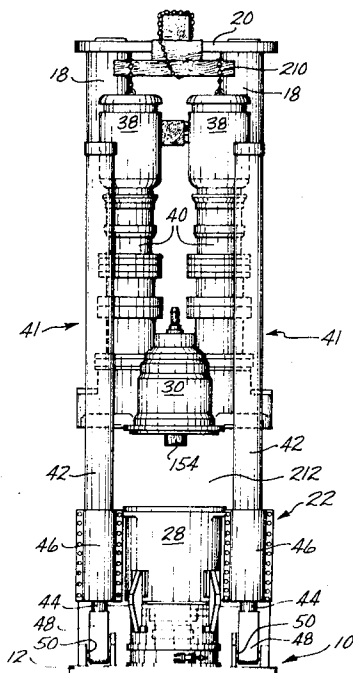


- [54] **BORING MACHINE HAVING INTERNAL ACCESS FEATURE AND DISASSEMBLY METHOD** 2,797,066 6/1957 Sewell..... 175/122
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- [22] Filed: **Oct. 20, 1971**
- [21] Appl. No.: **190,909**
- Related U.S. Application Data**
- [63] Continuation-in-part of Ser. No. 75,020, Sept. 24, 1970, Pat. No. 3,695,364.
- [52] U.S. Cl..... **173/152, 29/427, 173/57**
- [51] Int. Cl..... **E21b 3/02**
- [58] Field of Search..... 173/152, 163, 164, 173/57; 175/85, 122, 170; 29/426, 427
- [56] **References Cited**
- UNITED STATES PATENTS**
- 2,595,401 5/1952 Moon..... 173/152
- ABSTRACT**
- A traveling support frame is mounted for up and down travel along upstanding guide columns. Drilling equipment is carried by the traveling frame. The drilling equipment comprises a plurality of axially joined parts. The parts are constructed so that a portion of the drilling equipment can be anchored, removable connectors between two parts removed, and the traveling frame used to move the portion of the drilling equipment still attached to it away from the anchored portion. The internal components of the drilling equipment are easily removable from their housings within the access space provided when the two parts are moved apart.
- 11 Claims, 8 Drawing Figures**



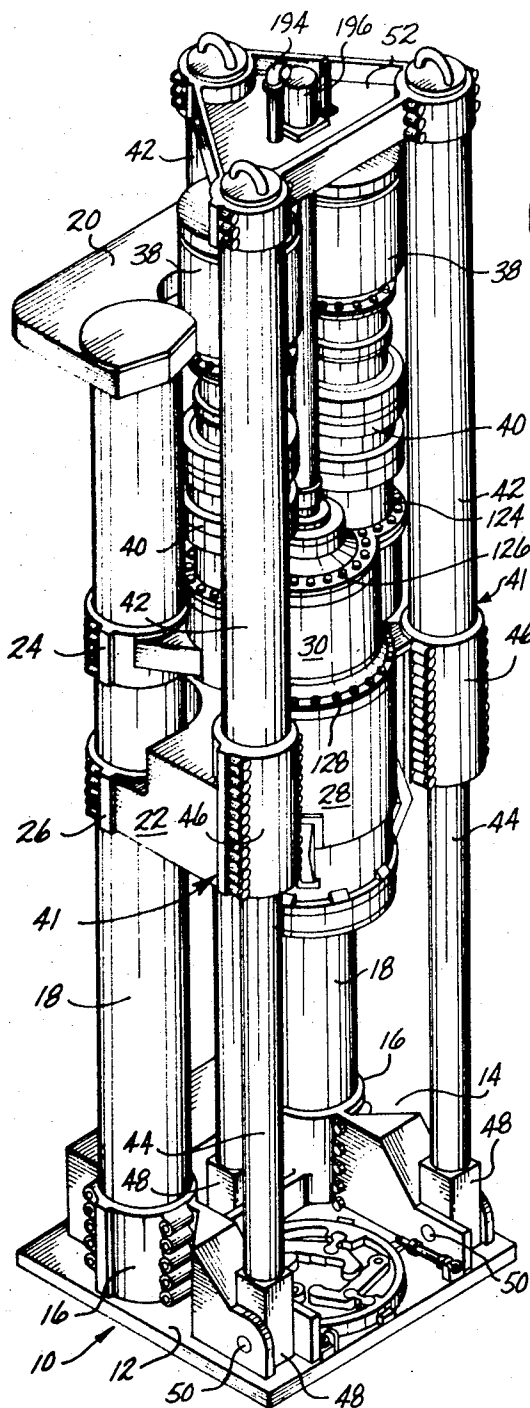


Fig. 1.

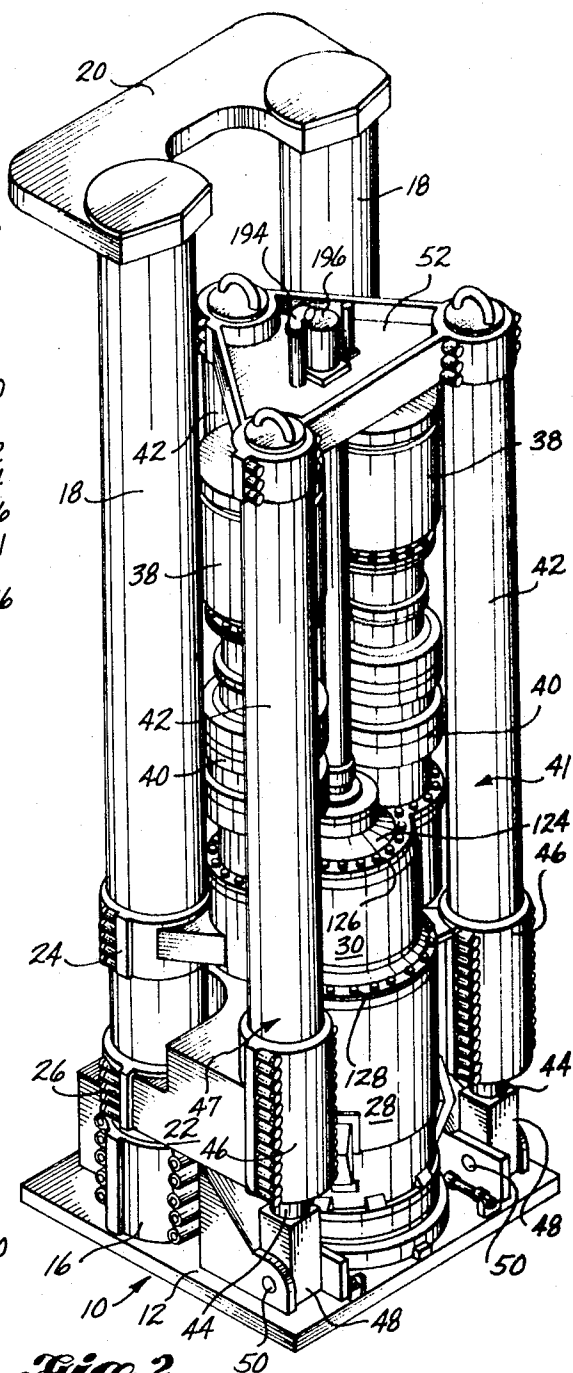
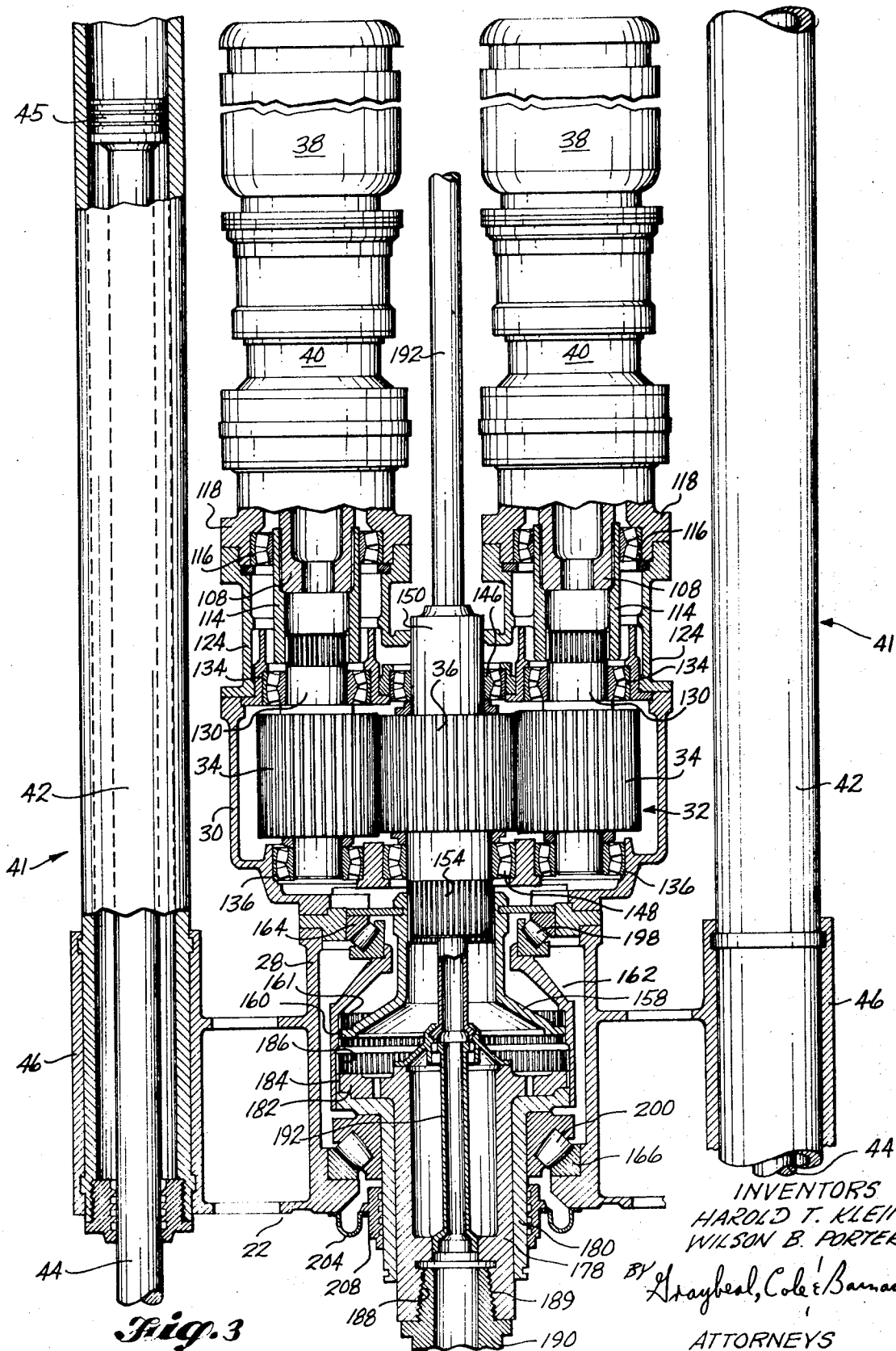


Fig. 2.

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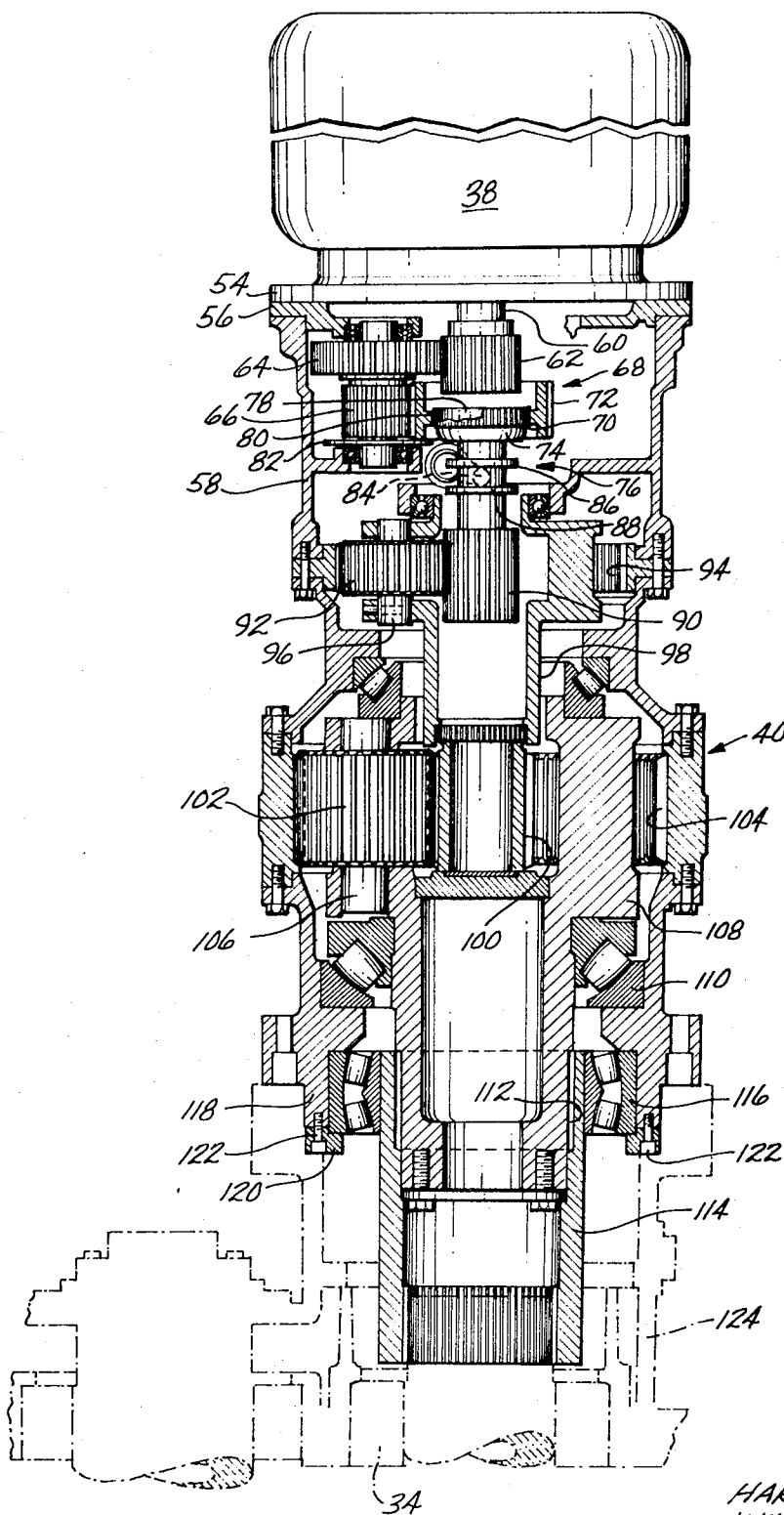


Fig. 4

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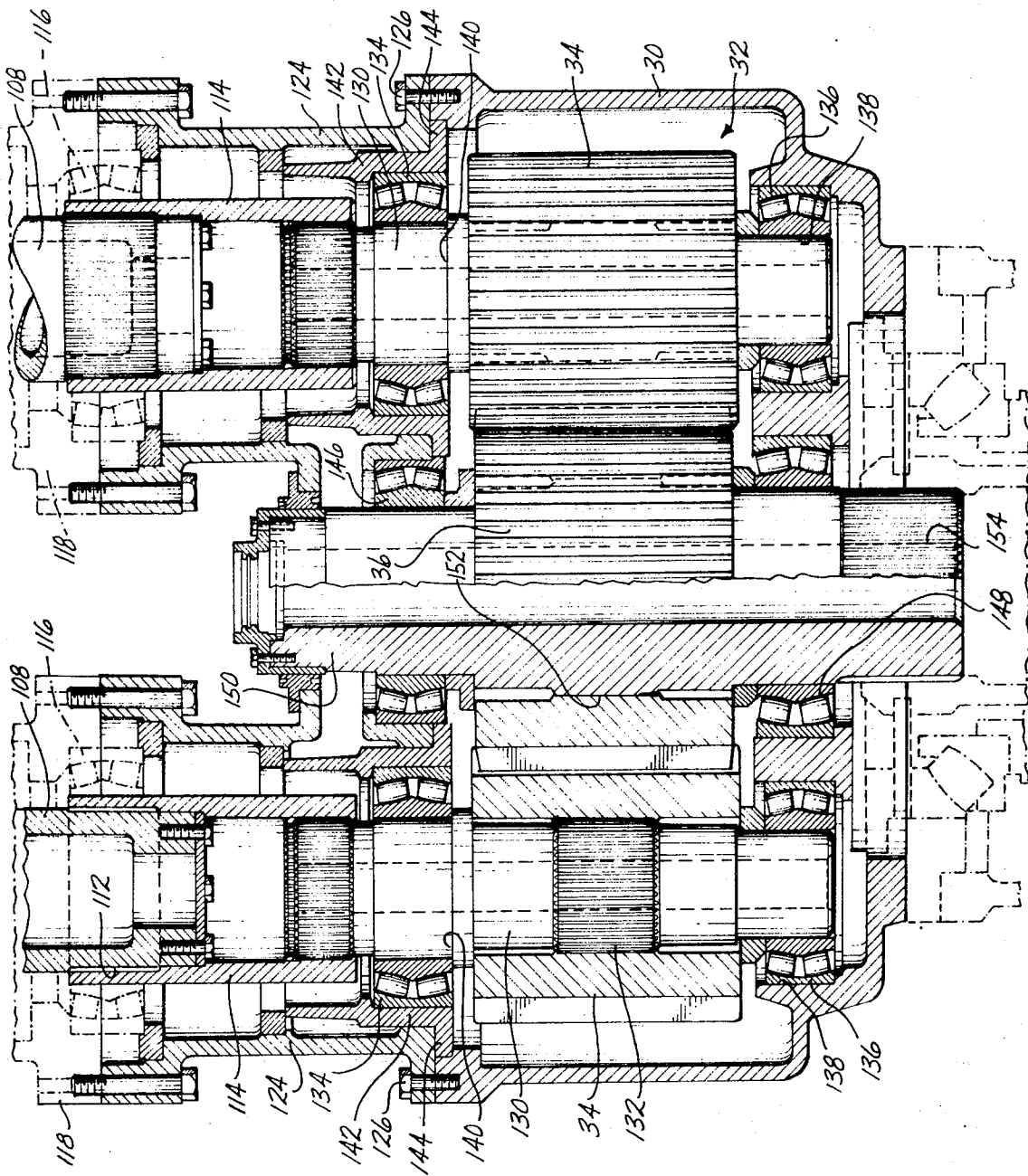


Fig. 5

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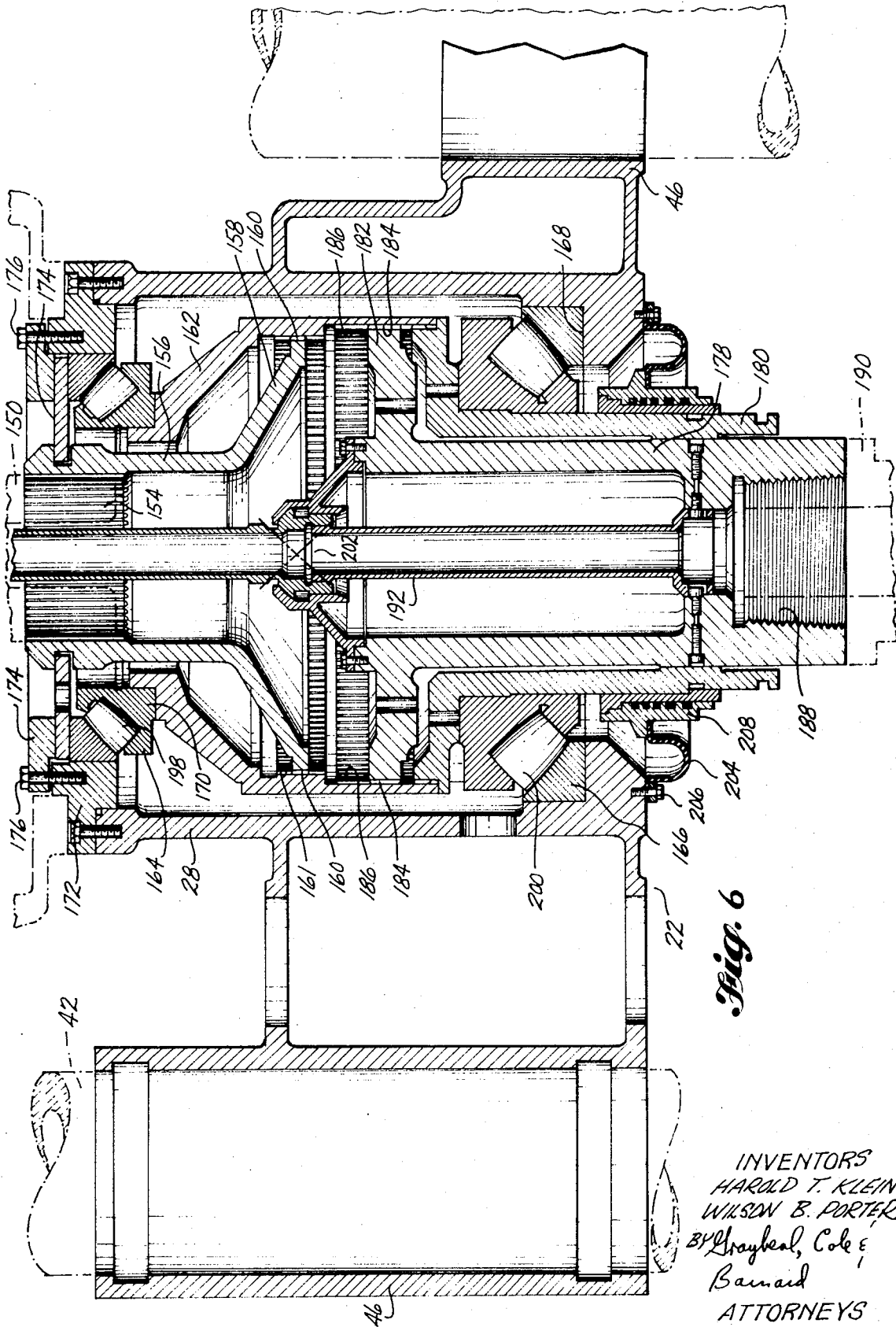


Fig. 7

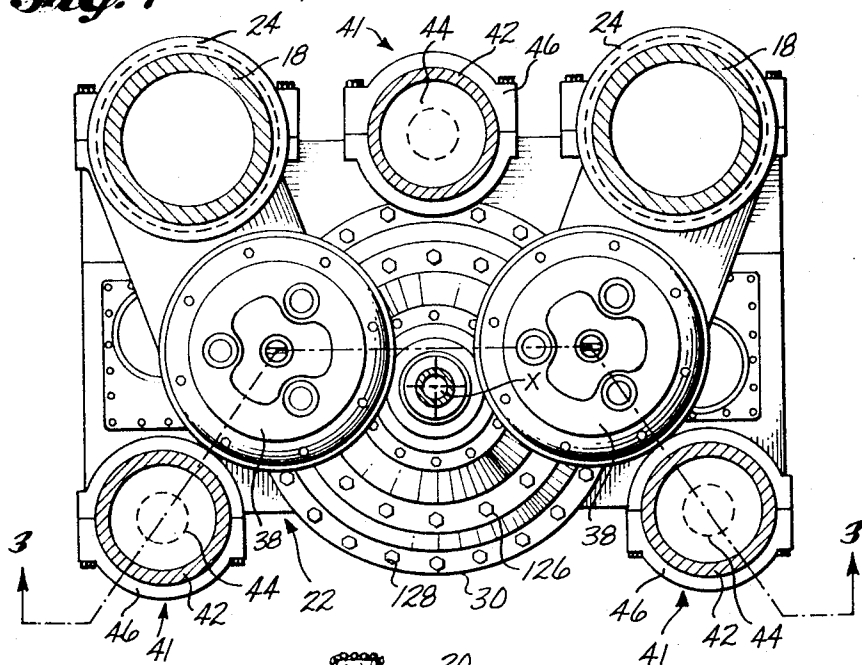
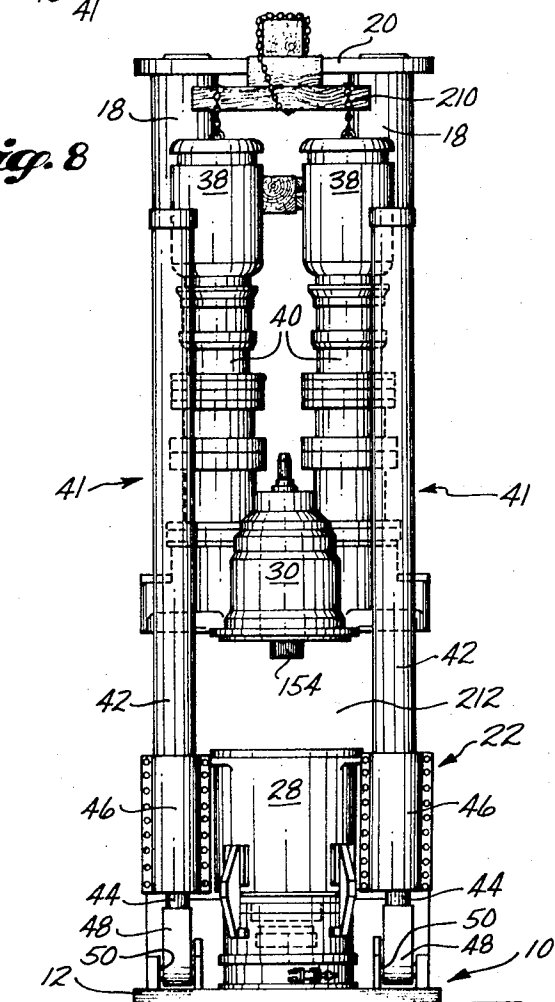


Fig. 8



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BORING MACHINE HAVING INTERNAL ACCESS FEATURE AND DISASSEMBLY METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of our copending application Ser. No. 75,020, filed Sept. 24, 1970 now U.S. Pat. No. 3,695,364 and entitled Earth Drilling Machine.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to earth boring or drilling machines. It particularly relates to constructional features of the machine rendering it easy to repair internal components of the rotary drive mechanism, and to features for minimizing wear of certain parts.

2. Description of the Prior Art

The present invention relates to an earth boring or drilling machine of the same basic type as disclosed in U.S. Pat. No. 3,220,494, granted on Nov. 30, 1965 to Robert E. Cannon et al., in U. S. Pat. No. 3,454,114, granted July 8, 1969 to Leland B. Poage, in U. S. Pat. No. 3,490,546, granted Jan. 20, 1970 to John S. Hatt-rup et al., in U. S. Pat. No. 3,463,247, granted Aug. 26, 1969 to Harold T. Klein, and in U. S. Pat. No. 3,554,298, granted Jan. 12, 1971 to Harold T. Klein. Like the machines disclosed by these patents the machine of the present invention is a precision earth drilling machine which includes rotary drilling equipment mounted for precision movement up and down along base supported guide column means by a traveling cross frame which is hydraulically raised and lowered.

SUMMARY OF THE INVENTION

Drilling machines according to the present invention comprise motor and gearing components for imparting rotation to a drill head. These components and the drill head are carried by a traveling cross frame which is mounted for precision movement up and down along upstanding guide columns, and is so moved by hydraulic thrust rams or linear motors, or the like. The various components of the drilling equipment are separately housed in housing parts which are axially connected together by removable fasteners. According to this invention one housing part or an assembly of several housing parts, and the contents thereof, are securely anchored. This may be done by securing them to a portion of the machine frame, e.g., near the upper end of the guide columns. Then, the removable fasteners are removed and the non-anchored portion of the drilling equipment, which is carried by the movable cross frame, is moved away from the anchored portion. The internal components of the drilling equipment are constructed such that at least some of them can be decoupled by a mere movement apart of the housing parts within which they are contained. Also, such internal parts are easily axially removable from their housing parts. According to the invention, the non-anchored portion of the drilling equipment is moved axially away from the anchored portion of the thrust rams, to provide access to the inside of one or both of the separated housing parts for repair or routine maintenance, etc.

BRIEF DESCRIPTION OF THE DRAWING

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

FIG. 1 is an isometric view taken from above and looking towards one side and the front of a drilling machine constructed according to the present invention, showing the rotary drive apparatus in a partially raised position;

FIG. 2 is a view like FIG. 1, but showing the rotary drive apparatus in a lowered position;

FIG. 3 is a fragmentary front elevational view of the rotary drilling apparatus, partially in section taken substantially along line 3—3 of FIG. 7;

FIG. 4 is a side elevational view, with some parts in section, of one of the motor-transmission assemblies which supply a rotary drive input to the collector gearing;

FIG. 5 is a fragmentary vertical sectional view, with some parts in side elevation, of the collector gearing and lower portions of the two motor-transmission assemblies;

FIG. 6 is a fragmentary side elevational view taken through the drive head assembly;

FIG. 7 is a cross-sectional view taken through the drilling machine substantially along line 7—7 in FIG. 2 and showing portions of the machine in top plan; and

FIG. 8 is an elevational view of the machine showing the motor, gear reduction and collector gearing portion thereof secured to an upper frame portion of the machine and the traveling cross frame and the rotary drive components carried thereby lowered downwardly from such anchored portion, to provide an access space for servicing internal parts of the rotary drilling apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more specifically to the several figures of the drawing, the illustrated embodiment is shown to comprise a lower or base frame assembly 10 including a base plate member 12 and a generally U-shaped (in plan) main frame 14 upstanding from the plate member 12. Frame 14 includes upstanding wall portions forming a pair of sockets 16 which occupy near corner positions on the plate member 12. The lower end portions of a pair of parallel guide columns 18 are received in the sockets 16 and are rigidly secured to the base frame member thereby. A fixed upper cross frame member 20 rigidly interconnects the upper ends of the guide columns 18. The base frame assembly 10 and the upper cross frame 20 together constitute "main frame means" in the illustrated embodiment.

The guide columns 18 support and guide a movable or traveling cross frame 22. Traveling cross frame 22 includes vertically spaced apart upper and lower guide sleeves 24, 26 which surroundingly engage the columns 18. A lower portion of the traveling cross frame 22 extends laterally from the sleeves 26 into a position over the base frame assembly 10. It includes wall means 28 forming a housing for a bearing assembly (FIG. 6). A second housing 30 extends laterally from the upper guide sleeves 26 into a position above the housing 28. Housings 28, 30, sleeves 24, 26 and the interconnecting parts of traveling cross frame 22 are structurally integrated into a single rigid frame assembly.

The upper housing 30 contains collector gearing 32 (FIGS. 3 and 5) having a pair of input gears 34 and a single output gear 36.

A pair of drive motor assemblies are bolted to the housing 30 and each has an output shaft which is cou-

pled to one of the input gears 34, as will hereinafter be explained in greater detail.

In preferred form the motor assemblies comprise an electric motor 38 and a planetary type reduction transmission 40, such as the type shown by FIG. 7 of the
5 aforementioned U.S. Pat. No. 3,454,114, and described in detail below.

Traveling cross frame 22 is raised and lowered by a plurality of thrust rams 41. According to the invention, each thrust ram 41 comprises a hollow piston chamber or "cylinder" designated 42, and a piston comprising a
10 rod 44 and a head 45. In the illustrated embodiment the closed ends of the piston housings 42 are directed upwardly and the open ends are directed downwardly. Mounting sockets 46 of split form receive the lower
15 end portions of the housings 42 and firmly secure them to the traveling cross frame 22 (FIG. 3). Piston rods 44 include lower end mounting portions 48 which are secured to the lower frame 10. The mounting portions 48
20 are received between vertical plate portions of the frame member 14 and are secured to such plate portions by transverse mounting pins 50. The thrust rams 41 are essentially identical to the thrust rams shown by the aforementioned U.S. Pat. No. 3,454,114. Accord-
25 ingly, further details of these thrust rams 41, including the means for supplying and exhausting a motive fluid to and from them, will not be specifically described herein. Rather, reference is made to U.S. Pat. No. 3,454,114, the contents of which are expressly incorporated
30 herein by this reference.

As best shown by FIGS. 1, 2 and 7, the guide columns 18 and two of the thrust rams 41 are spaced apart in a quadrangular pattern, with the guide columns 18 being relatively close to corner portions of the base frame assembly 10 on one side of such base frame 10 and the
35 two thrust rams 41 being in the corner portions on the other side of base frame assembly 10. The third thrust ram 41 is located generally between the guide columns 18 and forms a triangular pattern with the other two thrust rams 41. The drilling axis X (FIG. 7) is located
40 substantially at the center of forces within the triangle. The upper ends of the cylinders 42 are interconnected by a generally triangular shaped traveling head frame 52.

Herein the term "jack means" is sometimes used to describe the thrust ram assemblies 41. Indeed, the double acting linear hydraulic motors 41 are a type of
45 "jack means." It is recognized that the "jack means" could possible take other forms in other installations (e.g., as a mechanical screw).

Reference is now made to FIG. 4 of the drawing. In this figure, and in other figures as well, the motor is designated 38 and the speed reduction gearing is generally designated 40. Each motor-gear reduction assembly
50 38, 40 is in the form of an elongated vertical column which is substantially parallel to the guide columns 18 and the thrust rams 41.

A lower mounting flange 54 on the motor 38 is secured to an upper mounting flange 56 on a drive box 58 in which the reduction gearing is housed. The central output shaft 60 of the motor 38 projects downwardly into the upper portion of the drive box 58 and carries a first sun gear 62 at its lower end. The transmission is a two speed transmission. Sun gear 62 always
55 meshes with three large diameter planet gears 64 (one of which is shown in FIG. 4) constituting parts of three dual planet gear elements which are journaled at their

ends in portions of the drive box housing 58. Such elements include small diameter planet gears 66 which always mesh with a ring gear 68, coaxially related to the sun gear 62. Ring gear 68 includes internal teeth 70 as well as external teeth 72. The upper end gear 74 of an axially movable gear unit 76 also includes inner and outer teeth 78, 80, respectively. When gear unit 76 is moved upwardly and is supported in an upper position its inner teeth 78 mesh with gear 62 and it is completely
10 free of ring gear 130. This is a "high speed" condition. When gear unit 76 is moved downwardly and is supported in its lower position (the position shown by FIG. 4), the external teeth 80 mesh with the internal teeth 70 of the ring gear 68 and the gearing 64, 66, 68 be-
15 comes a part of the drive train. This is a "low speed" condition.

Ring gear 68 merely "floats" radially between the three planet gears 66. Axially it is supported on and by plates 82 which either turn with or are freely mounted about the lower end portion of the shaft for each gear
20 66.

Gear unit 76 is moved axially for shifting gears or changing the drive speed by a lever mechanism 84 which engages it between a pair of flanges 86, 88.

A relatively small sun gear 90 at the lower end of unit 76 meshes with three traveling planet gears 92 (one of which is shown in FIG. 4) which ride about a stationary internal ring or orbit gear 94. The gears 92 are journaled for free rotation about fixed shafts 96 which are
25 carried at the larger diameter end of a central shaft 98, coaxially related to shafts 60 and 76. The smaller diameter end of shaft 98 carries a sun gear 100 which meshes with three traveling planet gears 102. Gears 102 travel around a fixed internal ring or orbit gear 104 as they rotate. The gears 102 are mounted for free rotation about fixed support shafts 106 which are carried
30 at the larger diameter end of a main or output shaft 108. The main shaft 108 is journaled for rotation at its upper end by a combination bearing 110. As used herein the term "combination bearing" means a bearing capable of carrying both radial and axial or thrust loads.

The lower portion of main shaft 108 is spline connected at 112 to a tubular extension 114. A combined
35 bearing 116 is located within the lower portion 118 of drive box 58 in surrounding relationship to the upper end of the tubular extension 114. An annular retaining flange 120, connected to the drive box member 118 by a plurality of machine bolts 122, serves to hold the bearing 116 in place.

The extension 114 is located within a housing part which is bolted at its upper end to the gear box part 118 and at its lower end to the collector gearing housing 30. The bolts carrying the housing part 124 to housing 30
40 are designated 126 in FIGS. 1, 2 and 5. In the same figures the bolts which secure the lower mounting flange of the housing 30 to the housing 28 are designated 128.

Referring specifically to FIGS. 3 and 5, the extension 114 includes internal axial splines which mate with external splines on the upper end portion of a shaft 130 which mounts the pinion gears 34 for rotation. The gear member 34 is shown to be annular in form and to be spline connected at 132 to the shaft 130. The upper end of each shaft 130 is contained within a combination bearing unit 134 and the lower end portion of shaft 130 is contained within a similar lower combination bearing 136. The lower bearing 136 is received within
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a mounting socket 138 formed in the lower portion of casing 30. A shoulder 140 is formed on the shaft 130 and this shoulder 140 serves as a seat for the upper bearing 134. Each upper bearing 134 is surrounded by a housing 142 which includes a lower flange 144. The flange 144 is clamped between an upper shoulder portion of casing 30 and a lower flange portion of casing 124 when the casing parts 30, 124 are assembled.

As can be readily seen from an inspection of the drawing figures, the internal components of the collector gearing housing 30 and the drive head housing 28 therebelow are all mounted in such a way that they can be easily removed axially outwardly from their respective housings 28, 30 when such housings 28, 30 are disconnected and moved apart from each other, and when housing 30 is disconnected and moved apart from housing 124. The reason for this construction is hereinafter explained in detail.

Upper and lower combination bearings 146, 148 serve to mount a central shaft 150 to which the gear 36 is secured, such as by splines 152. The lower end portion of shaft 150 extends through a bottom opening in housing 30 and downwardly below such housing 30 and includes external splines 154. As best shown by FIG. 6, but also by FIG. 3, the splined lower end portion of shaft 150 extends into an upstanding tubular drive member 156. This drive member 156 includes an enlarged diameter lower end portion 158 which carries peripheral splines 160. This splined lower end portion 158 of member 156 is contained within a larger diameter tubular drive member 162. Drive member 162 is shown to be of composite construction, and to comprise upper and lower parts, each of which includes a reduced diameter end portion. The upper end portion of the upper part of member 162 is contained within a combination bearing 164. The lower end portion of the lower part of member 162 is contained within a larger combination bearing 166. A socket 168 is formed in the lower portion of housing 28 to receive the bearing 166. Bearing 164 is supported on a shoulder 170 formed at the upper end of member 162, and is radially outwardly bounded by an annular member 172. An annular disc like seal member 174 is secured between the upper surface of bearing 164 and an annular retaining flange 175 which is secured to member 172 by bolts 176. The seal member 174 makes loose contact with the upper end portion of drive member 156 so that relative movement can occur between the two. A main drive head 178 extends axially through the tubular lower portion 180 of drive member 162. Drive head 178 includes an enlarged diameter upper end portion 182 on the outer periphery of which are formed axial splines 184. The splines 184 mate with a set of longer axial splines 186 formed on the inside wall of the intermediate drive member 162. The splines 184, 186 couple the drive head 178 and the drive member 162 together for conjoint rotation, but permit a limited amount of axial movement of the drive head 178 relative to the drive member 162.

The lower end portion of the drill head 178 includes a tool joint component, shown in the form of an interiorly threaded socket or box 188. A complementary pin type tool joint component 189 of an upper section of drill pipe 190 is thread connected to the tool joint component 180. A tubular center shaft 192 extends from a lower portion of drive head 178, upwardly through the hollow interior of drive head 178, then through the hol-

low interior of drive member 156, then through the hollow interior of gear shaft 150, and then upwardly through space to a connection with the lower portion of a fluid transmitting swivel coupler (not shown) positioned below top frame member 52. Shaft 192 is connected to the output gear by the drill head 178 which is the slowest driven part of the drive system. Thus its bearings and seals are subjected to the smallest amount of wear as is possible. The upper portion of the fluid coupler is connected to a source of drilling fluid which is delivered downwardly through the coupler and the tubular shaft 192 to the hollow interior of the drill pipe. The upper portion of the swivel coupler 194 is also connected to a piston rod (not shown) which projects upwardly into a cylinder 196 located on top of frame member 52. The cylinder 196 is a part of a double acting linear hydraulic motor provided for balancing the weight of the drill stem and the drive head 178. This balancing feature is covered in detail in our copending application Ser. No. 75,020, filed Sept. 24, 1970, and entitled Earth Drilling Machine.

Referring specifically to FIG. 6, the combination bearings 164, 166 contain tapered roller elements 198, 200, respectively. The elements 198, 200 are longitudinally curved. The curvature is the same for all elements 198, 200 and falls on an imaginary circle having its center approximately at 202. Owing to this arrangement, at least the major bending forces transmitted to drive head 178 by the drill stem are not transmitted up to the central drive gear 36. Instead the bending forces merely cause the drive head 178 and the drive member 162 to which it is spline connected to rotate or tilt sideways slightly about the center 202. The splines 160 are short enough and enough clearance exists where they mate with splines 161 so that the drive member 156 tilts very little or not at all upon tilting movement of drive head 178 in drive member 162. Thus, in effect a "hinge" joint exists between drive members 158, 162 which is incapable of transmitting bending forces.

A flexible wall seal member 204 is secured to a lower portion of the traveling cross frame 22, such as by a plurality of bolts 206, and is also secured to an annular sleeve 208 which surrounds the lower portion 180 of drive member 162.

Referring now to FIG. 8, according to the present invention the thrust rams 41 are operated to move the drilling equipment to a relatively upper position. Then, the portion of the drilling equipment above and including housing 30 is anchored in an elevated position, such as by lashing it to the upper frame member 20, by means of chains 210, for example. The bolts 128 serving to connect housings 30, 28 together are removed and the thrust rams 41 are operated to lower the traveling cross frame 22. This provides an access space 212 between the housings 28, 30, providing access to the internal components of housing 28. As earlier mentioned, the components in housing 28 are designed so that they can be easily removed axially from the housing 28. Also, each part is of such a length that it can be removed within the space provided at 212.

According to the invention, the separation can be made between the housing 124 and the housing 30, by removal of the bolts 126. As earlier described, the internal components of housing 30 are also designed to be easily removed axially from the housing 30. Of course, in other embodiments the separation between casing parts could be made at still a different location.

Also, it is to be understood that the present invention is not limited to a machine in which the drill pipe is directed downwardly, but may also apply to a machine in which the drilling equipment is reversed on the traveling cross frame 22 and the drive head 178 and the drill pipe are directed upwardly. Further, it is to be understood that the machine may be adapted to drill at an angle from vertical; the direction of drilling is not particularly important to this invention.

It is to be understood that the illustrated machine, described above, is merely a typical, single embodiment of the invention, and in most respects the invention can take other hardware forms. The invention is to be defined and limited not by the drawing and description relating thereto, but rather by the following claims.

What is claimed is:

1. In a drilling mechanism comprising main frame means, upstanding guide column means rigidly connected to said main frame means, traveling cross frame means mounted for precision up and down travel along said column means, jack means interconnected between said traveling cross frame means and said main frame means for moving said traveling cross frame means up and down along said guide columns relative to said main frame means, and drilling equipment carried by said traveling cross frame means and including a rotary drill head connectible to drill pipe, motor means and transmission means drivingly connecting said motor means to said drill head, the improvement characterized by:

said drilling equipment comprising a driving portion in a first casing part and a driven portion in a second casing part;

said driving portion including a rotary driving member, said driven portion including a rotary driven member, and joint means normally coupling said members together for rotary drive transmission but permitting relative axial movement of each said member apart from the other member; and

said first casing part being axially connected to said second casing part by removable connector means, so that said casing parts can be disconnected from each other and moved axially apart;

whereby the driving portion of the drilling equipment, including the first casing part and the driving member therein, can be anchored and said jack means can be operated to move said traveling cross frame means and the driven portion of the drilling equipment carried thereby, including the second casing part and the driven member therein, away from the anchored driving portion of said drilling equipment.

2. The drilling mechanism improvement of claim 1, wherein each said casing part is connected to guide means engaging the said upstanding guide column means and serving to mount such part for up and down travel along said guide column means independently of the other part.

3. The drilling mechanism improvement of claim 1, wherein said jack means include at least one double acting hydraulic thrust ram comprising a piston housing connected to one of said main and traveling cross frame means, a piston head in said piston housing, a piston rod connected to said head and to the other of said main and traveling cross frame means, hydraulic fluid supply-removal passageway means leading into the piston housing on both sides of the piston head, and

means for selectively supplying a hydraulic fluid through one of said passageway means into the piston housing on one side of said piston head while removing it from the piston housing on the opposite side of the piston head through another of said passageway means.

4. The drilling mechanism improvement of claim 3, wherein the piston housing has an open end portion which is attached to said traveling cross frame means and said piston rod includes an outer end portion which is connected to the main frame means.

5. The drilling mechanism improvement of claim 1, wherein at least one of said casing parts includes rotary drive transmission components and means mounting them in said casing part so that they can be removed axially from said casing part when the two casing parts are moved apart.

6. The drilling mechanism improvement of claim 1, wherein said main frame means comprises a base member placeable on the ground and located on at least one side of a drilling axis established by the drilling equipment, means for rigidly securing a lower end portion of the upstanding guide column means to said base member, and said jack means comprising at least one double acting hydraulic thrust ram comprising a piston housing connected to one of said base member and cross frame means, a piston head in said piston housing, a piston rod connected to said head and to the other of said base member and cross frame means, hydraulic supply-removal passageway means leading into the piston housing on both sides of the piston head, and means for selectively supplying a hydraulic fluid through one of said passageway means into the piston housing on one side of said piston head while removing it from the piston housing on the opposite side of the piston head through another of said passageway means.

7. The drilling mechanism improvement of claim 6, wherein the piston housing has an open end portion which is attached to said cross frame means, and said piston housing extends upwardly from said cross frame means to a closed upper end, and said piston rod extends downwardly out from said piston housing and includes a lower end portion which is connected to the said base frame member in spaced relationship to the said upstanding guide column means.

8. The drilling mechanism improvement of claim 1, wherein said traveling cross frame means includes guide means engaging the said upstanding guide column means and serving to mount the traveling cross frame means onto said upstanding guide column means for precision up and down travel therealong and also means for securing the open end portion of the piston housing to the traveling cross frame means at substantially the same level as said guide means, and said traveling cross frame means includes a rigid torque transferring body which is interconnected between said guide means and said connector means, and said drilling equipment is rigidly secured to said traveling cross frame means.

9. The drilling mechanism improvement of claim 1, wherein said main frame means includes a frame member to which the driving portion of the drilling equipment can be secured and in that fashion anchored prior to using the traveling cross frame means for moving the driven portion of the drilling equipment away from said anchored driving portion.

10. The drilling mechanism improvement of claim 9, wherein said upstanding guide column means com-

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prises a pair of parallel, laterally spaced apart guide column members, and the said portion of the main frame means to which the driving portion of the drilling equipment is anchored comprises a laterally extending frame member rigidly interconnected between the upper ends of said guide column members. 5

11. A method of gaining access to internal components of drilling equipment in a drilling mechanism which comprises main frame means, upstanding guide column means rigidly connected to said main frame means, traveling cross frame means mounted for precision up and down travel along said column means, jack means interconnected between said traveling cross frame means and said main frame means for moving said traveling cross frame means up and down along said guide columns relative to said main frame means, and drilling equipment carried by said traveling cross frame means and including a rotary drill head connectible to drill pipe, motor means and transmission means drivingly connecting said motor means to said drill head, said method comprising: 15 20

locating a driving portion of the drilling equipment in a first casing part and a driven portion of such equipment in a second casing part;

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providing means for drivingly connecting the driving portion of the drilling equipment to the driven portion of such equipment in such a manner that rotary drive forces are transmitted from the former to the latter while permitting relative axial movement of each completely apart from the other;

securing the two casing parts together by removable connector means;

mounting the driven portion of the equipment and its casing part onto the traveling cross frame means; when it is desirable to have access to internal portions of the drilling equipment anchoring the driving portion of the drilling equipment, including its casing part;

removing the removable connector means holding the casing parts together; and

operating said jack means to move the traveling cross frame means and the driven portion of the drilling equipment carried thereby including the second casing part, away from the anchored driving portion of said drilling equipment, to provide an access space between the two casing parts.

* * * * *