United States Patent [19]

Klein

[11] **3,797,587**

[45] **Mar. 19, 1974**

[54] **SLEEVE CYLINDER POWERED DRILLING MACHINE**

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[73] Assignee: **The Robbins Company,** Seattle, Wash.

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[52] **U.S. Cl.** **173/152,** 92/52, 173/37

[51] **Int. Cl.** **E21c 5/11**

[58] **Field of Search** 173/152, 164, 43, 28; 92/52, 53

[56] **References Cited**

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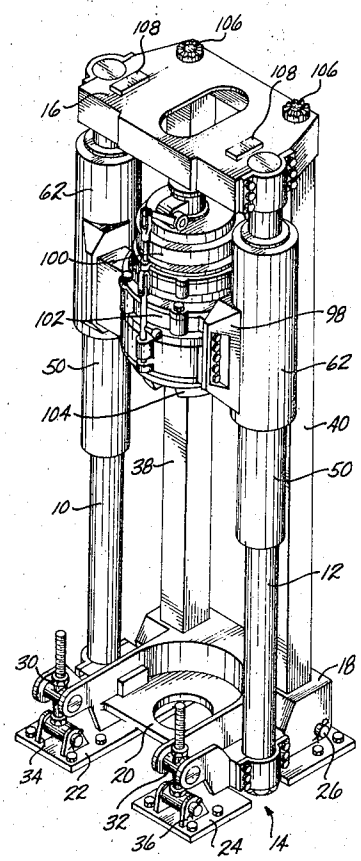
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[57] **ABSTRACT**

Rotary drilling equipment mounted on a traveling frame is moved up and down along a guide column by means of a first cylinder which surrounds and travels along the guide column and a second cylinder which surrounds and travels along the first cylinder. The guide column means is interconnected between a head frame and a base frame. The guide column means, the head frame and the base frame all together form a rigid closed box frame structure.

13 Claims, 6 Drawing Figures



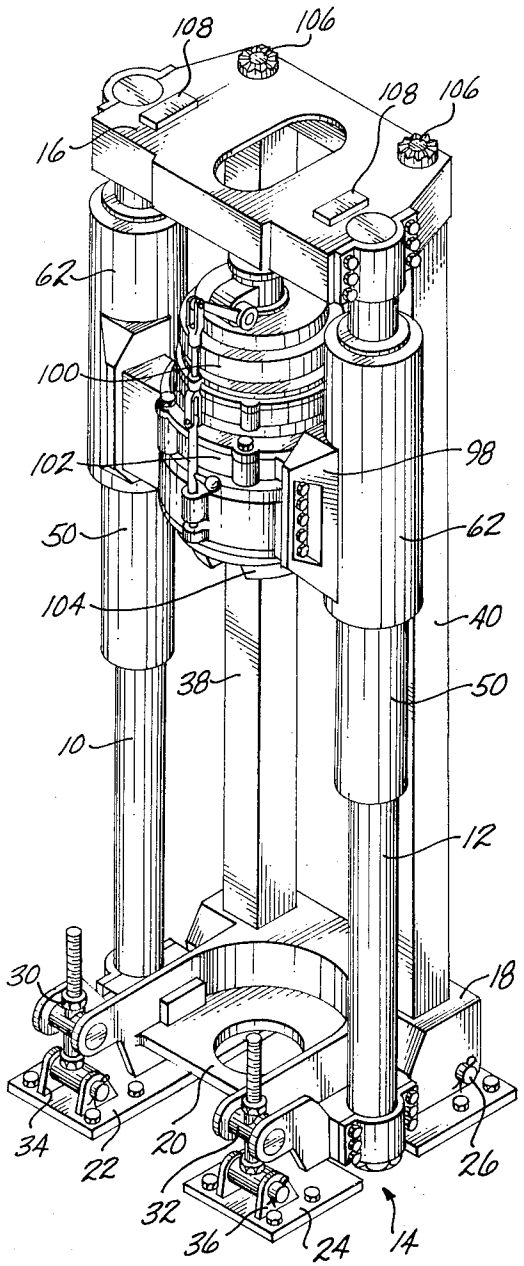

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Fig. 1

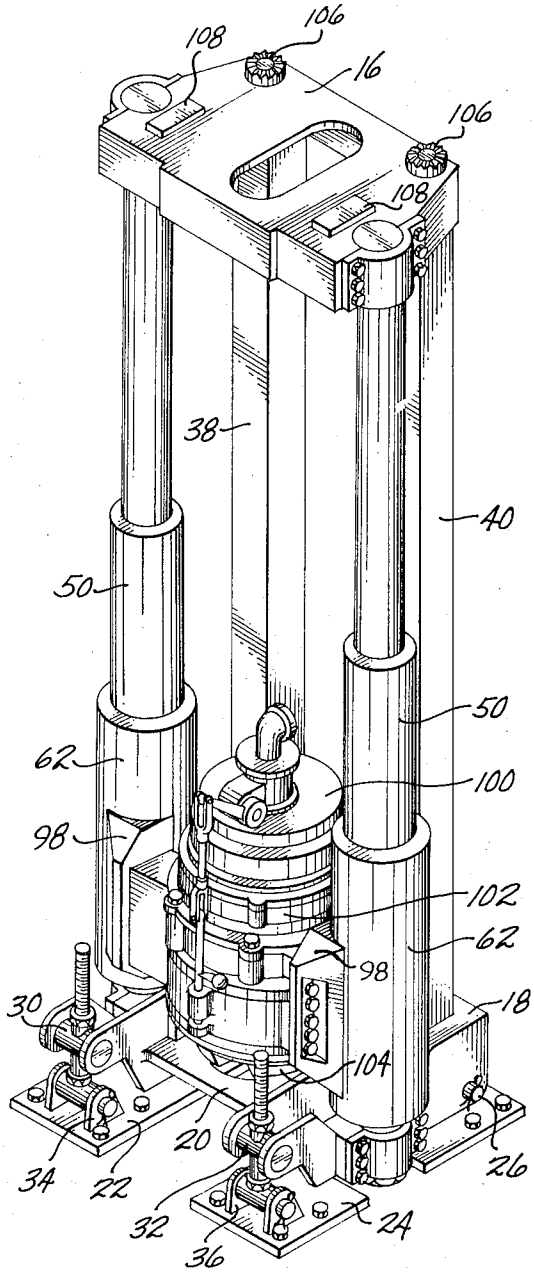

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Fig. 2

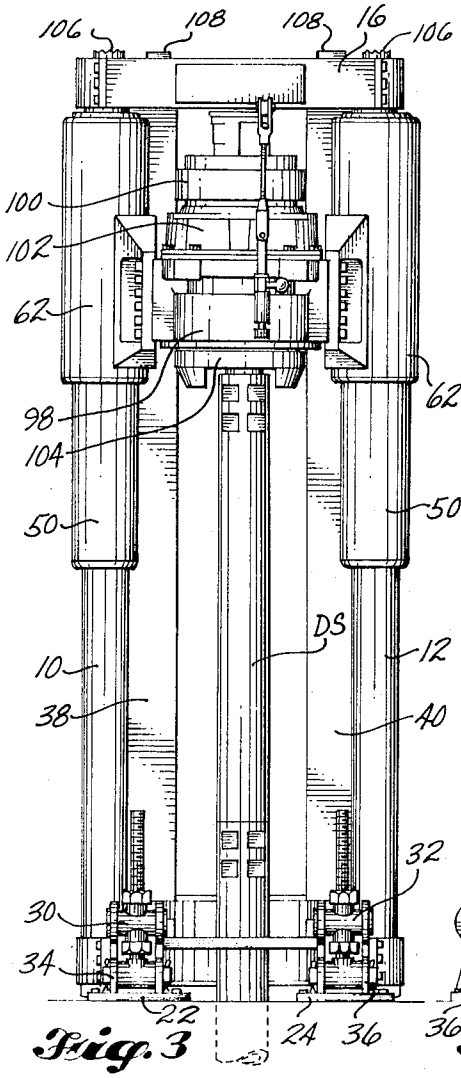


Fig. 3

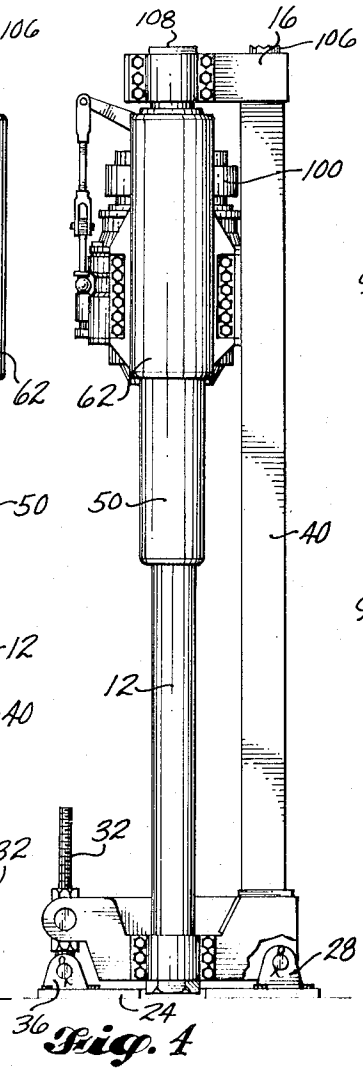


Fig. 4

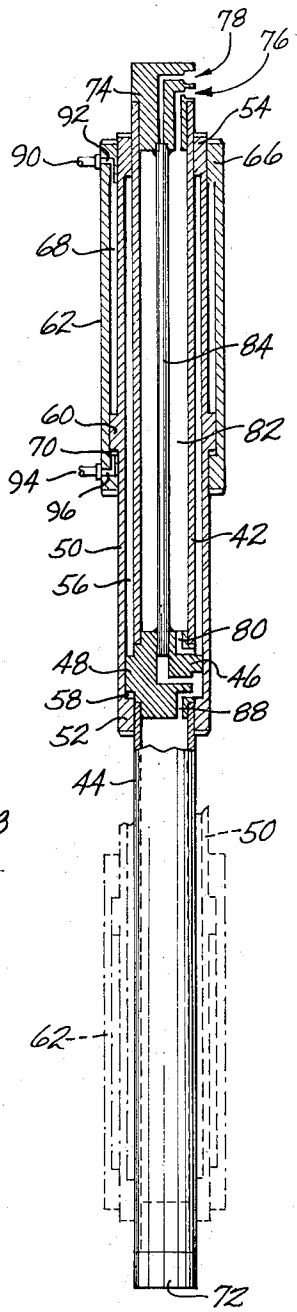


Fig. 6

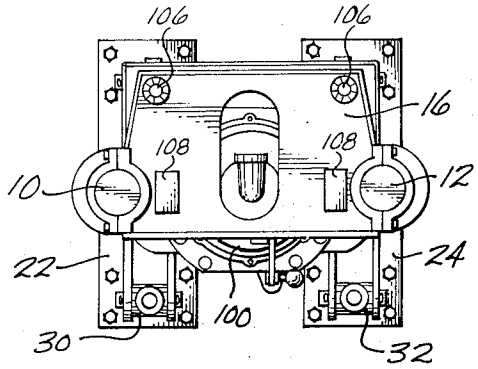


Fig. 5

SLEEVE CYLINDER POWERED DRILLING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to earth boring or drilling machines, and particularly relates to mechanism for axially driving and guiding the rotary drilling equipment of such machines.

2. Description of the Prior Art

U.S. Pat. No. 3,454,114, granted July 8, 1969, to Leland B. Poage discloses a drilling machine in which a traveling frame and rotary drilling equipment carried thereby are hydraulically raised and lowered by one or more linear hydraulic motors **82, 84,** and are guided along a pair of upstanding guide columns **38, 40.** A disadvantage of such drilling equipment is that in order to utilize the full stroke of the hydraulic motors **82, 84** it is necessary to raise the upper ends of the cylinders substantially above the upper end of the guide columns, necessitating a sufficient height clearance availability. Tunneling machines of this type are adapted for use within tunnels and other underground rooms in which vertical clearance is sometimes quite difficult to provide.

SUMMARY OF THE INVENTION

According to the invention, the rotary drilling equipment is moved up and down along at least one guide column by means of a first hydraulic cylinder which travels along the guide column and a second cylinder which travels along the first cylinder. The guide column may be termed a "piston column" in that it includes a fixed piston head intermediate its two ends. The first cylinder forms variable volume chambers on the opposite sides of the fixed piston head. A second piston head surrounds the first cylinder intermediate its two ends. The second cylinder helps define a second pair of variable volume working chambers on opposite sides of the second piston head. This arrangement permits a long drill stroke without varying the overall machine height.

In preferred form the machine has a lightweight, compact, but rigid, box frame composed of a pair of guide columns, a rigid base frame, a rigid head frame, and auxiliary column means interconnected between the head and base frame members. This "box frame" construction makes it possible for the machine to be transported by almost any method, including by skidding on the auxiliary column means. Also, lifting and setup of the machine is facilitated because of the frame construction.

These and other features, advantages and characteristics of the earth drilling equipment of this 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

FIG. **1** is a perspective view taken from above and looking toward the front and one side of an embodiment of the drilling machine of this invention, showing the drilling equipment in a raised position;

FIG. **2** is a view like FIG. **1,** but showing the drilling equipment in a lowered position;

FIG. **3** is a front elevational view of the drilling machine shown by FIGS. **1** and **2,** with the drilling equipment shown in a raised position and a sectional drill stem connected thereto;

FIG. **4** is a side elevational view of the drilling machine shown by FIGS. **1–3,** also showing the drilling equipment in a raised position;

FIG. **5** is a top plan view of the drilling machine of FIGS. **1–4;** and

FIG. **6** is a view partially in side elevation and partially in vertical section, of one of the piston columns and the two sleeve cylinders mounted thereon, showing one embodiment of the fluid supply and discharge ducting.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In preferred form, the drilling machine of this invention comprises a pair of laterally spaced apart, parallel, upstanding piston columns **10, 12.** These columns **10, 12** are connected at their lower ends to a base assembly **14** and at their upper ends to a head frame member **16.** The base frame assembly comprises a generally U-shaped base frame member **18** supporting a worktable **20.** The base frame member **18** includes integral rear and side portions. Frame member **18** includes integral rear and side portions. Frame member **18** is pivotally mounted to rear portions of a pair of mounting feet **22, 24** for pivotal tilting about a transverse axis **26.** Shaft means establishing axis **26** extend through aligned openings in side wall portions of the frame member **18** and in upstanding rear brackets **28** on the mounting feet **22, 24** (FIG. **4**).

In use, the mounting feet **22, 24** are rigidly secured to the ground or earth material at the drilling site, to a concrete pad formed at the drilling site, or to some other suitable mass. A pair of turnbuckles **30, 32** are interconnected between forward side portions of the frame member **18** and a forward set of upstanding brackets **34, 36.** These turnbuckles **30, 32** provide a way for adjusting the attitude of the piston columns **10, 12** relative to the mounting feet **22, 24,** for fixing the drilling angle.

The preferred embodiment also comprises a pair of laterally spaced apart, parallel rear support columns **38, 40.** These columns **38, 40** are rigidly connected between rearward corner portions of the base frame member **18** and rearward corner portions of the upper frame member **16.** The head frame member **16,** the base frame member **18,** the piston columns **10, 12** and the rear support columns **38, 40** all together form a rigid closed box frame structure which supports the rotary drilling equipment and permits transportaiton of the machine without disassembly. It is to be understood, however, that the drilling forces can be taken by the piston columns alone, making it possible to eliminate the rear columns **38, 40.**

In preferred form, the piston columns **10, 12** comprise a pair of cylindrical members interconnected by a central plug member. In FIG. **6,** relating by way of example to column **10,** the cylindrical members are designated **42** and **44,** and the central plug member is designated **46.** Plug member **46** includes opposite end portions which are sized to be snugly received within the inside diameter of the cylindrical members **42, 44,** and an enlarged diameter central portion **48** which forms a fixed piston head intermediate the length of the column

10 (or 12). A first traveling cylinder 50 surrounds the piston column 10. It has end portions 52, 54 which snugly receive the outside diameter of the column sections 42, 44 and an intermediate portion having an inside diameter for snugly receiving the fixed piston 48. Annular variable volume chambers 56, 58 are formed between cylinder 50 and the column sections 42, 44 on opposite sides of the fixed piston 48.

Cylinder 50 includes an enlarged diameter portion 60 intermediate its two ends which forms a second piston 60. A second cylinder 62 surrounds the first cylinder 50. Cylinder 62 includes end portions 64, 66 of a diameter matching the outside diameter of first cylinder 50. Between these end portions 64, 66 the inside diameter of cylinder 62 is sized to snugly receive the outside diameter of piston 60. Annular variable volume chambers 68, 70 are formed between the cylinders 62, 50 on opposite sides of the second piston 60.

Various arrangements can be employed for supplying and removing fluid to and from the chambers 56, 58 and 68, 70. In the illustrated embodiment a closure plug 72 is provided at the lower end of piston cylinder section 44. A similar plug 74 is provided at the upper end of piston cylinder section 42. Plug 74 is provided with a pair of two-way fluid passageways 76, 78. Passageway 76 extends axially through member 74 into the interior of piston column section 42, in the region above the dividing plug 46. A passageway 80 through the upper portion of plug 46 communicates the hollow interior 82 with chamber 56. Passageway 78 extends axially through plug 74 and communicates with the interior of a small diameter tube 84. Tube 84 extends completely through the center plug 46 and communicates with the interior 86 of piston column section 44. A passageway 88 in the lower portion of plug 46 communicates chamber 86 with the lower work chamber 58.

By way of typical and therefore nonlimitive example, first flexible conduit 90 is shown connected to the upper end portion of the outer cylinder 62. It communicates with a passageway 92 which in turn communicates with cylinder chamber 68. In similar fashion, a second flexible conduit 94 is shown secured to the lower end portions 64 of cylinder 62. It communicates with a passageway 96 which in turn communicates with the lower working chamber 70.

A traveling cross frame 98 is rigidly interconnected between the two cylinders 62. This cross frame carries a rotary drive assembly comprising a drive motor 100, a drive box 102, and drill head 104.

In operation, the cross frame 98 and the drilling equipment 100, 102, 104 carried thereby, are powered up and down by the cylinders 50, 62. Selective supply and exhaust of fluid into the chambers 56, 58 causes movement of the first cylinder 50 up and down relative to the fixed piston 46, and along the piston column 10, 12. Selective supply and exhaust of fluid to and from the chamber 68, 70 causes axial travel of the second cylinder 62 relative to the second piston 60, and also relative to the column 10.

The two dual cylinder assemblies 50, 62 are symmetrically positioned in opposite sides of the drilling load, for totally balanced thrust. The cross-sectional areas of all the fluid chambers 56, 58 and 68, 70 should be equal. If so, the upper chambers 56, 68 can be hydraulically linked and the lower chambers 58, 70 can be hydraulically linked. As long as equal volumes of fluid are delivered to the two assemblies 50, 62, equal cylinder displacement will occur on each side of the machine. The division of displacement between cylinders 50 and 62 may differ between the two sides, but this is of no consequence. Further, for special speed or force needs, the working surface areas on opposite side of the piston head may be made to be unequal.

The cylinders 50, 62 are the key to space saving in the machine of this invention. Cylinders 50, 62 permit a long drill stroke without varying the overall machine height. By way of example, the machine is able to achieve a full sixty inch (60 inch) vertical stroke within a fixed machine height of only one hundred and three inches (103 inches). Constant speed and force throughout the entire stroke is achieved by the balanced piston design. Since the piston columns also act as bearing columns, they share torque and bending forces.

Because of its compact design, light weight, and the rigid one-piece head and main frame assembly, the machine of this invention can be lifted or transported by almost any method. The unit can be skidded (e.g. on the rear columns 38, 40) or moved by rail or wheeled vehicle.

The drilling head 104 is shown to include an internally threaded box member for receiving an externally threaded pin portion of each section of the drill stem DS. However, in some installations it may be desirable to locate a pin member in the head 104.

The rotary drive equipment 100, 102, 104 is operated to supply rotative torque to the drill stem DS during at least downward thrusting of the drilling equipment 100, 102, 104 by means of the dual cylinder assemblies 50, 62. The piston assemblies 50, 62 serve to accurately guide such drilling equipment along the piston columns 10, 12, so as to establish a precision drilling line. The drilling machine may be anchored in place by the base assembly alone, or the machine may be provided with roof jacks 106 for anchoring. The roof jacks would be used during operation of the machine in a tunnel or other cavity having a roof, or walls in the case of horizontal drilling. The roof jacks may be housed within the columns 38, 40.

The machine may be adapted for upward drilling by mounting the drilling equipment on the columns 10, 12 with the head 104 directed upwardly. Wrench braces 106, 108 are installed atop the head frame 16 to receive and restrain the holding wrench during up drilling.

Although two concentric cylinders are shown and described, it is to be understood that a larger number of concentric cylinders can be employed, each outer one shorter than its mating inner unit, to form a still greater stroke-ratio-to-length or height of the machine. In some installations it may be advantageous to use only a single sleeve type cylinder on each piston column.

From the foregoing, various further modifications, component arrangements and mode 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.

What is claimed is:

1. An earth drilling machine for rotating and translating a sectional drill stem which carries cutter means at its end distal the machine, comprising:

a guide column including a fixed piston head thereon intermediate the ends of the column;

a frame supporting said guide column at both of its ends, said frame including first and second end frame members, and additional support column means offset from said guide column, said additional support column means and said guide column both being rigidly interconnected between the first and second end frame members;

tubular first wall means surrounding said column and with said column forming a variable volume fluid chamber on each side of said fixed piston head, said tubular first wall means including a second fixed piston head thereon intermediate its two ends;

tubular second wall means surrounding said tubular first wall means and forming therewith a variable volume fluid chamber on each side of said second fixed piston head;

rotary drilling equipment secured to said tubular second wall means to be carried thereby; and

means for selectively delivering fluid to and removing fluid from said variable volume fluid chambers, for driving the tubular first wall means along said column and the tubular second wall means along said tubular first wall means.

2. A drilling machine according to claim **1,** wherein at least a portion of the passageway means for delivering fluid to, and removing such fluid from, the variable volume fluid chambers formed by and between the tubular first wall means and the column is located inside said column.

3. A drilling machine according to claim **1,** wherein said column comprises a pair of tubular members interconnected by a plug member having opposite end portions connected to said tubular members, and a center portion which forms said piston head.

4. A drilling machine according to claim **3,** wherein one of said tubular members includes an end portion opposite the plug member having a fluid passageway therein communicating with the interior of said tubular member, and wherein the plug member includes a passageway communicating the interior of such tubular member with the variable volume chamber formed by and between such tubular member and the tubular first wall means.

5. A drilling machine according to claim **3,** wherein a tube defining a fluid passageway extends through one of said tubular sections to and through the connecting plug member and communicates with the interior of the second tubular section, and wherein said plug member includes a passageway communicating the interior of said second tubular section with the variable volume chamber formed by and between such second tubular section and the tubular first wall means.

6. An earth drilling machine comprising:

a base frame member, a pair of laterally spaced apart guide columns rigidly secured to said base frame member and projecting upwardly therefrom, each in parallelism with the other, each said guide column including a fixed piston head thereon intermediate its two ends;

tubular first wall means surrounding each said column and with said column forming a variable volume fluid chamber on each side of its fixed piston head, each said tubular first wall means including a second fixed piston head thereon intermediate its two ends;

a tubular second wall means surrounding each said tubular first wall means and forming therewith a variable volume fluid chamber on each side of the second fixed piston head;

a traveling cross frame rigidly interconnected between each of said tubular second wall means, to be carried therewith and guided thereby along said guide columns;

rotary drilling equipment secured to said traveling cross frame means to be carried thereby;

means for selectively delivering fluid to and removing fluid from the said variable volume fluid chambers, or driving the tubular first wall means along said columns and the tubular second wall means along said tubular first wall means;

a head frame member rigidly interconnecting the ends of the two guide columns opposite the base frame member; and

additional support column means offset from said guide columns, said additional support column means being rigidly interconnected between the head frame member and the base frame member.

7. A drilling machine according to claim **6,** wherein said head frame member, said base frame member, said guide columns and said additional support column means all together form a rigid closed box frame structure.

8. A drilling machine according to claim **7,** wherein said additional support column means comprises at least one column member which is rigidly connected at one end to the base frame member adjacent the side boundary thereof and is rigidly connected at its opposite end to a corresponding side boundary of the head frame member.

9. The drilling machine according to claim **6,** wherein at least a portion of the passageway means for delivering fluid to, and removing fluid from, the variable volume fluid chambers formed by and between the tubular first wall means and the columns is located inside of said columns.

10. A drilling machine according to claim **6,** wherein each said guide column comprises a pair of tubular members interconnected by a plug member having opposite end portions connected to said tubular members, and a center portion which forms the piston head.

11. A drilling machine according to claim **10,** wherein one tubular member of each guide column includes an end portion opposite the plug member for such column, which end portion has a fluid passageway therein communicating with the interior of such tubular member, and wherein each plug member includes a passageway commuting the interior of its said tubular member with the variable volume chamber formed by and between such tubular member and the tubular first wall means.

12. A drilling machine according to claim **10,** wherein in each guide column a tube defining a fluid passageway extends through one of said tubular sections to and through the connecting plug member and communicates with the interior of the second tubular section, and wherein said plug member includes a passageway communicating the interior of said second tubular section with the variable volume chamber formed by and between such second tubular section and the tubular first wall means.

13. An earth drilling machine for rotating and translating a section drill stem which carries cutter means at its end distal the machine, comprising:

a frame including at least one fixed guide column including a fixed piston head thereon intermediate the ends of the column and support means anchorable at a drilling site and supporting said guide column at both of its ends;

said support means comprising, first and second end frame members, and additional support column means offset from said guide columns, said additional support column means and said guide columns both being rigidly interconnected between the first and second end frame members;

tubular wall means surrounding said column and with said column forming a variable volume fluid chamber on each side of said fixed piston head;

rotary drilling equipment;

means mounting said rotary drilling equipment on said tubular wall means; and

means for selectively delivering fluid to and removing fluid from said variable volume fluid chambers, for driving the tubular wall means, and the rotary drilling equipment carried thereby, along said column.

* * * * *