normally due to the variations in the resistance to penetration of the work, will automatically effect control of the flow of fluid through the forward feed passages, and automatically interrupt supply to the forward feed as overload of sufficient degree occurs, and when the load on the drill bit becomes excessive the

forward feed is automatically vented to atmosphere.

The general mode of operation of the improved drilling apparatus is as follows. The apparatus may be set up in proper operating position with respect to the working face in the manner shown in Fig. 1 with the swivel plate 14 of the trunnion support suitably clamped in the saddle mounting of a conventional drill support. After a starting hole has been suitably formed in the working face, the drill rod 9 is coupled to the chuck 8 and the drilling motor is then fed forwardly either by means of the feed screw or the hydraulic cylinder to bring the core bit 10 in drilling position within the starting hole. Water is then supplied through the rod line to the drill bit and the drilling motor is started in the manner described in the application above referred to. The slide valve 40 is then manually moved into a position to supply liquid under pressure from the supply chamber 37 to the forward feed passage 44 to effect forward movement of the feed piston 16 within the feed cylinder 15 to feed the bit rotating motor forwardly while the drill bit is rapidly rotated, thereby to effect drilling. The forward feeding pressure on the drill bit is sufficient to overload the bit rotating motor in the event of any change in drilling conditions increasing the resistance to penetration above normal, and in the event of excessive resistance to penetration the control head 21 is moved relative to the drilling motor, compressing the heavy coil spring 33 and actuating the automatic control valve means from the wide-open position shown in Fig. 6 partially or completely to close the sleeve valve 66, thereby to reduce or completely cut off the flow of liquid through the forward feed passage to slow down or stop forward feed and preclude serious overloading of the motor. In Fig. 7 the sleeve valve 66 is shown in its position completely to cut off flow of liquid to the feed cylinder. When the bit rotating 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 working at its normal load rating. It will be apparent that sharp increases in resistance to penetration will entirely interrupt the supply of fluid for effecting forward feed momentarily, and slight increases will serve to reduce the supply of fluid which provides forward feeding pressure in accordance with the work requirements.

As is clearly described in the above mentioned Patent application Serial No. 322,267, the feed cylinder 15 of the hydraulic feeding means may be moved forwardly relative to the feed piston while flow of liquid to effect forward feed is uninterrupted. When the feed piston 16 has reached its limit of forward feeding travel within the feed cylinder, the feed screw 23 may be rotated by the hand crank to adjust the feed cylinder forwardly within the bore of the guide member 12 into a new feeding position, and thereafter forward feeding movement of the feed piston under the actuation of liquid under pressure will be resumed. Also, if desired, the bit rotating motor may be fed either forwardly or rearwardly solely by the hand crank of the feed screw wholly independently of flow of liquid under pressure to the feed cylinder.

The automatic feed control valve means 49, due to its automatic venting function, makes it

possible for the bit rotating motor to be fed forwardly while permitting flow of liquid to the forward feed passage of the hydraulic feeding means without necessitating manual adjustment of the slide valve 40. For instance, if during forward feeding of the drill bit by the hydraulic feeding means it is desired to feed the feed cylinder 15 forwardly within the guide bore in the guide member 12 by means of the hand crank of the feed screw, and so to move the feed cylinder forwardly relative to the feed piston 16, 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, i. e. at a rate greater than the drilling rate of the apparatus. This will obviously cause the normal feeding pressure on the drill bit to be increased and, as a result, the load on the bit rotating motor to become excessive so that the coil spring 33 is compressed to permit the control head 21 to move forwardly relative to the bit rotating motor, thereby moving the sleeve stem relative to the sleeve valve 66 into the position shown in Fig. 8. When the valve means is in the position shown in Fig. 8, the ports 72 are open so that the forward feed passage is vented, and as a result the liquid at the rear end of the feed cylinder will be forced out, as described above, through ports 72, axial passage 79, ports 81, the plug bore, ports 82, groove 83, port 84 and vent groove 85. The venting of liquid from the rear end of the feed cylinder at the rear side of the feed piston enables manual advancing of the feed cylinder relative to the guide member 12 by means of the hand crank of the feed screw. This venting function is at all times under automatic control so that varied rates of venting adapted to different degrees of cylinder movement are obtained, and if the feed venting 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. It will thus be seen that the automatic valve means embodying the automatic venting function enables the drill bit to be fed forwardly the combined distances of the feed piston in the feed cylinder and the feed cylinder relative to the guide member without interrupting the flow of liquid to the forward feeding means, thereby enabling reduction in the time consumed during drilling.

As a result of this invention it will be noted that an improved drilling apparatus of the high speed rotary diamond type is provided having improved feeding means whereby the drill bit is fed with respect to the work in an improved manner. It will further be noted that by the provision of the improved means for regulating the feeding pressure on the drill bit the rate of feed may be controlled automatically in accordance with variations in the resistance to penetration of the drill bit. It will further be noted that by the provision of the automatic feed controlling means embodying the automatic venting function, the drill bit may be fed manually with respect to the work without interrupting the flow of liquid under pressure to the hydraulic feeding means so that hydraulic feed of the bit is automatically resumed when the manual feed is discontinued. Other uses and advantages of the improved drilling apparatus will be clearly apparent to those skilled in the art.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this

form of the same is shown for purposes of illustration 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 motor for rotating a drill bit, means effective upon supply of operating medium thereto for feeding the drill bit, and means automatically responsive to variations in the resistance to drill bit penetration for controlling the feeding pressure on the drill bit, said automatic controlling means being operable wholly independently of the torque changes on said motor and embodying means for controlling the supply of operating medium to said feeding means positionable automatically to provide an increased supply rate upon a reduction in the resistance to drill bit penetration.

2. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, fluid actuated means for feeding the bit including a reciprocable feeding element, a control head carried by said reciprocable feeding element and by which said motor is supported, means for mounting the casing of said motor on said control head for axial non-rotary movement with respect thereto, and means responsive to variations in the resistance to drill bit penetration for automatically controlling the feeding pressure on the bit, said automatic controlling means being actuated upon relative axial movement between said motor and said control head.

3. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, fluid actuated means for feeding the bit including a reciprocable feeding element, a control head carried by said reciprocable feeding element and by which said motor is supported, means for mounting the casing of said motor on said control head for axial non-rotary movement with respect thereto, a relatively heavy coil spring interposed between the motor casing and said control head for controlling the axial relative movement therebetween, and means responsive to variations in the resistance to drill bit penetration for automatically controlling the feeding pressure on the bit, said automatic controlling means being actuated upon relative axial movement between said motor and said control head and controlled by the compression of said spring.

4. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, fluid actuated means for feeding the bit including a movable feeding element, a control head supported by said feeding element, means for mounting the casing of said motor on said control head for axial non-rotative movement with respect thereto, a coil spring interposed between said motor casing and the control head for urging the motor casing into its foremost position with respect to said control head, and valve means carried by said control head and actuated upon relative axial movement between the motor casing and the control head for controlling the feeding pressure on the bit.

5. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, fluid actuated means for feeding the bit including a movable feeding element, a control head supported by said movable

feeding element and on which said motor is mounted, means providing a sliding splined connection between the casing of said motor and said control head for permitting relative axial movement between the motor and the control head while precluding relative rotary movement, a coil spring interposed between the motor casing and the control head for urging the motor casing into its foremost position with respect to said control head, and valve means carried by said control head and actuated upon relative axial movement between said motor casing and said control head for controlling the feeding pressure on the bit.

6. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, fluid actuated means for feeding the bit, and means operable wholly independently of the torque changes on said motor and automatically responsive to variations in the resistance to bit penetration for controlling the feeding pressure on the bit, said controlling means embodying valve means for controlling the pressure of the fluid in said feeding means and operable automatically to provide an increased supply rate upon a reduction in the resistance to drill bit penetration.

7. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, fluid actuated means for feeding the bit, and means operable wholly independently of the torque changes on said motor and automatically responsive to variations in the resistance to bit penetration for controlling the feeding pressure on the bit and including means for venting the fluid exerting the feeding pressure when the resistance to bit penetration becomes excessive.

8. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, a control head on which said motor is mounted, means providing a sliding non-rotative connection between the casing of said motor and said control head, means for feeding said control head, and means automatically responsive to the variations in the resistance to bit penetration for controlling the feeding pressure.

9. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, a control head on which said motor is mounted, means providing a sliding non-rotative connection between the casing of said motor and said control head, means for feeding said control head, and means automatically responsive to the variations in the resistance to bit penetration for controlling the feeding pressure, said automatic means actuated by movement of said control head relative to the motor casing.

10. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, a control head on which said motor is mounted, means providing a sliding non-rotative connection between the casing of said motor and said control head, resilient means for controlling the relative axial movement between said motor casing and said control head, means for feeding said control head, and means automatically responsive to the variations in the resistance to bit penetration for controlling the feeding pressure, said automatic means being actuated upon relative movement between said motor casing and said control head.

11. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having a casing, a control head on which

said motor is mounted, means providing a sliding non-rotative connection between the casing of said motor and said control head, a coil spring interposed between the motor casing and the control head for exerting on them a force tending to effect a relative movement opposite to that which resistance to bit penetration tends to cause, means for feeding said control head, and means automatically responsive to the variations in the resistance to bit penetration for controlling the feeding pressure, said automatic means controlled by said spring and actuated by movement of said control head relative to the motor casing.

12. In a drilling apparatus, the combination comprising a motor for actuating a drill bit, means for mounting said motor for axial movement relative thereto, power operated means for feeding the drill bit, and means responsive to variations in the resistance to drill bit penetration for automatically controlling said feeding means, said automatic controlling means being actuated upon relative axial movement between said motor and said mounting means.

13. In a drilling apparatus, the combination comprising a motor for actuating a drill bit, means for mounting said motor for axial movement relative thereto, resilient means for controlling the relative axial movement between said motor and said mounting means, power operated feeding means for feeding the drill bit, and means responsive to variations in the resistance to drill bit penetration for automatically controlling said feeding means, said automatic controlling means being actuated upon relative axial movement between said motor and said mounting means under the control of said resilient means.

14. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, power operated means effective upon supply of operating medium thereto for feeding the drill bit, and means operable wholly independently of the torque changes on said motor and automatically responsive to variations in the resistance to drill bit penetration for controlling said feeding means, said controlling means embodying means for reducing or interrupting the supply of operating medium to said feeding means.

15. In a drilling apparatus, the combination comprising a motor for actuating a drill bit, a support by which said motor is carried, said motor having an element thereof mounted on said support for axial movement relative thereto, power operated means for feeding the drill bit and having a feeding element operatively connected to said support for feeding the latter, and means automatically responsive to the variations in the resistance to drill bit penetration for controlling said feeding means, said automatic means being actuated upon relative axial movement between said motor element and said support.

16. In a drilling apparatus, the combination comprising a motor for actuating a drill bit, a support by which said motor is carried, said motor having an element thereof mounted on said support for axial movement relative thereto, resilient means for controlling the relative axial movement between said motor element and said support, power operated means for feeding the drill bit and having a feeding element operatively connected to said support for feeding the latter, and means automatically responsive to the variations in the resistance to

drill bit penetration for controlling said feeding means, said automatic means being actuated upon relative axial movement between said motor element and said support under the control of said resilient means.

17. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having cooperating relatively movable motor elements one of which is a reaction element and which elements upon the supply of power medium to the motor have a force exerted between them which effects the production of power, means for mounting one of said motor elements for axial movement relative thereto, power operated means for feeding the drill bit, and means automatically responsive to variations in the resistance to drill bit penetration for controlling said feeding means, said automatic controlling means being actuated upon relative axial movement between said motor element and said mounting means.

18. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, said motor having cooperating relatively movable motor elements one of which is a reaction element and which elements upon the supply of power medium to the motor have a force exerted between them which effects the production of power, means for mounting one of said motor elements for axial movement relative thereto, resilient means for controlling the relative axial movement between said motor element and said mounting means, power operated means for feeding the drill bit, and means automatically responsive to variations in the resistance to drill bit penetration for controlling said feeding means, said automatic controlling means being actuated upon relative axial movement between said motor element and said mounting means under the control of said resilient means.

19. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, mounting means for said motor, said motor including cooperating relatively movable motor elements one of which is a reaction element and which elements upon the supply of power medium to the motor have a force exerted between them which effects the production of power, one of said elements being movable in an endwise direction relative to said mounting means, power operated feeding means for the drill bit, and means responsive to variations in the resistance to drill bit penetration for automatically controlling said feeding means, said automatic controlling means being actuated upon relative endwise movement between said motor element and said mounting means.

20. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, power operated feeding means effective upon supply of operating medium thereto for feeding said motor and the drill bit, said feeding means having a feeding element movable in an endwise direction relative to said motor, and means responsive solely to variations in the resistance to drill bit penetration for automatically controlling said feeding means, said automatic means embodying means actuated upon relative endwise movement between said feeding element and said motor for controlling the flow of operating medium relative to said feeding means.

21. In a drilling apparatus, the combination comprising a drill bit, means for actuating said drill bit including a bit actuating motor, feeding means operative upon the supply of operating

medium thereto to apply a feeding pressure to said drill bit, and controlling means automatically controlled by changes in the resistance to drilling for precluding the application by operation of said feeding means by operating medium supplied thereto of a feeding pressure in excess of a desired value to the drill bit, said controlling means being actuated, in a direction to reduce or interrupt the supply of operating medium to said feeding means, by a movement consequent upon a predetermined resistance to drilling and including a reaction member which moves axially of said bit actuating motor automatically from a normal position upon the resistance to drilling exceeding a predetermined value.

22. In a drilling apparatus, the combination comprising a drill bit, means for rotating said drill bit including a bit actuating motor, feeding means operative upon the supply of operating medium thereto to apply a feeding pressure to said drill bit, and controlling means automatically controlled by changes in the resistance to drilling for precluding the application by operation of said feeding means by operating medium supplied thereto of a feeding pressure in excess of a desired value to the drill bit, said controlling means being actuated, in a direction to reduce or interrupt the supply of operating medium to said feeding means, by a movement consequent upon the building up of a predetermined resistance to drilling and operable wholly independ-

ently of the resistance to drill bit rotation, said controlling means including a reaction member which moves automatically from a normal position upon the resistance to drilling exceeding a predetermined value.

23. In a drilling apparatus, the combination comprising a motor for rotating a drill bit, fluid actuated means for feeding the bit, and means operable wholly independently of the torque changes on said motor and automatically responsive to variations in the resistance to bit penetration for controlling the feeding pressure on the bit, said controlling means embodying valve means for controlling the flow of feeding fluid relative to the feeding means, said valve means movable automatically upon changes in the resistance to bit penetration, to effect opposite changes in the pressure of the fluid in said feeding means.

24. In a drilling mechanism, in combination, a drilling tool, a motor for rotating said tool, means supporting said motor for bodily movement relative to the material to be drilled and for limited yielding movement relative to said supporting means, means for yieldingly feeding said motor relative to the material to be drilled, and means actuated by the limited yielding movement between said motor and said supporting means for limiting the feeding pressure imposed on said motor through said yielding means.

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