United States Patent

[11] **3,568,779**

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[21] Appl. No. **859,288**
[22] Filed **Sept. 19, 1969**
[45] Patented **Mar. 9, 1971**

[54] **UNDERGROUND ROTARY DRILL**
12 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **173/44,** 173/28, 173/160
[51] **Int. Cl.** **E21c 11/02**
[50] **Field of Search** 173/23, 28, 160, 43, 44; 74/424.8, 841

[56] **References Cited**

UNITED STATES PATENTS

2,375,991	5/1945	Hoffar	74/841
3,258,983	7/1966	Valenti	74/424.8X
3,454,114	7/1969	Poage	173/28

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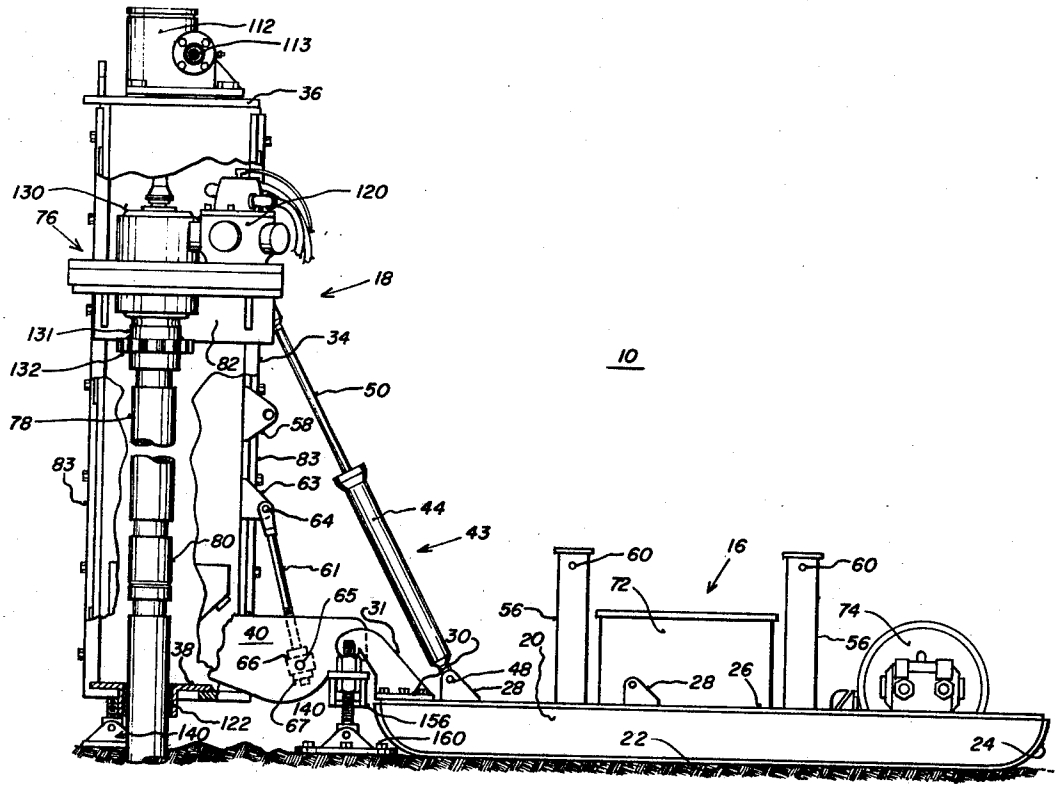
ABSTRACT: A rotary drilling apparatus of the portable type having a two-part frame including a base and head which are pivotally adjustable relative to one another with the headframe carrying the drill and feed structure. The headframe incorporates a feed drive in the form of a ball-screw arrangement which supports the cross head carrying the drill and motor for the same to reduce the overall size and length of the supporting structure for the drill and feed motors. This provides a compact drilling apparatus particularly adaptable for drilling sites having a minimum of head room.



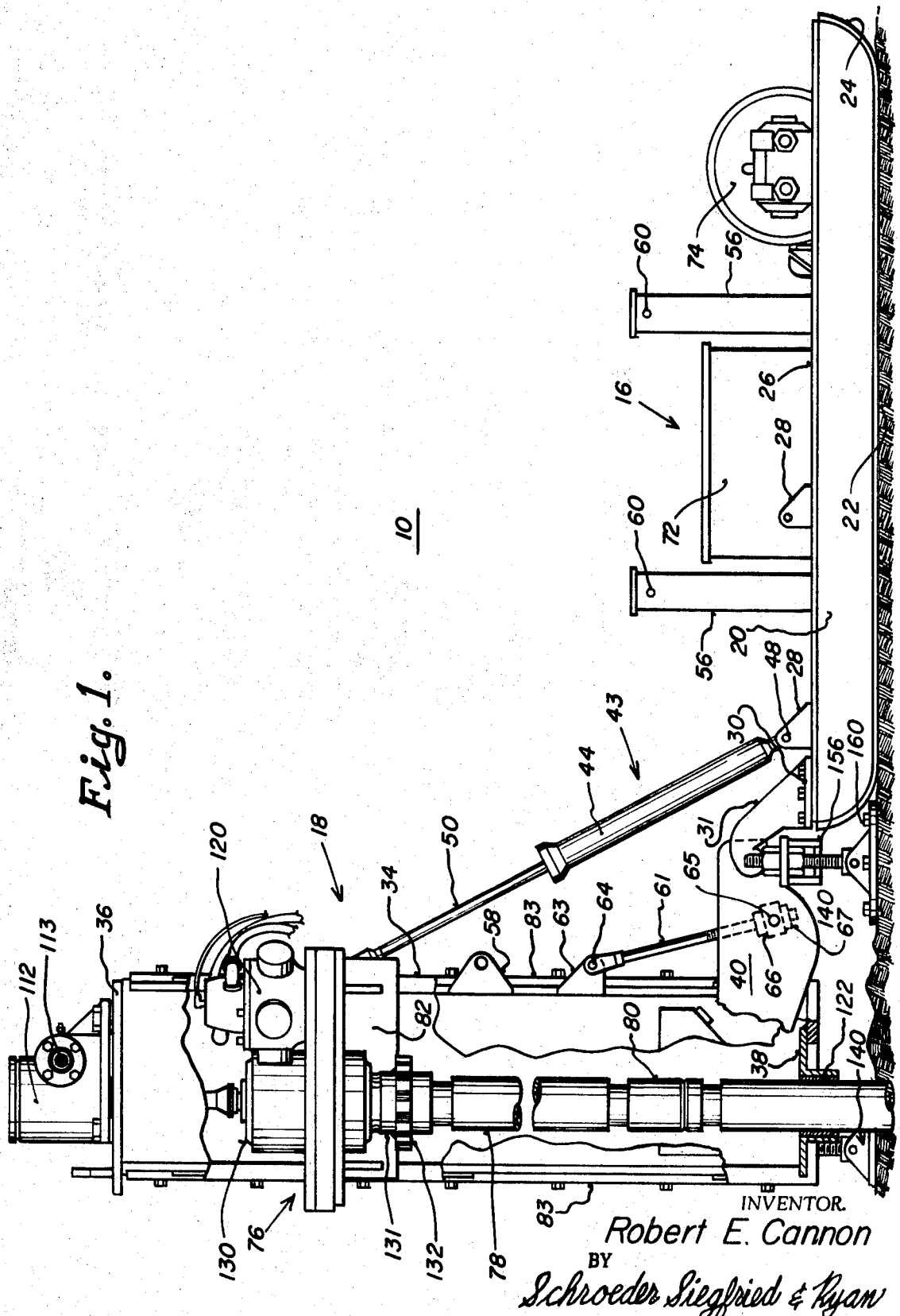


Fig. 1.

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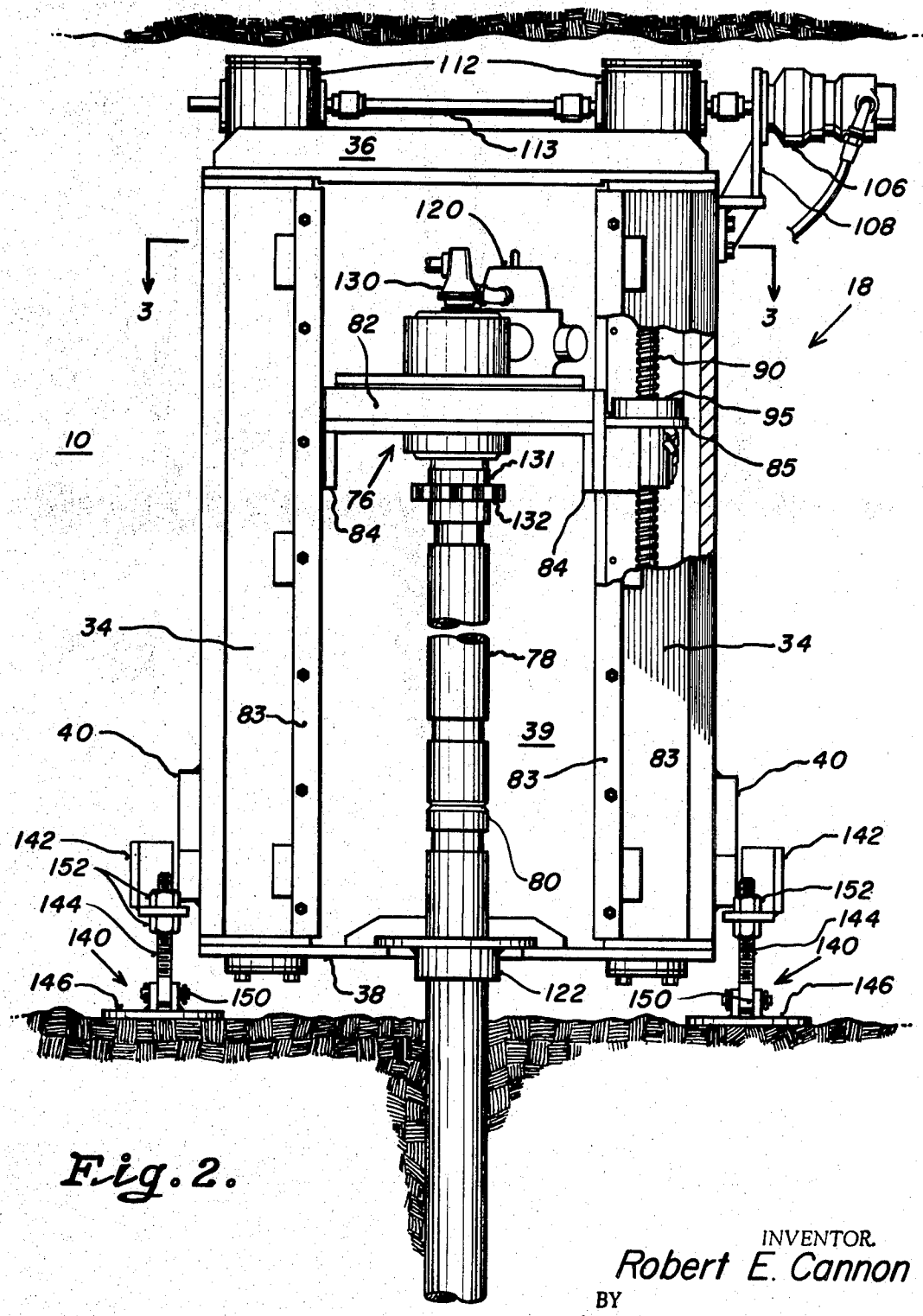

Fig. 2.

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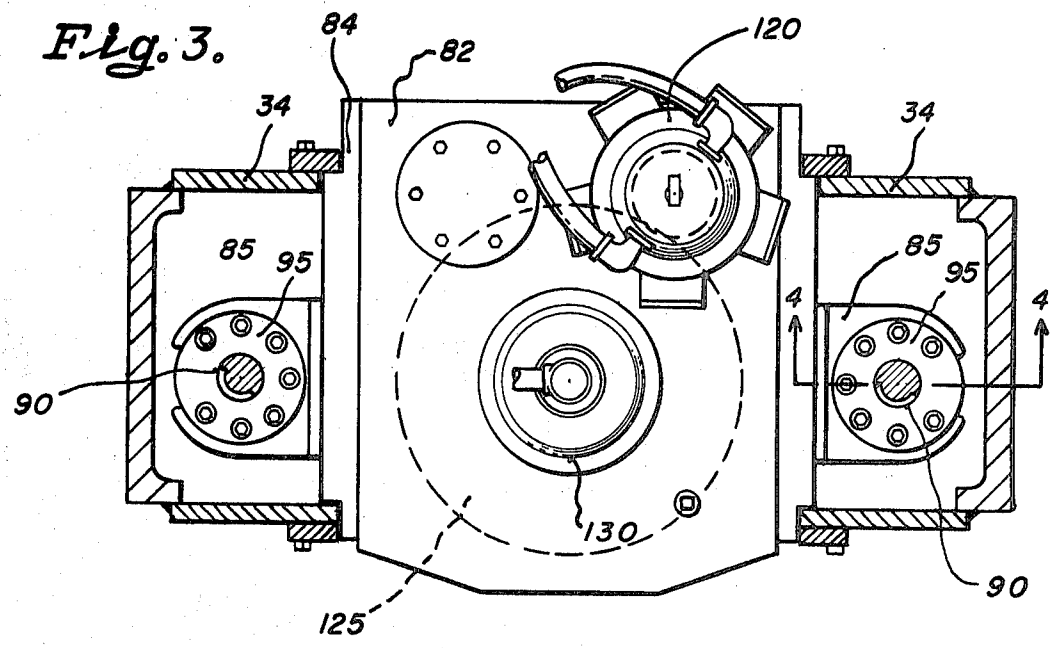
Fig. 3.



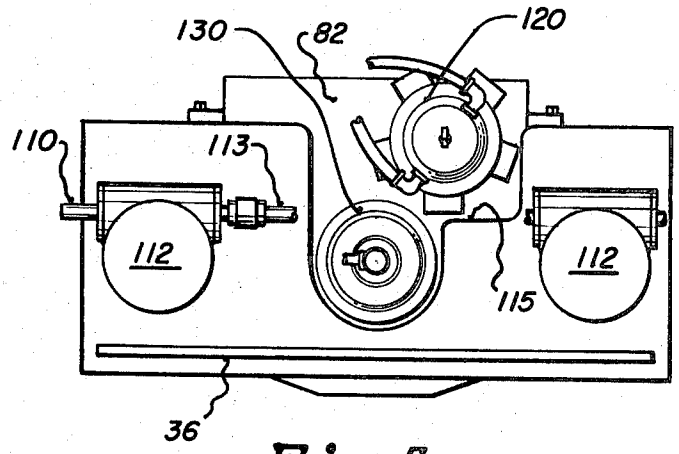


Fig. 5.

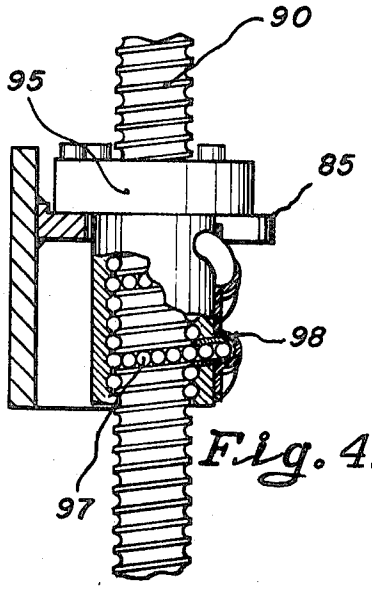


Fig. 4.

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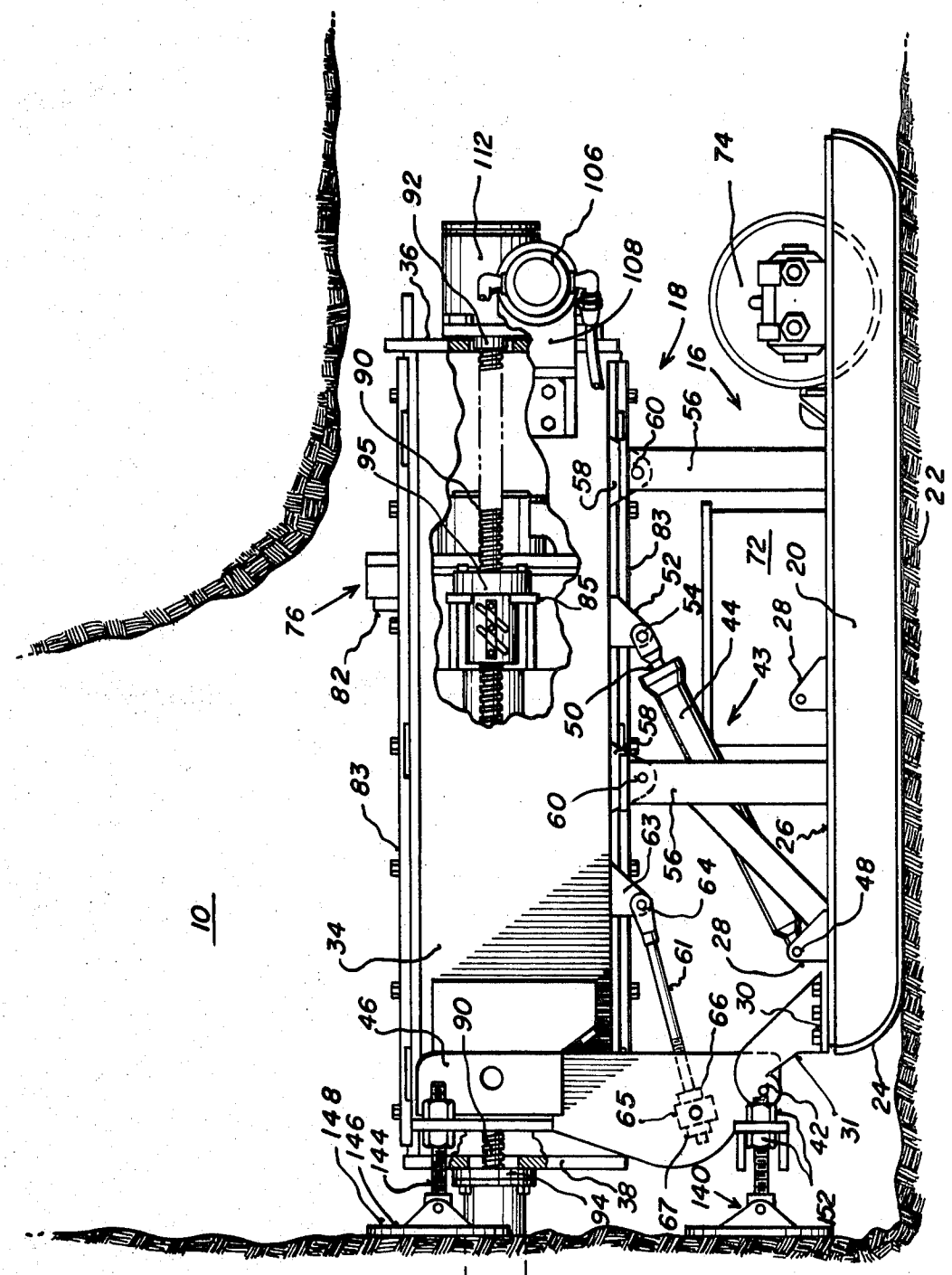

Fig. 6.

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UNDERGROUND ROTARY DRILL

The present invention relates to rotary drilling apparatus and more particularly to an improved rotary drilling apparatus of the hydraulically powered type which is compact in design with an improved drill feed mechanism and is particularly adapted for underground drilling applications in areas of restricted dimension.

Rotary drilling apparatus is conventionally employed in all types of mining construction and exploration operations. Drill rigs utilized under such conditions are portable, and it is generally provided that a drill head be moved longitudinally on the rig or base in guides as a function of the drilling operation. Further, such apparatus have been constructed to drill at angles to the surface upon which the rig or apparatus is positioned. However, such prior apparatus has generally been exceedingly complex in design and of such physical size as to be limited in application to surface level drilling. In particular, such prior apparatus require considerably larger and longer feed structures and supporting apparatus than the length of drill stroke to significantly increase the physical size of the apparatus. Where such structures have been used in underground mining, the site of operation must be exceedingly large so as to greatly limit the application of the same.

In the present invention, an improved rotary drilling apparatus is provided which is particularly applicable to restricted size drilling sites, such as underground locations, and which is adaptable for drilling at varying angles in such locations with a minimum of setup time and without any special requirement for anchoring the apparatus. In the improved drilling apparatus, a mobile or movable base is provided which mounts an adjustably positioned headframe carrying a cross head which mounts the rotary drill and the apparatus for advancing and retracting the same. In the improved rotary drilling apparatus, a special feed structure permits the stroke length of the drill to approach the overall height of the apparatus and eliminates the necessity of long length linear actuators and supports for the same which greatly extend the overall height of the apparatus beyond the length of drill stroke. Thus, the improved drilling machine requires a minimum of height and base area at a drilling site. In addition, the supporting headframe is suitably anchored through a simple anchoring plate carried thereby to provide a rigid drill base for the apparatus. The improved rotary drilling apparatus incorporates hydraulic motors operated from a hydraulic source mounted on the base to provide a compact, substantially self-contained, drilling rig.

Therefore, it is the principal object of this invention to provide an improved rotary drilling apparatus of the portable type.

It is also an object of this invention to provide in a rotary drilling apparatus a simplified compact feed mechanism.

Another object of this invention is to provide in the rotary drilling apparatus an improved feed arrangement utilizing a recirculating ball-screw mechanism to impart variable longitudinal force and speed to the drill head.

A further object of this invention is to provide in an improved rotary drilling apparatus a simplified feed arrangement comprised of a ball-screw drive operated from fluid actuators to provide a variable drilling force to a drill stem and feed motion for advancing and retracting the drill stem from a structure whose length dimension is substantially coextensive with a drill stroke.

Another object of this invention is to provide in an improved rotary drilling apparatus a simplified combination of rotary hydraulic motors for moving the drill stem and drill bed through a variable speed range for variable drilling applications.

A still further object of this invention is to provide an improved drilling apparatus incorporating a portable skid structure and an overall drilling apparatus of physical size to enable drilling operation at drill sites having restricted dimensions.

It is also an object of this invention to provide a simplified rotary drilling structure with a simplified anchoring arrangement to stabilize drilling operation.

Another object of this invention is to provide an improved rotary drilling apparatus particularly adaptable for underground locations which is simple in construction, efficient in operation, dependable, and easy to use.

These and other objects of this invention will become apparent from a reading of the attached description together with the drawings, wherein:

FIG. 1 is a side elevation view of the improved drilling apparatus of the present invention;

FIG. 2 is an end elevation view of the improved drilling apparatus with parts broken away;

FIG. 3 is a sectional view of the improved drilling apparatus of FIG. 2 taken along the lines 3–3 therein;

FIG. 4 is a sectional view of a portion of the improved drilling apparatus taken along the lines 4–4 in FIG. 3;

FIG. 5 is a top view of the improved drilling apparatus; and

FIG. 6 is a side elevation view of the improved drilling apparatus oriented in a horizontal condition to illustrate boring a hole with the same in a vertical phase.

In the drawings, the improved and compact rotary drilling assembly or apparatus is generally designated at 10. This improved drilling apparatus is particularly adaptable for drilling in underground sites and under conditions where a minimum of head room is available for a drilling operation. In addition, this improved drilling apparatus will drill holes at a plurality of angles varying from normal to the surface on which the drill is positioned, as indicated in FIG. 1, to a substantially horizontal position, as indicated in FIG. 6, and varying angular positions therebetween. In the improved rotary drilling assembly, this compactness or reduction in overall height size is made possible through an improved feed drive structure, to be hereinafter described, which greatly reduces the overall length of the feed supporting or headframe such that such dimensions approach the actual feed stroke. This shape and arrangement of parts is set forth hereinafter.

The drill assembly includes two basic components, namely a base frame, indicated generally at 16, and a headframe, indicated generally at 18, which frames or structures are pivotally interconnected at one end of the same to permit the headframe to be pivoted between a plurality of angular positions extending over substantially 90° relative to the supporting base frame for a plurality of drilling angles or positions. The base frame 16 includes a supporting frame structure 20 having runners or skids 22 positioned at the base of the same which are curved at the extremities, as indicated at 24, to facilitate movement or portability of the drilling apparatus. The upper surface of the supporting frame 20 is flanged, as at 26, and a plurality of transversely extending pivot flanges 28 are connected thereto, as indicated in FIGS. 1 and 6. In addition, one end of the base frame or frame structure 20 mounts a transversely extending bracket assembly 30 with a pair of pivot flanges 31 formed integral therewith and located on opposite sides of the supporting frame 20 for the purpose of mounting the headframe 18.

The headframe 18, as will be best seen in FIGS. 1 and 2, includes a pair of parallel side frame or column members 34 interconnected at the top by a cross frame member 36 and at the bottom by a bottom frame member or guide 38 forming a generally rectangular structure with an interior opening 39. Attached to each side column at the lower edge thereof is a pivot bracket plate 40 which is welded or otherwise suitably secured thereto and includes at its free extremity an aperture (not shown) coinciding with a similar aperture (not shown) in the flanges 31 to mount a pivot pin 42 for pivoting the headframe on the base frame. This pivot pin defines a pivot axis between the headframe 18 and the base frame 16 which is offset from the general extent of either structure through the location of the same at the ends of the brackets 30 and 40 such that the headframe may be pivoted to a position substantially parallel with the extent of the base frame for a transport or drill position, as indicated in FIG. 6.

The positioning of the headframe 18 about the axis of the pivot pins or bolts 42 connecting the headframe and base

frame is effected through the use of a pair of hydraulic actuators, generally indicated at 43, which include a double acting hydraulic cylinder 44 pivotally attached to one of the upstanding flanges 28 on the base frame through pivot pins 48 which attach the cylinder 44 of the actuator thereon. The shaft extremities 50 of the actuators are similarly pivotally connected to upstanding flanges 52 on the side columns 34 of the headframe through pivot pins or bolts, indicated generally at 54. The actuators 43 are positioned on each side of the base frame and headframe and the application of hydraulic fluid under pressure to one or the other end of the actuator will effect a raising or lowering of the headframe 18 relative to the base frame 16 or pivoting the same on its pivot structure relative thereto to adjust the angular relationship between these parts of the drill assembly. In addition, the base frame 16 includes a pair of upright supports or props 56 secured to the base support frame structure 20 which provide a rest or stop for the headframe 18 when pivoted onto the base frame in the parallel relationship therewith or for transport purposes, as shown in FIG. 6. The upper ends of these support or prop members cooperate with similar transversely extending flanges 58 suitably attached to the column members 34 of the headframe and aligning therewith in the horizontal relationship between the head and base frames to secure the parts in the rest or transport position. The flanges 58 include apertures therein and which align with cooperating apertures 60 in the upright support or prop member 56 such that suitable pins (not shown) may be placed therethrough to lock the structure for horizontal drilling or for transport.

In addition to the actuators 43 which adjust the angular position of a headframe relative to the base frame, suitable threaded tie rods 61 are connected on each side of the headframe at supporting flanges 63 through a pivotal connection 64 and coupled with a pivoted coupling 65 mounted on the pivot plates 40 to permit the adjustment of nuts 66, 67 on the threaded tie rods 61 so that the headframe may be locked in any desired angular position relative to the base frame and maintained in such a relationship during a drilling operation after being adjusted thereto through operation of the actuators 43. The base frame 16 also mounts the hydraulic or fluid power supply for operation of the actuators 43 and the remaining actuators of the drilling mechanism and feed mechanism, as will be hereinafter defined. Thus, as will be seen in FIGS. 1 and 6, the supporting frame structure 20 of the base frame includes a hydraulic supply tank 72 and a suitable motor pump assembly 74 which will be operative to pump fluid under pressure from the supply tank through suitable hoses (not shown) and controlled by suitable control valves (not shown) to the extremities of the actuators 43 and the remaining actuators of the drilling assembly. It will be understood, however, that the control motors may be electric or pneumatic within the principles of the present invention.

The headframe 18 is designed to mount a cross head assembly, indicated generally at 76, which drives a drill stem 78, such that it rotates and feeds the same in the drilling operation. Such a drill stem is normally of a hollow metal construction or predetermined length coupled together with a coupling, such as is indicated at 80. Individual drill sections or stem sections 78 are shorter than the total travel of the cross head in the headframe to enable the assembly of the drill stem during a drilling operation and disassembly thereof as sections are added to the drill or the drill is removed from a bore hole. The cross head 76 includes a head housing 82 which extends across the open area 39 between the side columns 34 of the headframe and includes a pair of vertical side plate members 84 designed to guide movement of the cross head between the side columns in the feed direction. Similarly, guide strips 83, adjustably secured to the face of the side columns, cooperate in guiding the cross head on the headframe 18. The cross head housing includes flange sections 85 which extend into the open area in the side column members 34, the latter being generally channel shaped in form to facilitate mounting of the cross head in the headframe, as will be hereinafter defined.

The side column or members 34 enclose and mount elongated drive screws 90 which are journaled in the end of the same through suitable journal means, indicated at 92 at the upper extremity, and at 94 at the lower extremity of the column members. The drive screws have a helical screw surface therein designed to receive a ball bearing or a series of ball bearings in a conventional recirculating bearing screw-type drive structure. The flange extremities 85 of the cross head housing 82 mount the recirculating ball bearing housing, which is indicated at 95, on the screws 90 for the purpose of feeding the cross head assembly 76 in the headframe. The sectional view in FIG. 4 shows a plurality of ball bearings 97 in a helical enclosed housing 98 which recirculate in the grooves of the screws to effect a conventional drive screw ball bearing type actuator. In this arrangement of parts, the recirculating housing is fixed rather than movable, and mounts the cross head assembly 76 on the screws 90 in the headframe or the side columns 34 thereof, and the screws 90 are rotated simultaneously in the same direction to effect the feed movement by moving the recirculating housings and hence the cross head housing 82 to which they are attached up and down the length of the screws 90 for the feed movement.

The drive for the feed screws 90 in each of the side columns is effected from a single motor, indicated at 106, which is mounted on a flange 108 on one of the side columns. It is coupled through by it output shaft 110 to a pair of gear transmissions 112 connected to the ends of each of the drive screws. The gear transmissions 112 are mounted on the top frame member 36 which is recessed, as at 115, (see FIG. 5) for purposes to be later noted. An extension of the shaft 110, as indicated at 113, extends between the gear housings 112 associated with each of the screws 90 in the side columns to effect simultaneous rotation in the same direction of the drive screws. The gear housings 112 are conventional and merely direct the rotational movement of the output shaft 110 to the drive screws located normal to the extent of the same.

The upper cross brace or frame 36 at the end of the column members 34 of the headframe mounts the shafts 113 and the gear housings 112 and this cross brace assembly is notched or other wise recessed, as at 115, to permit full movement of the cross head assembly 76 in the headframe 18 and clearance for the drive motor 120 and pneumatic coupling 130 for the drill mounted thereon. The lower extremity of the headframe or the cross brace 38 connected thereto includes a guide sleeve 122 for the drill stem which guide sleeve is removable and adjustable for varying sized drill stems.

The cross head housing or the cover portion thereof (not shown) mounts the drive motor 120 for the drill stem, which motor is offset from the geometric center of the housing and the drill axis or axis of rotation of the drill stem 78 and is coupled thereto through suitable gearing, indicated in phantom at 125 positioned in the housing 82 in FIG. 3. The motor 120 may use any power source and, in the present disclosure, it is hydraulic to be compatible with the hydraulic power supply being coupled thereto through suitable hoses (not shown). In addition housing 82 mounts the rotary pneumatic coupling 130 which permits the introduction of air under pressure into the interior of the drill stems 78 through the housing for the purpose of removing cores therefrom The output of the rotary motor 120 connected through gearing 125 within the housing drives an output shaft 131 having an extremity with internal threading therein (not shown) by means of which the drill stems or sections 78 are attached. A suitable notched flange 132 is mounted on the output shaft 131 of the cross head assembly to permit movement of the shaft independent of the drive motor through a suitable tool or wrench (not shown) for connection and disconnection of the drill stem sections.

The headframe 18 includes anchoring plates 140 connected thereto which serve to secure the headframe to the surface being drilled or in which the bore hole is to be drilled for the purpose of stabilizing the drill assembly during the drill operation. Thus, the side plates 40 connected to the column members 34 of the headframe have a flange portion 142 through

which a bolt member 144 extends, the bolt member having pivotally connected thereto a platelike anchor member 146 with suitable anchoring holes 148 therein. The plate member is mounted on the extremity of the threaded bolt 144 through a pivot member 150 and nuts 152 positioned on the bolt on either side of the flange 142 permits vertical adjustment of the same. A pair of anchoring plates are mounted on each side of the headframe near the forward extremity thereof and a similar pair of plates are connected through a flange portion 156 on the opposite extremity of the pivot plates 140 near the flanges 31 connected to the base frame. This assembly secures the headframe and also the base frame to the surface being worked for the drilling operation. Suitable anchoring bolts, indicated generally at 160, extend through the apertures 148 in the mounting plates 140 to secure the plates to the ground and hence the drilling rig for stability purposes.

As indicated in FIGS. 1 and 6, the improved drilling apparatus may be oriented in any position from the horizontal drilling attitude to a vertical drilling attitude or any intermediate angular position and the anchoring plates 140 secured to the surface to be drilled for stability purposes. The simplified anchoring structure and the low profile headframe with a minimum amount of weight compared to compatible drilling structures permit a simplified anchoring of the headframe assembly and hence the drilling apparatus to the drilling surface through anchoring bolts for any desired position without the requirement of special mounting surfaces or complex anchoring arrangements. In the improved drilling apparatus, the use of the ball-screw drive for mounting and advancing the cross head assembly with the drill motor and drill stem thereon eliminates any extension of the supporting structure and places the actuators within the confines of the headframe so as not to enlarge or extend the supporting structure for the same. The improved ball-screw drive arrangement permits an infinite feed range or speed of rotating for driving the motor for drilling in varied types of materials. Similarly, the variable speed drive motor is adjustable and compatible with the feed rate for a variety of drilling applications. The improved drilling apparatus is particularly adaptable for underground mining or drilling in that its low profile and compactness requires a minimum of head room making the structure applicable or available for drilling at sites with a minimum of head room and under an increased number of applications.

While the feed motor and drive motor for the drill stem have been shown to be as hydraulic herein, it will be readily understood that any fluid or air motor or electric motor may be employed for this purpose. The structure is adaptable for varying sized drill stems and varying sized drill holes may be drilled with this structure. The adjustability or removability of the guide sleeve 122 in the base of the head frame permits interchange of such guide structures for varying sized drill stems. As an example of the compactness of structure and versatility of the drill, an overall height of the headframe of approximately 7 feet is required in a structure in which the feed movement is approximately 5½feet. This permits interchange of the stem sections and an efficient drilling operation with a minimum of elevated mass and drill and feed supporting structures to improve increased stability in a drilling apparatus while permitting a simplified base mass and anchoring arrangement for the same. Comparable equipment for each feed range employs supporting structures having an overall height or length of several times the feed range. Similarly, the entire structure may be collapsed to the horizontal position for storage and transportation purposes requiring a minimum of space for clearance for the same.

I claim:

1. A drilling machine comprising, a base frame, a headframe, pivot means included in part at one extremity of the base frame and at one extremity of the headframe and pivotally mounting the headframe on the base frame for angular adjustment relative thereto, said headframe having side supporting column members and cross bracing at the extremities of the same defining an open interior therebetween, screw means positioned in each of the side columns and extending along the extent of the same parallel to one another being journaled on the headframe, a cross head positioned between the column members and extending across the open interior of the headframe being mounted on the screw means, recirculating bearing means positioned in the extremities of the cross head and mounting the cross head on the screw means in the column members, means positioned on the headframe for providing relative movement between the screw means and the recirculating bearing means to move the cross head relative to the column members along the extent of the headframe and with a reciprocating movement, and rotary motor means positioned on the cross head and including means for mounting a drill stem such that the drill stem is rotated in the cross head and reciprocated in the headframe.

2. The drilling machine of claim 1 in which the means positioned on the headframe and providing relative movement between the recirculating bearing means and the screw means is a motive means connected to the screw means for rotating the same simultaneously and at the same speed of rotation.

3. The drilling machine of claim 2 in which the motive means coupled to the screw means includes a fluid motor mounted on the headframe and coupled to the screw means in the column members through gearing for simultaneous rotation of the same.

4. The drilling machine of claim 2 in which the headframe includes guide means positioned on the column members and cooperating with the cross head to guide the same for reciprocating motion to advance and retract the drill stem in a drilling operation.

5. The drilling machine of claim 2 in which the base and headframes are elongated members of substantially the same length and width dimension and in which the base frame includes skid means mounted on the same for positioning the drilling machine.

6. The drilling machine of claim 1 and including anchor means positioned at the pivoted extremity of the headframe being adjustable longitudinally relative thereto and adapted to secure the headframe to the surface into which the drill stem is to be positioned.

7. The drilling machine of claim 2 in which the motive means rotating the screw means and the motive means on the cross head rotating the drill stem are rotary fluid motors and including a source of fluid power positioned on the base frame and adapted to be connected to said rotary fluid motors.

8. The drilling machine of claim 1 and including linear actuator means connected between the base frame and headframe for pivoting the headframe relative to the base frame for varying angular positions.

9. The drilling machine of claim 8 and including adjustable stop means connected between the base frame and headframe for maintaining the headframe in any desired angular position relative to the base frame.

10. The drilling machine of claim 1 and including electric motor means and pump connected through a source of hydraulic fluid and adapted to be selectively connected through hose means to the motive means on the driving screw means and the rotary motor means for the drill stem.

11. A drilling machine comprising, a base frame, a headframe pivotally mounted on the base frame at one extremity thereof for angular adjustment relative thereto, said headframe having a pair of longitudinal guide means thereon, a cross head positioned on the headframe for longitudinal movement therein on the guide means, screw means for each guide means positioned on the headframe and extending through the cross head and parallel to the guide means, recirculating bearing means positioned on the cross head and mounting the cross head on the screw means in the headframe, means providing relative movement between the screw means and the recirculating bearing means to move the cross head relative to the headframe along the extent of the guide means for reciprocating feed movement, and rotary motor means including means for mounting a drill stem mounted on

the cross head for rotating the drill stem with feed movement of the cross head.

12. The drilling machine of claim 11 in which the means providing relative movement between the recirculating bearing means and the screw means is a rotary motive means mounted on the headframe and connected to the screw means for rotating the screw means at a variable speed and at a reversible direction of rotation to vary the speed and direction of rotation of feed movement of the drill stem.