Feb. 10, 1942. H. S. HOFFAR 2,272,620

DIAMOND DRILL

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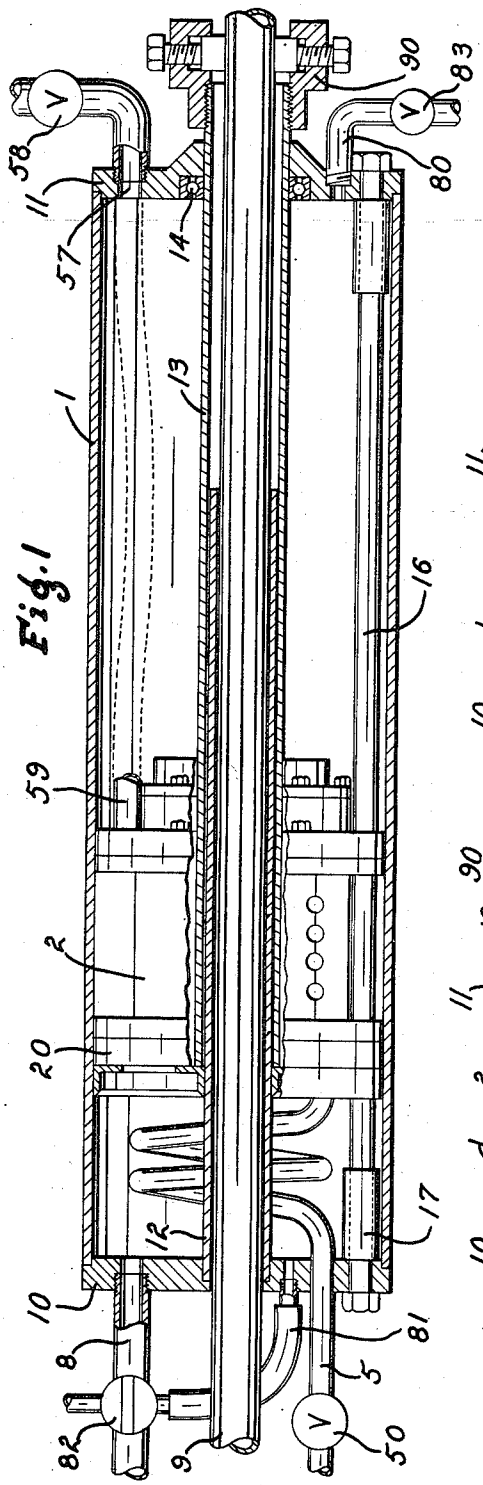


Fig. 1

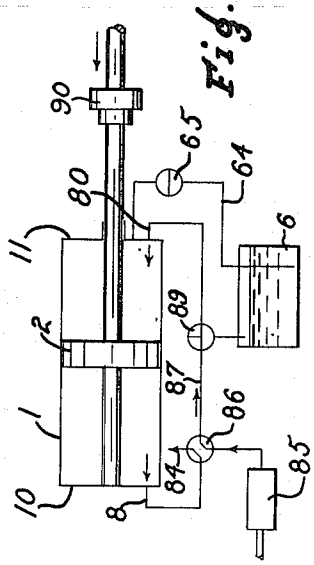


Fig. 5

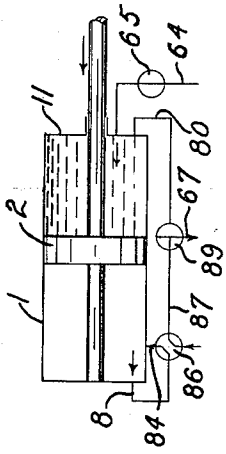


Fig. 7

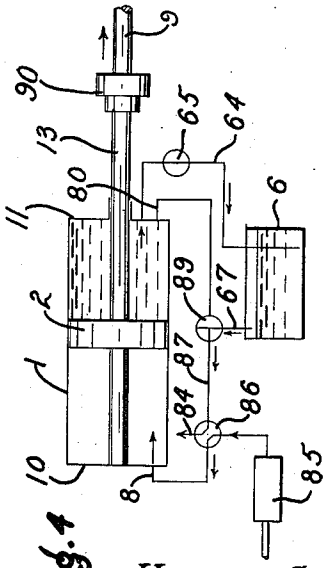


Fig. 4

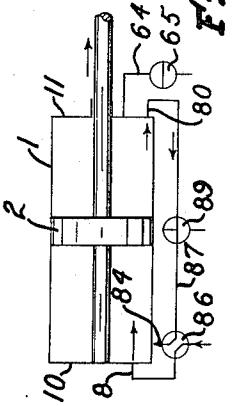


Fig. 6

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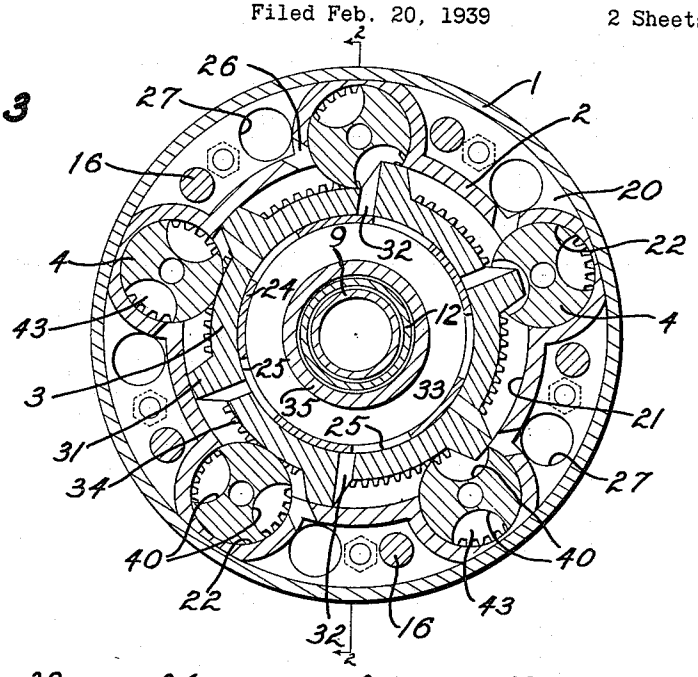
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Feb. 10, 1942. H. S. HOFFAR 2,272,620

DIAMOND DRILL

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Fig. 3



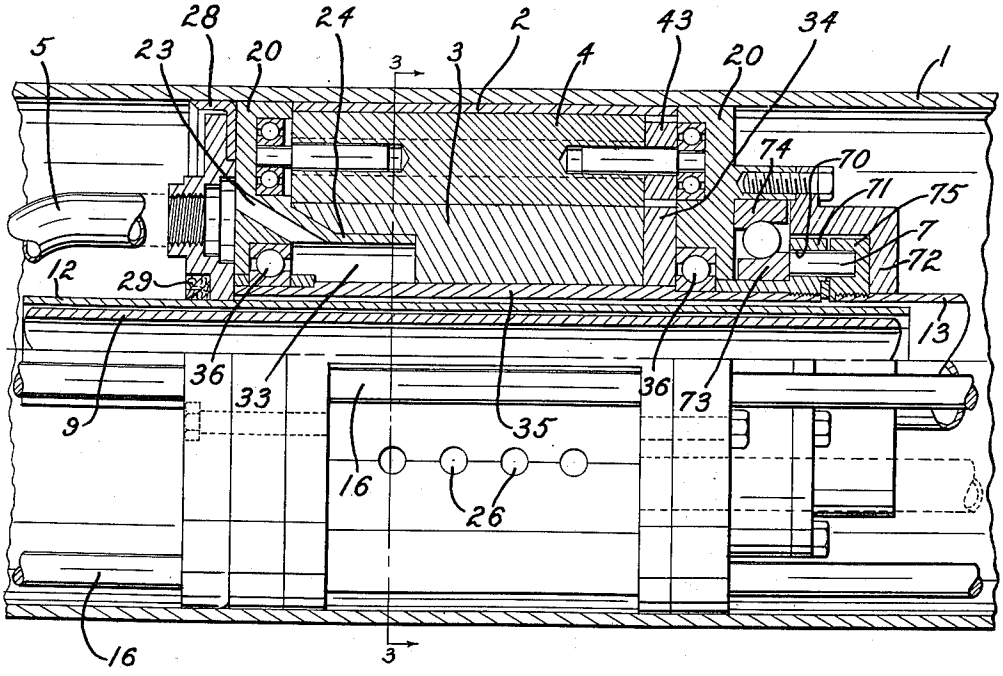


Fig. 2

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2,272,620

UNITED STATES PATENT OFFICE

2,272,620

DIAMOND DRILL

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Application February 20, 1939, Serial No. 257,540

14 Claims. (Cl. 255—45)

The present invention relates to diamond drills or the like, and to feeds or feed control mechanisms therefor, and is in part an improvement upon the mechanism disclosed in my Patent No. 2,192,909, issued Mar. 12, 1940.

In my former application the feed piston, to which was connected the drill rod, was advanced, to advance the drill rod, by air under pressure, acting in opposition to a resisting liquid flowing through a restricted orifice, whereby to control and govern the maximum rate of advance. As a result of the necessary presence of the liquid it was necessary to rotate the drill rod by a motor mounted externally of the feed cylinder upon a tube projecting from the feed piston. This necessarily increased somewhat the length and bulk of the diamond drill as a whole, and rendered it somewhat awkward to handle in restricted spaces, and its bulk was further increased by the weight of the water, which was at all times within the cylinder or within a reservoir that surrounded the feed cylinder.

There are few rock formations where it is necessary to guard against an uncontrolled rapid advance of the drill, as for instance when breaking into a fissure, and since this occurrence is relatively rare, it is possible to eliminate the presence of the resisting liquid, thereby materially lightening the drill as a whole, and further, principally by reason of the elimination of the liquid, it is possible to dispose the rotary motor within the feed cylinder, and preferably within the feed piston, so that the motor constitutes in effect the feed piston, and this has the further effect of lightening and shortening the length of the drill, therefore making it more compact and more readily usable in cramped spaces.

It may not be wholly desirable under all conditions to eliminate the liquid resistance, and by the present arrangement there is provided a liquid reservoir (but one separate from the feed cylinder) and a means whereby the feed piston may be moved in each direction by air pressure, as needed, thereby making unnecessary the use and presence of the liquid, but making it possible also to supply the liquid when needed from the reservoir, and this without the necessity of disturbing the rotary motor within the piston, so that the drill, with the liquid supplied for use as occasion may demand, has all the capabilities of the former drill, yet because it does not have to retain or to contain the liquid at all times, is appreciably lighter and more compact.

It is to the above ends that the present invention is directed, and these and other objects will appear as this specification progresses.

My invention comprises the novel parts and the novel combination and arrangement thereof, as shown in the accompanying drawings, described in this specification, and as will be more particularly defined by the claims which terminate this specification.

In the accompanying drawings I have shown my invention embodied in a typical form, as at present preferred by me, and diagrammatically, it being understood that the details of construction, particularly of the motor itself, may be varied without departing from the spirit of this invention.

It is desired to point out here that the internal construction of the motor is not in itself considered a necessary part of this invention, for the motor, so constructed, may be used in other ways than as a part of the feed piston; in other words, the motor might be employed exteriorly of the feed cylinder, much as was the motor in my former application; and, conversely, the motor which is incorporated as part of the feed piston may be constructed otherwise than as shown in the drawings of this application. The illustrated motor, therefore, is intended as merely representative of a suitable and satisfactory form of motor, which may be incorporated within the feed piston, and the present invention is concerned more with the idea of incorporating a motor within a feed piston in such an assembly than with the details of the motor per se.

Figure 1 is an axial section through such a diamond drill, except through the rotary motor thereof, and the latter is shown in elevation.

Figure 2 is an enlarged view, partly in elevation and partly in axial section, through the motor and associated parts on the line 2—2 of Figure 3, and Figure 3 is a cross section through the same on the line 3—3 of Figure 2.

Figures 4, 5, 6, and 7 are diagrammatic views in the nature of axial sections, illustrating four different phases of operation of a suitable feed control device.

The feed cylinder 1 is provided with the opposite heads 10 and 11, and these heads are centrally apertured, so that the tubular drill rod 9 may extend through the cylinder. Within the cylinder a casing 2 is axially movable, and this casing is either externally cylindrical or is provided with a circular head or heads 20, so that it closes off communication between the opposite ends of the cylinder 1, and functions as a piston, sliding lengthwise of the cylinder. It is packed at 28 relative to the cylinder. It is likewise axially apertured for the passage through it of the drill rod 9, and suitable means are provided to prevent leakage through such aperture, and to transmit thrust from the casing 2 to the exterior, and thence to the drill rod 9. To these ends a pair of telescopic tubes 12 and 13 may be provided, suitably connected or packed, as at 29, to prevent leakage between them, and one of them, the tube 12, is received and fixed in the head 10, surrounding the axial aperture therein, and the other of this pair of telescoping tubes, the tube 13, is secured to the casing 2 or to a member associated with the latter, and projects through the axially disposed aperture in the op-

posite head 11. Exteriorly of the cylinder the tube 13 supports a chuck 90, by means of which the drill rod 9 may be engaged, so that the latter moves conjointly with the tube 13. Since the tube 13 is intended to have both axial and rotary movement, and to accomplish both such movements simultaneously, so that the chuck and drill rod will be given both axial and rotary movement. The better to support the tube 13 at the head 11, a bearing 14 may be provided surrounding the tube. Suitable packing means may be employed at this point, especially if this end of the cylinder is to contain liquid, but such packing means have been omitted for clearer illustration.

Within the casing 2, and between its circular ends 20, is contained a rotary motor, preferably one driven by a fluid pressure medium, such as compressed air. The interior of this casing 2 defines a cylindrical chamber 21, within which is rotatable a rotor 3, carrying abutments 31. Offset from the axial cylindrical chamber 21, within which rotates the rotor and its abutments, are a plurality of angularly spaced valve chambers 22, generally part-cylindrical in shape, within which are rotatable cylindrical valves 4, each of which is provided with two pockets 40. A central sun gear 34, upon the rotor 3, meshes with a planet gear 43 upon each of the valves 4, thereby rotating and timing the latter in such fashion that the abutments 31 will enter the pockets 40. Preferably of the abutments and valves, an odd number of one and an even number of the other is provided; six abutments 31 and five valves 4 are shown.

Compressed air is supplied through a flexible hose 5 and control valve 50 to a connection at one of the heads 20 of the casing, whence it passes through passage 23 to a chamber 33 within the rotor, between the rotor itself and an inner sleeve 35 which rotates with it. The head 20 is provided with a skirt or sleeve 24 that projects within the chamber 33, and this sleeve 24 is provided with angularly spaced ports 25. The rotor 3 is provided with similar ports 32, which, by the rotation of the rotor, will be brought into registry with the ports 25, and which will remain in registry therewith for a time. The ports 32 terminate exteriorly within the chamber 21, behind each abutment 31. Air escapes from each impulse space defined between succeeding abutments 31 and the rotor and casing by means of an exhaust port 26 through the casing, and into the space between the heads 20, and port 27 permits the air to escape through the head 20 which is opposite that to which the air supply hose 5 is connected.

The type of motor is not in its general principles new, and its operation will therefore be readily understood. Assuming that the rotor rotates clockwise as seen in Figure 3, air admitted through the hose 5 and port 23 is admitted in timed relationship through the ports 25 and 32 into an impulse space behind an abutment, just after the latter has emerged from a pocket 40 in one of the valves 4. Thus in Figure 3 the uppermost abutment is about to receive a charge of air under pressure. The size of this impulse space varies as the air expands, and as this space comes into registry with the next successive exhaust port 26, the pressure is exhausted from this particular space, which by now has been closed off from the air supply chamber 33. The exhaust port 27 may be connected, as suggested by the hose 59 in Figure 1, to and through the opposite head 11 of the cylinder, where it may be controlled by a valve 58, if desired, but ordinarily it may be permitted to discharge into this end of the cylinder 1, and to find its way out through the port 57 in the head 11, which may be left freely open. The space within the cylinder acts similarly to an exhaust muffler, and lessens the noise of the exhaust.

Rotation of the casing 2 relative to the cylinder 1 is prevented by any suitable means, as for instance by means of longitudinal rods 16 secured in the opposite head 10 and 11 of the cylinder, and passing through apertures provided therefor in the circular heads 20 of the casing. Spacers or limit stops 17 may be provided on these rods to limit the axial movement of the casing 2.

Whether as an extension of the tube 13, or as part of the rotor 3, there is provided an inner tubular member 35, which extends between the heads 20 at opposite ends of the casing, and through one of these heads. Suitable rotary bearings 36 may be provided to facilitate the rotation of this tubular member 35 with the rotor, and relative to the casing 2 or its heads 20. All rotary movement of the rotor 3 must be communicated through this tubular member 35 to the drill rod 9, acting through the tube 13, and the tube 13 must likewise transmit axial thrust from the casing 2 to the drill rod 9. It is preferred to divorce the two types of force—torque and axial thrust—so that the rotor is relieved of all axial thrust, which is primarily developed by the casing 2, and to do this there is secured to the projecting end of the tubular member 35 a flange 71 provided with a series of angularly spaced apertures 70, through each of which is freely slidable a thrust pin 7. The thrust pin 7 is secured, in position to transmit thrust, in a flange 75 which is secured upon the adjacent end of the tube 13, and the opposite end of the pin 7 bears upon the inner race 73 of a combined radial and thrust bearing, the opposite race 74 of which bears upon the head 20 of the piston-like casing. In this way drill-rod-advancing thrust from the casing is transmitted through the bearing 74, 73 to the pin 7, and thence to the tube 13, yet no end thrust is transmitted to the rotor 3. The latter, however, through the sliding pin and hole connection at 7 and 70, transmits torque to the tube 13. In effect the tube 13 and the tubular member 35 are continuations one of the other, and the arrangement described is employed primarily to divorce the axial end thrust from the rotor and from its bearings. In Figure 1 no distinction has been made between the tube 13 and the tubular member 35, and if it were not necessary nor deemed desirable to divorce the torque and axial thrust they might be made integral, as shown in Figure 1. Rod-pulling end thrust, to retract the rod or the tube 13, is applied to the latter from the casing 2 through the cage 72, which is secured to the casing and which encloses the flange 75.

Since the casing 2 is in effect a piston, and is provided with packing at 28 and 29, so that it may slide without leakage relative to the cylinder 1 and to the tube 12, respectively, it may be moved lengthwise of the cylinder 1 by providing a suitable fluid pressure supply to accomplish such movement. To this end a fluid pressure supply connection 8 is shown connecting to the end 10 of the cylinder, and a similar connection 80 is shown at the head 11. There may be also a vent connection 81 at the head 10, and a valve 82 is provided at the crossing of the connections 8

and 81, whereby to connect this end of the cylinder either with the pressure source through the conduit 8 or to vent this end of the cylinder through the vent 81. The opposite end would likewise be suitably vented when necessary, communication being through a valve 83. These valves may be suitably controlled manually or otherwise to accomplish the necessary or desired movement of the piston-like casing 2 under the influence of air under pressure or of liquid under pressure. If a liquid is used as the pressure medium, the hose 59 should be employed, so that the pressure medium employed for operating the motor is segregated from the pressure medium used to move the piston, and it is preferred to segregate the motor pressure medium from the piston pressure medium even if the two are alike. Both the movement of the piston and the operation of the motor may be accomplished by the same medium, if air under pressure be chosen as the medium, or they may be operated by different media, that is, the motor by air pressure and the piston by hydraulic pressure.

The arrangement described is ideally suited to the operation of the piston selectively by either pneumatic pressure or, in part, at least, under the control or governance of hydraulic means. The hydraulic means is desirable at times to control the rate of advance, and to check any tendency to too rapid advance, yet under most conditions the advance under pneumatic pressure at as rapid a rate as is feasible is preferred. To accomplish these two ends the arrangement of Figures 4 to 7 inclusive may be adopted. Here a closed liquid reservoir is shown at 6, a compressor at 85, and the latter is connected alternatively to the connection at 8 or at 80, past a four-way valve 86, and through the connections 8 or the connections 87, 80, and the three-way valve 89. The connection between 87 and 80 may be through the three-way valve 89, and by way of a connection 67 they may both be connected to the reservoir 6. The liquid in the reservoir 6 is connected by a conduit 64 and past the valve 65 to the head 11 of the cylinder. The four-way valve 86 is connected to the compressor 85, to the supply connection 8, to the alternative supply connection 87, and to a vent 84.

With parts in the position shown in Figure 4 the compressor 85 is connected through the valve 86 to the supply connection at 8, and liquid contained in the right-hand end of the cylinder is being vented through the connection 64 and open valve 65 back to the liquid reservoir 6. The rate of discharge of the liquid, and therefore the rate of advance of the piston, is controlled by the amount of opening of the valve 65, and in this respect the present arrangement, thus operated, is analogous to the arrangement of my former application. Liquid is prevented from passing out through the passage 80 by the block established by the position of the valve 89, and the latter is so turned as to vent the top of the closed liquid reservoir 6 through the conduit 87, the valve 86, and the vent 84. The piston 2, it is understood, is, in Figure 4, moving to the right at a rate controlled by the size of the orifice through the valve 65, and may move to the right until the liquid is substantially wholly discharged from the right-hand end of the cylinder.

Assuming that the liquid has been thus discharged, and it is desired to retract the piston 2 to the right by air pressure, the valves are placed in the position of Figure 5, and now the compressor 85 is connected through the valve 86, the conduit 87, the valve 89, and the conduit 80, to the head 11 of the cylinder. No liquid can enter the cylinder by reason of closure of the valve 65, and further by reason of the block established by the position of the valve 89 which prevents entrance of air to the top of the reservoir 6. The left-hand end of the cylinder is vented through the connection 8 and the valve 86 to the vent 84. As a result the piston 2 moves to the left under the influence of air under pressure only, and all the liquid remains within the liquid reservoir 6.

If it is desired to advance the piston, and consequently the connected drill rod, that is, to move it to the right as seen in Figure 6, and to do this solely by air pressure, without any impedance by a liquid resistance, the valves are placed in the positions of Figure 6. Now since the liquid valve 65 remains closed, there is no possibility of liquid entering the right-hand end of the cylinder or opposing movement of the piston. Air from the compressor enters past the valve 86 and the supply connection 8, and the opposite end of the cylinder is vented through the connection 80, the valve 89, the conduit 87, and the valve 86 to the vent 84. The result is the piston is pneumatically moved to the right, to cause its advance.

If it is desired to draw liquid into the right-hand end of the cylinder, preparatory to advancing the piston, under the governing impedance of the liquid, as in Figure 4, this may be accomplished by positioning the valves as shown in Figure 7. Here the left-hand end of the cylinder is vented through the connection 8, the valve 86, and the vent 84, while air pressure is communicated through the valve 86, the conduit 87, and the valve 89, to the connection 67 at the top of the closed liquid reservoir, whereupon the liquid is forced out of the reservoir, and rises in the conduit 64 through the now open valve 65, and into the right-hand end of the cylinder. The connection 80 is closed at the valve 89, so there is no escape of pressure in this direction, therefore the piston 2 moves to the left under the influence of pressure, and while this may be considered as hydraulic pressure, the hydraulic pressure is in this instance generated by the air pressure upon the surface of the liquid within the reservoir.

In such an arrangement, it will be observed, the liquid reservoir is separate from the diamond drill feed cylinder, and may be placed somewhat distant from the latter, and need not be shifted in position with the cylinder, during normal use. Only the valves and connections need be located near the feed cylinder and when the feed cylinder is adjusted into various positions and disposed at different angles, it may the more readily be moved about thus, since the liquid reservoir forms no part of the feed cylinder. Thus the arrangement is made light and compact, and is further made compact by reason of the inclusion of the rotating motor within the cylinder as the piston therein.

What I claim as my invention is:

1. A diamond drill or the like comprising a casing and a rotor therein, means to connect said casing and rotor to a drill rod for conjoint movement, a cylinder receiving said casing and guiding the same for axial movement, means to advance the casing and the rotor and drill rod axially of the cylinder, means, independent of the advancing means, and operable during axial advance of the casing, to rotate the rotor and drill rod relatively to the casing, and control means

operable to vary relatively the speed of rotation and force effecting axial translation of the drill.

2. A diamond drill or the like comprising a non-rotative cylindrical casing and a rotor therein, a chuck formed and arranged for connection to the drill rod for conjoint movement, a tube carrying said chuck and operatively connected to the rotor, a thrust bearing between the chuck and the rotor's casing, a cylinder receiving said casing and guiding the same for axial movement, means to effect advance of the casing, and the rotor and drill rod, in a direction axially of the cylinder, and means, operable during axial advance of the casing, to rotate the rotor and drill rod relatively to the casing and cylinder.

3. A diamond drill or the like comprising a cylindrical axially apertured casing, a rotor having an axial aperture of a size to receive the drill rod, and itself received in said casing, rotative and axial thrust bearings between the rotor and the casing, a cylinder enclosing the casing and guiding it for axial reciprocation, means to prevent relative rotation between the cylinder and the casing, each head of the cylinder having a central aperture, aligned with the rotor's and the casing's apertures, through all of which the drill rod may pass, a pair of telescoping tubes, one received in the aperture in one cylinder head, and passing through the aperture of the casing, and the other secured to the rotor and extending through the opposite cylinder head, whereby to engage the drill rod for movement conjointly with said tube and rotor, packing means to seal the two ends of the cylinder, and the casing relative to the cylinder, means to supply a fluid pressure medium within the cylinder to effect axial movement of the casing and connected elements, and means to supply a pressure medium within the casing to effect rotary movement of the rotor and connected elements.

4. A diamond drill or the like comprising a cylindrical axially apertured casing, a rotor having an axial aperture of a size to receive the drill rod, and itself received in said casing, rotative and axial thrust bearings between the rotor and the casing, a cylinder enclosing the casing and guiding it for axial reciprocation, means to prevent relative rotation between the cylinder and the casing, each head of the cylinder having a central aperture, aligned with the rotor's and the casing's apertures, through all of which the drill rod may pass, a pair of telescoping tubes, one received in the aperture in one cylinder head, and passing through the aperture of the casing, and the other secured to the rotor and extending through the opposite cylinder head, whereby to engage the drill rod for movement conjointly with said tube and rotor, packing means to seal the two ends of the cylinder, and the casing relative to the cylinder, means to supply a fluid pressure medium within the casing to effect rotary movement of the rotor and connected elements, means to supply a pressure medium within one end of the cylinder to effect axial advance of the casing and connected elements, the discharge from within the casing passing into the opposite end of the cylinder, such latter end of the cylinder being ported for escape of such discharge.

5. A diamond drill or the like comprising a cylindrical axially apertured casing, a rotor having an axial aperture of a size to receive the drill rod, and itself received in said casing, rotative and axial thrust bearings between the rotor and the casing, a cylinder enclosing the casing and guiding it for axial reciprocation, means to prevent relative rotation between the cylinder and the casing, each head of the cylinder having a central aperture, aligned with the rotor's and the casing's apertures, through all of which the drill rod may pass, a pair of telescoping tubes, one received in the aperture in one cylinder head, and passing through the aperture of the casing, and the other secured to the rotor and extending through the opposite cylinder head, whereby to engage the drill rod for movement conjointly with said tube and rotor, packing means to seal the two ends of the cylinder, and the casing relative to the cylinder, a hose extending through an end of the cylinder and connected to the casing within to supply a fluid pressure medium to rotate the rotor and connected elements, other means to supply a pressure medium within one end of the cylinder to advance the casing, as a piston, and connected elements axially, the discharge from within the casing passing out at the opposite end of the cylinder, such latter end of the cylinder being ported for escape of such discharge.

6. A diamond drill or the like comprising a cylindrical axially apertured casing, a rotor having an axial aperture of a size to receive the drill rod, and itself received in said casing, rotative and axial thrust bearings between the rotor and the casing, a cylinder enclosing the casing and guiding it for axial reciprocation, means to prevent relative rotation between the cylinder and the casing, each head of the cylinder having a central aperture, aligned with the rotor's and the casing's apertures, through all of which the drill rod may pass, a pair of telescoping tubes, one received in the aperture in one cylinder head, and passing through the aperture of the casing, and the other secured to the rotor and extending through the opposite cylinder head, whereby to engage the drill rod for movement conjointly with said tube and rotor, packing means to seal the two ends of the cylinder, and the casing relative to the cylinder, means to supply a fluid pressure medium within the casing to effect rotary movement of the rotor and connected elements, means to supply a pressure medium within one end of the cylinder to effect axial advance of the casing and connected elements, the discharge from within the casing passing into the opposite end of the cylinder, such latter end of the cylinder being ported for escape of such discharge, and means to supply a pressure medium within the latter end of the cylinder, and to vent its opposite end, to retract the casing and connected elements.

7. A diamond drill or the like comprising a cylindrical axially apertured casing, a rotor having an axial aperture of a size to receive the drill rod, and itself received in said casing, rotative and axial thrust bearings between the rotor and the casing, a cylinder enclosing the casing and guiding it for axial reciprocation, means to prevent relative rotation between the cylinder and the casing, each head of the cylinder having a central aperture, aligned with the rotor's and the casing's apertures, through all of which the drill rod may pass, a pair of telescoping tubes, one received in the aperture in one cylinder head, and passing through the aperture of the casing, and the other secured to the rotor and extending through the opposite cylinder head, whereby to engage the drill rod for movement conjointly with said tube and rotor, packing means to seal the two ends of the cylinder, and the casing relative to the cylinder, two

lengths of hose, one extending through each end of the cylinder, and connected, one to the supply connection of the casing, and one to the discharge from the casing, whereby to supply a fluid pressure medium to, and to discharge it from the casing and exteriorly of the cylinder, to rotate the rotor and connected parts, and means to supply a different fluid pressure medium within the cylinder, to effect axial movement of the casing and connected elements.

8. A diamond drill or the like comprising a cylindrical axially apertured casing, a rotor having an axial aperture of a size to receive the drill rod, and itself received in said casing, rotative and axial thrust bearings between the rotor and the casing, a cylinder enclosing the casing and guiding it for axial reciprocation, means to prevent relative rotation between the cylinder and the casing, each head of the cylinder having a central aperture, aligned with the rotor's and the casing's apertures, through all of which the drill rod may pass, a pair of telescoping tubes, one received in the aperture in one cylinder head, and passing through the aperture of the casing, and the other secured to the rotor and extending through the opposite cylinder head, whereby to engage the drill rod for movement conjointly with said tube and rotor, packing means to seal the two ends of the cylinder, and the casing relative to the cylinder, two lengths of hose, one extending through each end of the cylinder, and connected, one to the supply connection of the casing, and one to the discharge from the casing, whereby to supply a fluid pressure medium to, and to discharge it from the casing and exteriorly of the cylinder, to rotate the rotor and connected parts, means to supply another fluid pressure medium within the cylinder at either end, and means operable to control supply of such fluid to one end or the other of the cylinder, and its discharge from the opposite end, to effect and control the direction of axial movement of the casing and connected elements.

9. A feed for a diamond drill or the like comprising a cylinder, a piston reciprocable therein, rotor means within said piston, means to connect said rotor means and said piston to a drill rod to move the latter axially, means to supply a fluid pressure medium to the piston and rotor to rotate the latter, and to rotate the drill rod connected thereto, means to supply air under pressure within either end of the cylinder, means to supply liquid under pressure within one end of the cylinder, and valve means to control and govern the supply and discharge of the fluid pressure media supplied to the cylinder, thereby to effect and govern the axial movement of the piston, and of the drill rod.

10. A diamond drill or the like comprising a casing and a fluid driven rotor therein, a cylinder receiving said casing and guiding the same for axial movement, means to connect said casing and said rotor means to a drill rod, means to advance the casing and rotor axially of the cylinder, and flexible fluid supply means extending from the exterior of the cylinder therethrough to said casing and rotor of a length to supply driving fluid under pressure directly to the rotor in all operative positions of the casing lengthwise of the cylinder, for rotating the drill in any operative position of translation axially.

11. A diamond drill or the like comprising a casing and a fluid driven rotor therein, a cylinder receiving said casing and guiding the same for axial movement, means to connect said casing and said rotor means to a drill rod, means to advance the casing and rotor axially of the cylinder, two hoses one extending through each end of the cylinder and connected to the casing and rotor, for supply of fluid under pressure thereto and for discharge of fluid therefrom to the exterior of the cylinder, respectively, to effect rotation of the rotor, said hoses being of sufficient length to communicate with the casing and rotor in all operative positions of the casing and rotor lengthwise of the cylinder, and means operable to regulate flow of fluid through said hoses for controlling the speed of drill rotation independently of the position of or force effecting drill translation axially.

12. A feed for a diamond drill or the like comprising a cylinder, a piston reciprocable therein, means to connect said piston to a drill rod to move the latter axially, means operable to supply air under pressure during the piston's working stroke to the end of said cylinder remote from the cutting end of the drill rod, and alternatively operable to vent such cylinder end during the piston's return stroke, liquid filling the other end of the cylinder during such working stroke, such cylinder end having a restricted outlet for flow of liquid therefrom at a controlled rate, thereby to limit the rate of piston movement during its working stroke effected by the air under pressure, and means selectively operable to supply under pressure either liquid or air, during the piston's return stroke, to such other end of the cylinder for returning the piston.

13. A feed for a diamond drill or the like comprising a cylinder, a piston reciprocable therein, means to connect said piston to a drill rod to move the latter axially, means operable to supply air under pressure during the piston's working stroke to the end of said cylinder remote from the cutting end of the drill rod, and alternatively operable to vent such cylinder end during the piston's return stroke, and valve means selectively operable to supply under pressure either liquid or air, during the piston's return stroke, to the other end of the cylinder for returning the piston, and alternatively operable to afford discharge of liquid or air from such cylinder end during such working stroke, said valve means including means to limit the rate of such discharge when the cylinder contains liquid, thereby to limit and control the rate of piston movement during its working stroke effected by the air under pressure.

14. A feed for a diamond drill or the like comprising a cylinder, a piston reciprocable therein a rotor within said piston, means to connect said rotor and said piston to a drill rod to move the latter axially, means to supply air under pressure during the piston's working stroke to the end of said cylinder remote from the cutting end of the drill rod, to feed said piston forward, and to rotate the rotor and the drill rod connected thereto, liquid filling the other end of the cylinder, such cylinder end having an outlet for flow of liquid therefrom, and valve means independent of the air supply means to control the rate of discharge of liquid through such outlet, thereby to limit and control the rate of piston movement effected by the air under pressure irrespective of the supply or pressure of such air.

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