Jan. 20, 1970 J. S. HATTRUP ET AL 3,490,546

DRILLING MACHINE FOR USE IN SMALL TUNNELS

Filed June 4, 1968 4 Sheets-Sheet 1

Fig. 1.

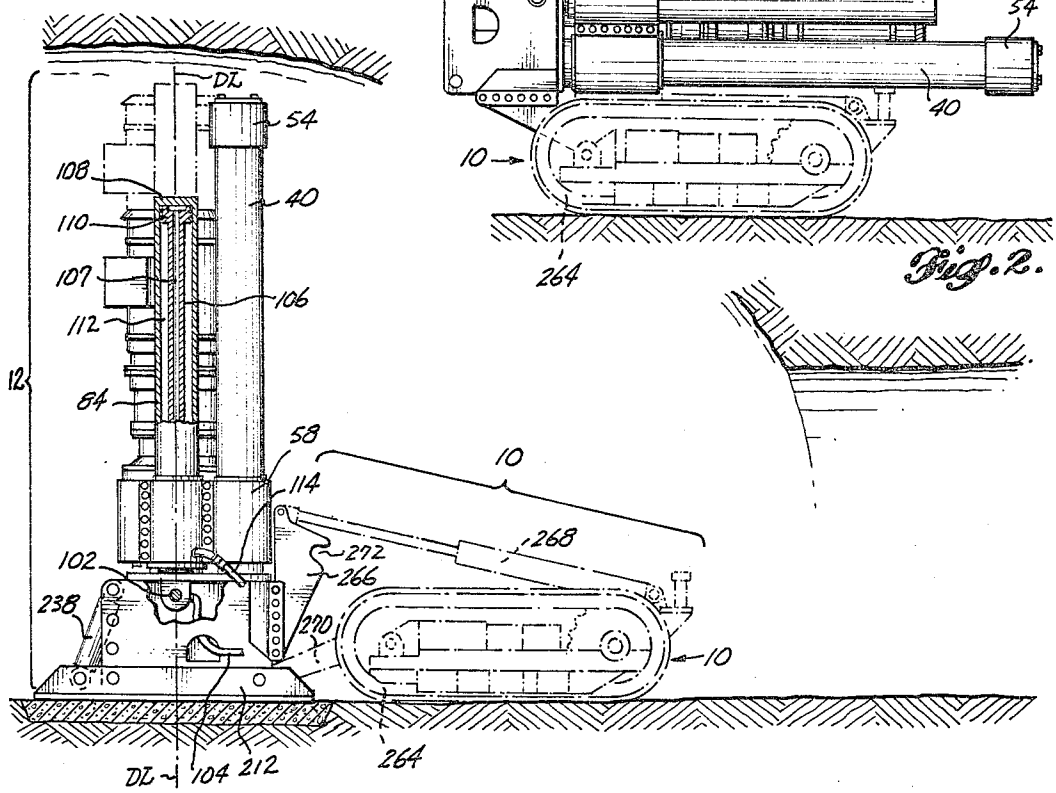


Fig. 2.

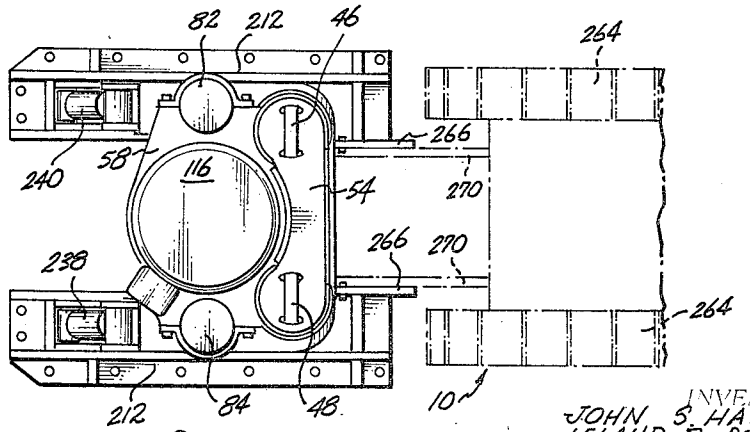


Fig. 3.

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DRILLING MACHINE FOR USE IN SMALL TUNNELS

Filed June 4, 1968 4 Sheets-Sheet 2

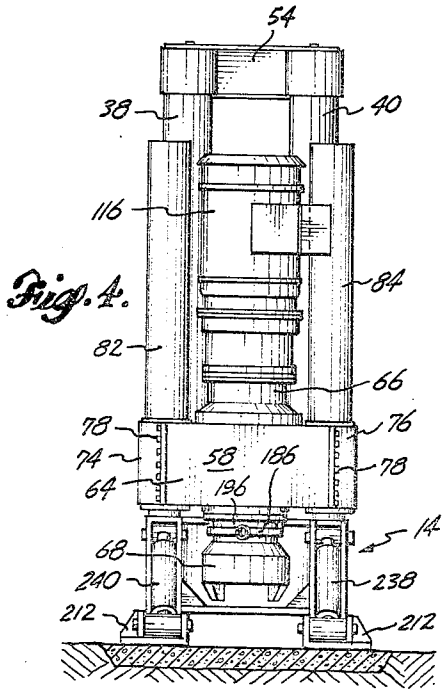


Fig. 4.

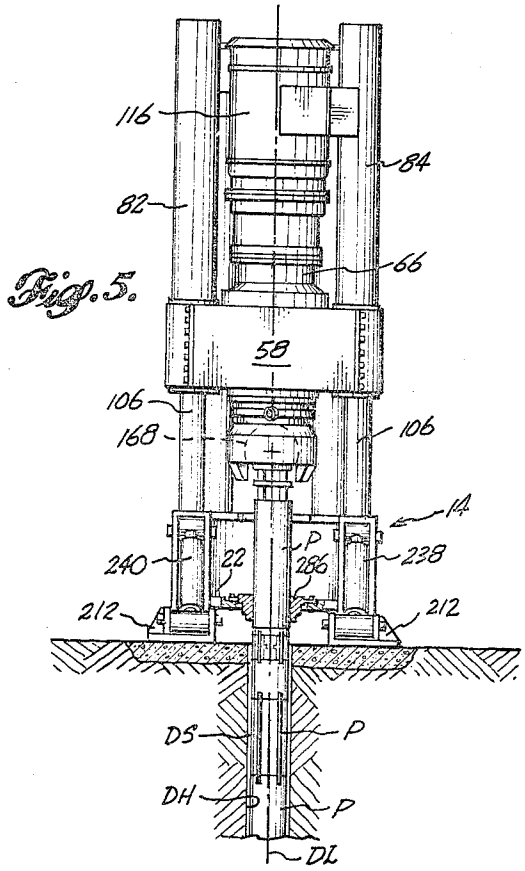


Fig. 5.

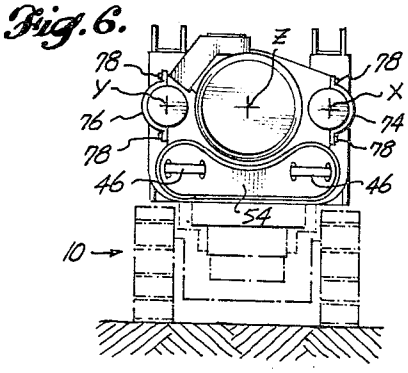


Fig. 6.

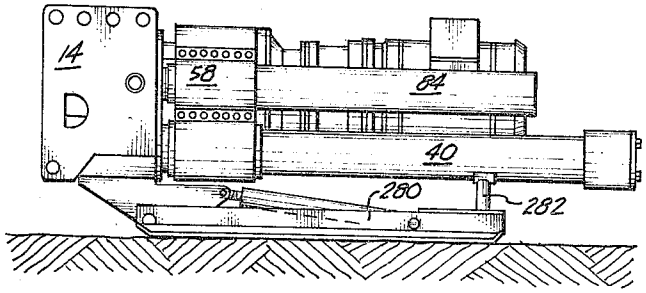


Fig. 8.

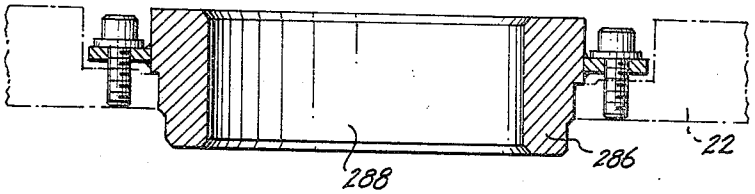


Fig. 7.

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DRILLING MACHINE FOR USE IN SMALL TUNNELS

Filed June 4, 1968 4 Sheets-Sheet 3

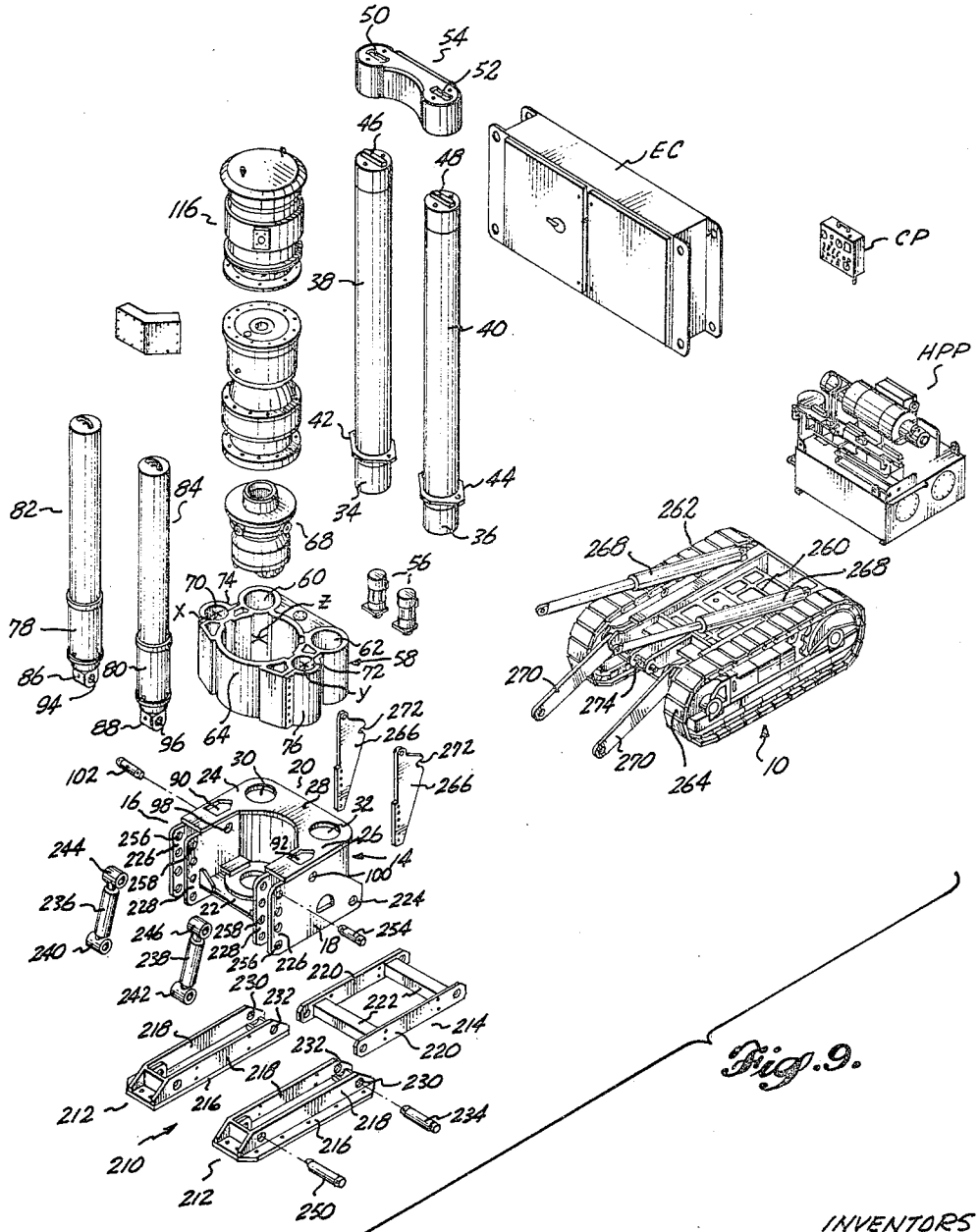


Fig. 9.

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DRILLING MACHINE FOR USE IN SMALL TUNNELS

Filed June 4, 1968 4 Sheets-Sheet 4

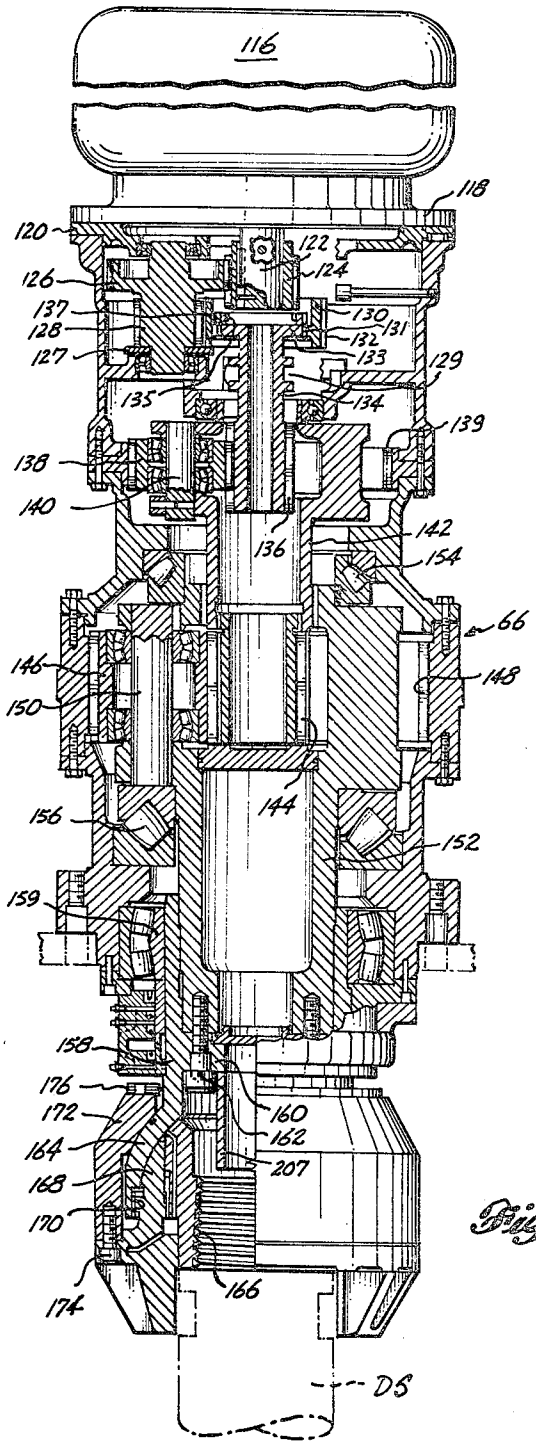


Fig. 10.

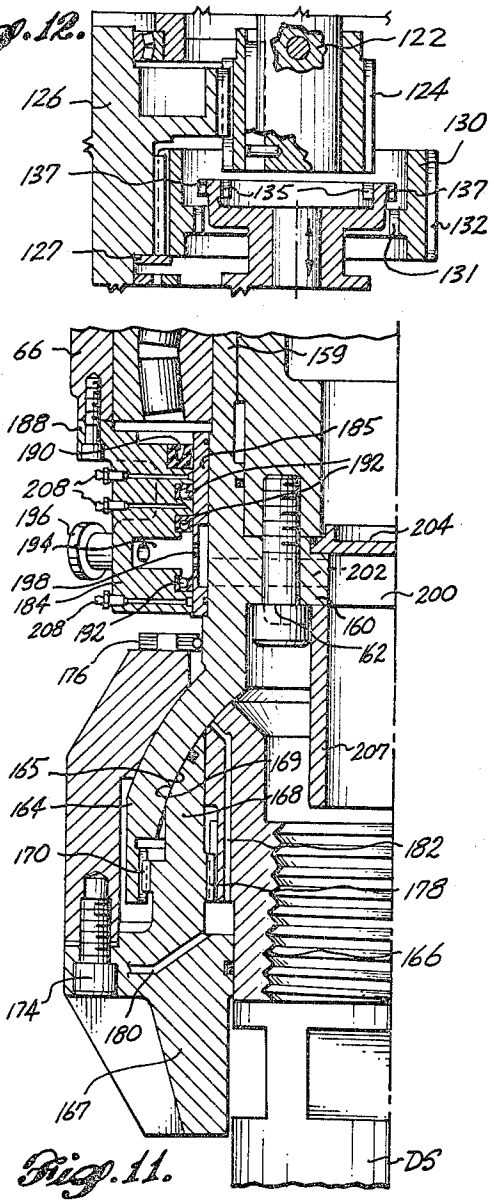


Fig. 11.

Fig. 12.

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3,490,546

DRILLING MACHINE FOR USE IN SMALL TUNNELS

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Filed June 4, 1968, Ser. No. 734,324
Int. Cl. E21c 11/02, 1/04; E21b 7/02
U.S. Cl. 173—23 9 Claims

ABSTRACT OF THE DISCLOSURE

A traveling support frame is mounted for up and down travel by two parallel guide columns secured at their lower ends to a main frame. A portion of the traveling frame projects forwardly of the drive columns and supports coaxially related motor, reduction gearing and drive head means which are closely adjacent to and in parallelism with the two columns. A pair of thrust rams are interconnected between the traveling frame and the main frame on opposite sides of the coaxial drive components. Multiple reduction planetary gearing is employed and is isolated from moments caused by a loading of the drill stem by means of a universal joint located between the output shaft of the gearing and the drive head connected to the drill stem. This equipment is movable between an upright drilling position endwise of the transporter and a relatively short supine position on the transporter.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to earth boring or drilling machines usable in relatively small tunnels as well as on the surface. It particularly relates to drilling machines comprising a ground contacting transporter and drilling equipment movable between a supine transport position on the transporter and a generally upright use position, and to features rendering such machine short in height when the drilling equipment is supine, so that the machine may be moved through relatively small tunnels.

Description of the prior art

The present invention relates to an earth boring or drilling machine which in some respects constitutes an improvement over the earth boring machine disclosed by U.S. Patent No. 3,220,494, issued on Nov. 30, 1965, to Robert E. Cannon et al. One disadvantage of the machine shown by this patent is that, owing to the construction of the drilling equipment it possesses, it is relatively high even when the drilling equipment is retracted into a transport position, making such machine unsuitable for use in relatively small tunnels. Its relatively large transport position height is attributable to a relatively large front-to-rear depth of the drilling equipment. One contributing factor to such relatively large front-to-rear depth of the drilling equipment is the placement of the drive motor to the rear of the support column means, the use of four corners positioned support columns, and the use of a parallel shaft type of reducing gear mechanism.

Known prior art vehicular drilling rigs are shown by Caldwell, U.S. Patent No. 2,334,312; Bury, U.S. Patent No. 2,516,182; Gunning, U.S. Patent No. 2,733,896; Braun. U.S. Patent No. 2,792,198; Putt, U.S. Patent No. 2,856,155; Garrett et al., U.S. Patent No. 3,088,531; and Sewell, Canadian Patent No. 600,948. However, none of these patents are concerned with the problem of constructing the drilling assembly and its transporter in such a way that the transport position height of the machine

is relatively small, i.e. they are not concerned with moving drilling equipment through relatively small tunnels. They are also not concerned with firmly anchoring the drilling equipment to the tunnel floor or to the earth immediately surrounding the drill hole, requiring its removal from the transporter.

Mistrot U.S. Patent No. 2,956,782 discloses mounting a well drilling machine on a sled type of transporter. However, the machine is strictly for surface use and is not adapted for travel within a relatively small tunnel. Also, the drilling equipment remains on the sled base during the drilling operation.

Canadian Patent No. 600,948, issued July 5, 1960, to Ben W. Sewell, discloses using a short piece of pipe mounted near the ground in spaced relationship from the drive head of the drilling equipment to improve alignment of an auger type of drill stem. However, this patent is not concerned with the problem of isolating speed reduction gearing from moments caused by stressing of the drill stem.

Greve U.S. Patent No. 1,377,575 and Hanson U.S. Patent No. 1,398,551 each disclose well drilling equipment comprising coaxially arranged motor, speed reduction gearing and drive head means. However, these patents are not concerned with the problem of constructing a transportable type drilling machine in a manner making it transportable through relatively small tunnels, nor the problem of isolating the gearing from drill stem elements.

SUMMARY OF THE INVENTION

The present invention relates to transportable earth drilling or boring machines constructed to have a relatively short transport position height, so that the machine may be moved through relatively small tunnels.

Drilling machines of the present invention are characterized by drive means comprising coaxially arranged motor, gear reduction and drive head means. Such drive means are mounted on a traveling support frame forwardly of a single pair of parallel guide columns on which such traveling frame is mounted for up and down travel. The drive assembly is partially nested between the two guide columns and is located about as close to the rear of the drilling assembly as possible. The coaxial arrangement of the drive components provide the drive assembly with a minimal thickness or front-to-rear depth. The forwardmost boundaries of the traveling support frame, the main frame of the drilling assembly, and the drive assembly are closely colinear. The drilling machine includes a transporter which is built relatively low to the ground. When the drilling assembly is supine on the transporter in its transport position the foregoing features combined to give the machine a relatively short height dimension, so that it can be transported through relatively small tunnels.

This invention primarily relates to the constitutional details of certain key components, and the relationship of the various components, of the machine which provide it with a relatively short transport position height.

These and other features, advantages and characteristics of the earth boring equipment of the invention will be apparent from the following detailed description of typical and therefore nonlimitive embodiments of the invention, and from the accompanying illustrations.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing like letters and numerals refer to like parts, and:

FIG. 1 is a view in side elevation of the equipment with the drilling rig mounted on the base member in an upright position wihin an enlarged zone in a tunnel, with the crawler tractor type transporter thereof being shown in

phantom, and with the foregound piston-cylinder unit in section;

FIG. 2 is a view in side elevation of the drilling rig in a supine position on the transporter, with the equipment being shown in a tunnel, and with the transporter being shown in phantom;

FIG. 3 is a top plan view of the equipment, with the drilling rig shown in full lines, and including a fragmented portion of the transporter, in phantom;

FIG. 4 is a front elevational view of the drilling rig, showing the driving means in a lowermost position;

FIG. 5 is a view similar to FIG. 4, but showing the drive means in a partially raised position, showing a drill stem being stabilized by a bushing at the work table, and showing the drive head cut away to expose the universal joint;

FIG. 6 is a front elevational view of the equipment readied for transport, with the transporter shown in phantom;

FIG. 7 is an axial sectional view of the work table bushing, on an enlarged scale, with portions of the work table being shown in phantom;

FIG. 8 is a view similar to FIG. 2, but showing a "sled" type of transporter;

FIG. 9 is an exploded pictorial view of the major components of the equipment;

FIG. 10 is a side elevational view, with some parts in section, of the motor, transmission and drive head assembly;

FIG. 11 is an enlarged scale sectional view of the portion of FIG. 10 relating to the drilling fluid delivery collar and the universal joint; and

FIG. 12 is an enlarged scale sectional view of the portion of FIG. 10 relating to the speed control gearing, showing such gearing in a neutral position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more specifically to the several figures of the drawing, the mobile drilling machine of the present invention comprises a transporter **10** and a drilling assembly **12** adapted to be carried by the transporter **10**, and to be moved between its transport position on the transporter and drilling position off from the transporter, by equipment carried by the transporter.

As perhaps best shown by FIG. 9, the drilling assembly comprises a lower or main frame **14** having side parts **16, 18** interconnected at the top by a generally U-shaped plate **20** and at the bottom by a work table **22**. The upper plate **20** has two side portions **24, 26** and interconnecting rear portion **28**, but is open at the front. Openings **30, 32** are provided in the rear side corners of plate **28** to receive the lower end portions **34, 36** of a pair of guide columns **38, 40**. The columns **38, 40** are provided with mounting collars **42, 44** which rest on the upper surface of plate **28** about the openings **30, 32**, and are welded or otherwise firmly secured to the plate **28**. The upper ends of the columns **38, 40** are shown to each include an upwardly projecting keys **46, 48**, each of which is adapted to fit within a locking slot **50, 52** for it at the opposite ends of a head frame **54**. The head frame **54** is secured to the upper ends of the columns **38, 40**, such as by the use of anchoring bolts on each side of the mated keys and slots **46, 50** and **48, 52**. The mated keys and slots **46, 50** and **48, 52** prevent rotation of the head frame **54** relative to the columns **38, 40**.

Two motor and lubrication pump units **56** may be positioned on the main frame **14** within or below the lower end portions **34, 36** of the columns **38, 40**.

The guide columns **38, 40** function to support and guide a movable cross frame means **58**. The cross frame means **58** is formed to include a pair of elongated guide sleeves **60, 62** at the two rear corners of such cross frame means **58** which surroundingly engage the columns **38, 40**.

The cylindrical boundaries of the guide sleeves **60, 62** are formed by wall means, an inner portion of which is also a part of the wall of a larger cylindrical sleeve **64** which receives the lower portion of the gear box **66** and perhaps an upper portion of the drive box **68**.

A pair of mounting sockets **70, 72** are located laterally outwardly, on the opposite sides, of the sleeve **64** and preferably include an inner wall portion which is also a portion of the wall forming sleeve **64**. The sockets **70, 72** are spaced forwardly of the sleeves **60, 62** and are formed about center axes *x, y* which are in coplanar parallelism with the center axis *z* of sleeve **64**. Preferably, inner portions of the side walls forming the sockets **70, 72** are also portions of the side wall forming sleeve **64**. It may be said that the cylindrical sleeves **60, 62** and the cylindrical sockets **70, 72** are circumferentially spaced about and tangentially related to the large sleeve **64**. Also, the portions of cross frame means **58** forming the sockets **70, 72** and the sleeve **64** are supported in cantilever fashion out forwardly of the guide sleeves **60, 62** and the guide columns **38, 40** along which they travel.

The cylindrical sockets **70, 72** are preferably longitudinally split into two halves, the inner one of which is an integral part of the cross frame means proper. The outside half **74, 76** is removably secured in place, such as by means of bolts **78** (FIG. 6). During assembly the lower mounting portions **78, 80** of a pair of hydraulic rams or piston-cylinder units **82, 84** are set into the inner halves of the sockets **70, 72**. Then the outer sections **74, 76** are added and bolted in place. The mounting portions **78, 80** are parts of the cylinders or piston chambers **82, 84**, and in this manner the cylinders **82, 84** are firmly secured to the traveling cross frame means **58**, in a position of parallelism with the guide columns **38, 40**. During assembly the lower ends **86, 88** of the piston are inserted downwardly through openings **90, 92** in the upper plate **28** of main frame **14**. Eye openings **94, 96** in the lower end pieces are aligned with openings **98, 100** in the side parts **16, 18** of the main frame **14**. Cross pins, one of which is shown in FIG. 9 and designated **102**, are inserted through the aligned openings **94, 98** and **96, 100** for the purpose of securing the lower ends of the pistons to the main frame **14**.

Herein the term "cylinder" is used not to designate shape, but rather to denote the functional components of the hydraulic rams in which the pistons are slidably received. It is to be understood that although the cylinders or chambers **82, 84** are shown to be cylindrical in shape, and this is the preferred shape of these components, they could just as well be made square, rectangular, etc. in cross-section.

Hydraulic fluid for raising the traveling cross frame means **58** is delivered by a flexible conduit or hose **104** into an inlet port at the lower end of the piston. The piston rod **106** includes a central passageway **107** through which the fluid flows up to an upper chamber between the closed upper wall **108** of the cylinder and the upper surface of a piston head **110**. During upward travel of the cylinder and other components any hydraulic fluid within the annular chamber **112** surrounding the piston rod **106** is returned to the fluid reservoir via hose **114**. As will be evident, a reverse or downward drive of the movable drilling components is effected by reversing the direction of flow through conduits **104, 114**.

Referring now to FIG. 10 in particular, the drilling equipment carried by the traveling cross frame means **58** comprises a motor **116**, speed reduction gearing within gear box **66** and drive head means within drive box **68**. According to the invention the motor **116**, the speed reduction gearing and the drive head means are coaxially arranged on the cross frame means **58**, in parallelism and closely adjacent the rigid giude columns **38, 40**.

As best shown by FIG. 10, a lower mounting flange **118** on the motor **116** is secured to an upper mounting flange **120** on the drive box **66**. The central ouput shaft **122** of the motor **116** projects downwardly into the upper portion of the drive box **66** and carries a first sun gear

124 at its lower end. The transmission is a two speed transmission. Sun gear 124 always meshes with three large diameter planet gears 126 (one of which is shown in FIG. 10) constituting parts of three dual planet gear elements which are journaled at their ends in portions of the drive box housing 66. Such elements include small diameter planet gears 128 which always mesh with a ring gear 130, coaxially related to the sun gear 124. Ring gear includes internal teeth 131 as well as external teeth 132. The upper end gear 133 of an axially movable gear unit 134 also includes inner and outer teeth 135, 137, respectively when unit 134 is moved into and supported in its upper position its inner teeth 135 mesh with gear 124 and ring gear 130 turns free. This is "high" gear, when unit 134 is moved into and supported in its lower position, the external teeth 137 mesh with internal teeth 131 and gear 130 becomes a part of the drive train. This is "low" gear.

Ring gear 130 merely "floats" radially between the three gears 128. Axially it is supported on and by plates 127 which either turn with or are freely mounted about the lower end portion of gear 128. Gear unit 134 is moved axially and is supported by a fork (not shown) which engages unit 134 at 129.

A smaller sun gear 136 at the opposite end of unit 134 meshes with three traveling planet gears 128 (one of which is shown in FIG. 10) which ride about a stationary internal ring or orbit gear 139. The gears 138 are journaled for free rotation about fixed shafts 140 which are carried at the large diameter end of a center shaft 142, coaxially related to shafts 122 and 134. The smaller diameter end of shaft 142 carries a sun gear 144 which meshes with three traveling planet gears 146. Gears 146 travel around a fixed internal ring or orbit gear 148 as they rotate. The gears 146 are mounted for free rotation about fixed support shafts 150 which are carried at the larger diameter end of a main or output shaft 152. The main shaft 152 is journaled for rotation at its upper end by a combined bearing 156. As used herein, the term "combined bearing" means a bearing capable of carrying both radial and axial or thrust loads.

The drive head means includes a member 158 having a tubular upper portion 159 which is insertable upwardly into the lower end of the drive box 66 in concentric surrounding engagement with the lower end of main shaft 152. A transverse internal flange 160 carried by tubular shaft 158 abuts against the lower end of main shaft 152. A plurality of anchoring bolts 162 are used for securing the internal flange 168 to the lower end portion of the main shaft 152. Element 158 also includes a bell like lower portion 164 which has substantially spherical inner and outer surfaces in at least a part of its extent. The drive head means also includes a box type connector 166 having an upper "ball" portion 168 with an outer spherical surface that mates with the inner spherical surface on bell 164. A mating set of generally axially extending splines 170 extend circumferentially about the ball 168 and the bell 164 and serve to transmit torque from one to the other, while permitting angular movement of the ball 168 within the axial planes of the splines. The drive head means also includes a retainer sleeve 172 which is boltable to the ball portion 168, such as by bolts 174. The upper portion of sleeve 172 includes an inwardly facing spherical surface which contacts and rides on the outer spherical surface of bell 164. Preferably, an annular dirt seal 176 is carried at the upper end of element 172, and is constructed to be resilient enough to give during angular movement between the upper and lower parts.

The upper ball end portion 168 of the box 166, the bell portion 164 of tubular shaft 158 and the retainer sleeve 174 together form a universal joint for connecting the drive head to the main or output shaft 152. Such joint functions to isolate the shaft 152, its support bearings 154, 156 and the remainder of the speed reduction gearing from moments caused by bending or other stressing of the drill stem DS connected to the drive head.

As best shown by FIG. 11, the head box 166 is preferably mounted for a limited amount of axial travel relative to its carrier 167 by means of a set of mated splines 178. A lubricant passageway 180, 182 may be provided for delivering a suitable lubricant to the spherical surfaces 165, 169.

A stationary drilling fluid delivery collar 184 is secured to the lower end of the drive box 66 in concentric surrounding engagement with the rotating, generally cylindrical portion 159 of a tubular element 158. A rotary sleeve 185 immediately surrounds the cylindrical portion 159 of element 158, and the collar 184 surrounds the sleeve 185. Collar 184 includes an upper flange 88 by which it is bolted or otherwise secured to the lower end of the drive box housing 66. A suitable sealing ring 190 is located in a well formed in the upper end of collar 186. Additional seals 192 are provided both above and below an annular manifold chamber or passageway 194. One or more drilling fluid inlets 196 are provided for delivering the drilling fluid into manifold 194. Delivery ports 198 extend through sleeve 184 and are in communication with the manifold 194, and also with the hollow interior 200 of the drive head via radial passageways 202. A sealing plug 204 is secured to the mounting flange 160 and closes the central opening inwardly of the flange 160, so as to prevent movement of the drilling fluid upwardly. A tubular nozzle 207 is bolted to the underside of flange 160 and serves to direct the fluid into box 168 and away from the machined mating spherical surfaces 165, 169.

Lubricant fittings 208 are provided for delivering lubricant to the regions of the seals 190, 192. Collar 186 is itself a bearing and bearing surfaces exist where it makes contact with the bearing sleeve 184.

The annular drilling fluid supply collar 186 is employed because the motor 116 and the speed reduction gearing are located above the upper end of the drill stem. However, it is contemplated that a hollow drive shaft 122 may be used in the motor 116 so that a drilling fluid delivery tube can be inserted through the motor 116 and the reduction gearing down to the upper end of the drill stem DS, enabling the use of a top positioned swivel such as swivel 176 shown by Cannon et al. U.S. Patent No. 3,220,494.

As clearly shown by FIGS. 3 and 6, for example, the coaxial motor and speed reduction gearing means are in effect contained in a single elongated tubular housing (of composite form), and said housing is partially nested in the space between the parallel guide columns 38, 40. The inner surface of the head frame 54 is of concave curvature laterally, so as to also accommodate a peripheral portion of such housing.

In use the above described drilling equipment is mounted onto a rigid base means which is preferably pinned, bolted, or otherwise firmly secured to the supporting material at the drill site. If the material is rock, the main frame 14 may be directly connected to it. Or, it may be necessary to rigidly enplace a base member in fixed position on the floor or supporting surface at the drill site. The base member may be of concrete, a metallic member or a combination of both. In the illustrated embodiment the base member is formed by pouring a concrete pad on the floor about the drilling point. A metallic base means is positioned on the concrete, is secured to the floor, and with the concrete forms the base member. In other installations the concrete may be dispensed with, or the metallic base members may be dispensed with.

Referring again to FIG. 9, the metallic base means 210 is shown as comprising a pair of side parts 212 and an interconnecting frame 214. The base assembly 212, 214 is in effect a flat-bottomed base member rigidly anchorable to the floor in substantially surrounding relation to the axis of the hole to be formed. As used herein, the expression "substantially surrounding" means that

the base member has supporting parts (212) on at least opposite sides of the drill hole and also endwise of a transverse line cutting across the side members 212 and coinciding with the axis of the drill hole.

Each base member 212 comprises a flat bottom plate 216 and a pair of laterally spaced upright walls or plates 218. Portions of the flat bottom plate 216 project laterally outwardly from the outer wall 218 to form a flange through which mounting pins or bolts may be inserted. The interconnecting frame may comprise laterally spaced side members 220 interconected by box like end members 222. The side members 220 are bolted or otherwise firmly secured to the inner side walls 218 of the base members 212.

The drilling equipment commencing with main frame member 14 on up is preferably adjustably affixable in position on the base member. In the preferred embodiment this is achieved by providing a pivot pin opening 224 at the lower rear corners of the main frame side parts 16, 18, generally vertically below the rear side boundary of the guide columns 38, 40. The side members 16, 18, which are each formed by a pair of spaced, vertical parallel plates 226, 228, are narrower than the spacing between the upright plates 218 of the base members 212. The lower portions of the side members 16, 18 are normally nested between the side plates 218 of members 212, with the openings 224 aligned with openings 230, 232 in the plates 218. Husky pivot pins 234 serve to pivotally mount the two rear corners of main frame 14 to the respective rear ends of the base members 212.

The forward end of the main frame 14 is angularly adjustable with respect to the base means 210 by means of a pair of threaded turnbuckle assemblies 236, 238, each of which is adjustable between respective lower sleeves 240, 242 and respective upper sleeves 244, 246. The lower sleeves 240, 244 are pivotally mounted by fixed pins 250 which extend through aligned openings in the forward end portions of the side plates 218, and through the sleeves 240, 242 between such openings. The upper sleeves 246, 248 are pinned by respective pins 254 to an aligned pair of the respective series of adjustment holes 256, 258 arranged vertically along the forward edges of the respective plates 226, 228.

As will be evident, angular adjustment of the drill line DL with respect to the plane of the bottom of the base means 210 occurs about the pivot axis provided by the pins 234. Coarse adjustment is affected by selective placement of pins 254 in the desired pairs of adjustment openings 256, 258. Fine angular adjustment is affected by varying the length of the turnbuckle assemblies 238, 240.

In the preferred embodiment the transporter 10 is of a crawler tractor type. It includes a central supporting frame 260 and a pair of side located power driven tracks 262, 264.

As best shown by FIGS. 1 and 9, a pair of vertical lever plates 266 are secured to the rear portion of the main frame 14 laterally inwardly of the opposite sides thereof. A pair of rams or piston-cylinder assemblies 268 are interconnected between rear portions of the transporter fame 260 and the upper ends of the lever plates 266. A pair of loading links 270 are interconnected between the pivot pins 234 on the base members 212 and pivot pins mounted near the forward corners of the transporter frame 260. Links 270 are pivotal at each of their ends, and the piston-cylinder assemblies 268 are pivotal at each of their ends. Bearing point notches 272 are provided in upper rear portions of the vertical plates 266. The spacing between the pivotal axes of pins 234 and the center of the notches 272 is substantially equal to the length of the links 270 between the two pivot axes provided at the opposite ends thereof.

Referring now to FIG. 1, when it is desired to move the drilling equipment from a generally upright use position into a supine transport position (FIG. 2), the pistons of units 268 are retracted back into the cylinders of such units 268, causing the entire equipment to pivot rearwardly about the axes of pins 234. The equipment from main frame 14 on up is disconnected from the base means 210, and the piston-cylinder units 268 are actuated to tilt the equipment clear back until the notches 272 engage the transverse support bar 274, or the like, mounted at the forward end of transporter frame 260 between the rear pivot axes of the links 270. Further retraction of the pistons causes the equipment to pivot about support pin 274 down into the supine position depicted by FIG. 2. As clearly shown by FIGS. 1 and 2, the inner or rearmost boundaries of the main frame 14 and the guide columns 38, 40 are substantially colinear, and when the equipment is supine such boundaries are closely contiguous the upper surface of the support frame 260. The outermost or forwardmost boundaries of the traveling cross frame means 58, the housing for the electric motor 116, the gear box housing 66, the drive box housing 68, and the main frame means 14 are closely colinear and together constitute the uppermost portions of the mechanism when the drilling assembly is supine. Owing to this arrangement, the mechanism has a minimum height when in the supine position and is capable of traveling through relatively small tunnels.

FIG. 8 is a view similar to FIG. 2, but shows the use of a "sled" type transporter in place of a self-propelled tractor crawler. The use of the shorter sled makes it possible to further decrease the overall supine height of the mechanism. The loading and unloading mechanism for the sled 280 is like the above described loading and unloading mechanism 266, 270, 272, 268 in the preferred embodiment. The sled 280 includes ground or rail engaging runners or the like, or is merely flat bottomed. It is shown to include a support bracket 282 near its rear end on which the guide columns 38, 40 rest. Other forms of transporter may include a transporter having flanged wheels for engaging rails, or ground engaging wheels, i.e. like a wagon.

Another feature of this invention involves the use of a sleeve bushing 286 at the work table 22, at least during the starting of drilling. The universal joint means 164, 168, 172 isolates the output box (or pin in other installations) from moments caused by bending or other stressing of the drill stem DS. The presence of the universal joint makes the drill stem DS free to deviate or meander from the drill line DL. According to the invention, this is prevented by mounting a bushing 286 onto the work table 22, and using special starter sections of drill pipe P which have smooth machine surfaces as opposed to rough outer surfaces so they will turn within the bushing opening 288. The bushing 286 provides a support against lateral movement which is axially spaced from the output box member 166. This two point bracing against lateral movement results in the drill hole DH being started straight. After the drill stem DS is in the ground a sufficient distance to enable the installation of rotary stabilizers (not shown) the use of the bushing 286 and the starter pipe becomes unnecessary. From then on out the rotary stabilizers in combination with the lateral support at the drive box 166 will keep the drill stem DS on the drill line DL.

The electrical equipment cabinet EC, the operator's control panel CP, and the hydraulic power package HPP are transported separately from the drilling equipment.

From the foregoing, various further modifications, component arrangements and modes of utilization of the drilling mechanism of the invention will be apparent to those skilled in the art to which the invention is addressed, within the scope of the following claims. For example, the machine may be adapted for up drilling of the pilot hole and down drilling of the enlarged hole.

What is claimed is:

1. In a drilling mechanism comprising a drilling assembly including main frame means, rigid column means sup-

ported by said main frame means, rigid cross frame means mounted for up and down travel along said column means, and for transmitting drilling torque through said column means to said main frame means, hydraulic drive ram means interconnected between said cross frame means and said main frame means for moving said cross frame means up and down in a straight line path, with said cross frame means including a mounting portion including means engaging the column means and serving to accurately guide said cross frame means along a path in substantially true parallelism with said column means, and motor, speed reduction gearing and drive head means carried by said cross frame means, the improvement comprising:

said cross frame means including a drilling equipment support portion laterally offset from said mounting portion,

said motor, speed reduction gearing and drive head means being coaxially arranged,

said speed reduction gearing means including a tubular outer housing secured to the support portion of said cross frame means and projecting axially from said cross frame means into a position closely adjacent said rigid column means,

said motor means including a tubular outer casing secured to said housing and extending axially therefrom, also closely adjacent said rigid column means,

said speed reduction gearing also including an output shaft coaxial with the motor, and

said drive head means being connected to said output shaft and being disposed on the opposite side of said cross frame means from said motor means.

2. Drilling mechanism according to claim 1, wherein said speed reduction gearing means comprises speed reducing planetary gearing in said housing drivingly connecting the output shaft to said motor.

3. Drilling mechanism according to claim 2, wherein said column means comprises a single pair of spaced apart, parallel guide columns, each secured at one end thereof to the main frame means near one side boundary of said main frame means, and standing out from said main frame means wherein the main frame means and the support portion of the cross frame means both extend laterally from the two columns, on the same side thereof, and wherein the casing of said motor and the housing of said speed reduction gearing means are partially nested in the space between the parallel columns.

4. In a mobile drilling mechanism comprising a horizontally elongated transporter and a drilling assembly including lower frame means, rigid guide column means supported by said lower frame means, rigid across frame means mounted for up and down travel along said column means, and motor, speed reduction gearing and drive head means carried by said cross frame means, wherein during normal operation the drilling assembly is moved between a position of use in which the column means and the motor, speed reduction gearing and drive head means are generally upright and the lower frame means is located off of said transporter, and a transport position in which said lower frame means, said column means and said motor, speed reduction gearing and drive head means are supine on said carrier, the improvement comprising:

said guide column means being composed of only a single laterally spaced pair of guide columns secured at their lower ends to said lower frame means near one side boundary thereof, so that said lower frame means is mostly situated on one side of the general plane of the two guide columns,

said rigid cross frame means including a first portion having guide means engaging said guide columns, and a second portion projecting laterally outwardly from the general plane of said columns, on the same side thereof as the lower frame means;

and said motor, speed reduction gearing and drive head means are coaxially arranged on said second portion, in parallelism with and closely adjacent said columns, with the boundaries of the cross frame means and the lower frame means opposite the drilling assembly from the columns, and the boundaries of the coaxial motor, speed reduction gearing and drive head means on the same side of the assembly, all being closely colinear and together constituting a first boundary of the drilling assembly, with the outer boundaries of said columns constituting a second boundary of the drilling assembly, and with one of said first and second boundaries being adjacent the uppermost portions of said transporter, and the other such boundary generally constituting the uppermost portion of the mechanism, when the drilling assembly is supine on the transporter.

5. Mechanism according to claim 4, wherein said transporter is a relatively low crawler tractor.

6. Mechanism according to claim 4, wherein said transporter is a low sled and has a bottom portion adapted for sliding along the ground.

7. Mechanism according to claim 4, further including a pair of parallel hydraulic rams interconnected between said lower frame means and said cross frame means on opposite sides of the assembly comprising the coaxially arranged motor, speed reduction gearing and drive head means, said rams lying on a plane that is substantially parallel with the general plane of rail guide columns and passes through said lower frame means.

8. Mechanism according to claim 4, wherein said cross frame means includes side wall means defines a socket for receiving an intermediate portion of the speed reduction gearing housing.

9. In a drilling mechanism comprising a drilling assembly including main frame means including a work table in a plane perpendicular to the drilling axis, and ground contacting base plate means adjacent the work table, rigid column means supported at one end by said main frame means, and outstanding therefrom, rigid cross frame means mounted for up and down travel along said column means, motor, speed reduction gearing and drive head means carried by said cross frame means, and a drill stem extending axially from said drive head, the improvement comprising:

said speed reduction gearing means including a housing having an output end portion, output shaft means projecting from said housing, and a bearing in the output end portion of the housing, radially between said housing and said output shaft means;

universal joint means connecting said drive head means to said output shaft means, and functioning to substantially isolate said output shaft from lateral forces caused by bending or stressing of the drill stem connected to said drive head means, and

bushing means spaced axially of said drill stem from said drive head and anchored to the work table of said main frame, said bushing means surrounding said drill stem and restraining it against lateral movement.

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