

- [54] INVERTIBLE DRILLING MACHINE
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[73] Assignee: The Robbins Company, Seattle, Wash.
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[51] Int. Cl. E21c 5/11, E21b 19/16
[58] Field of Search 173/28, 31, 32, 152, 29,
173/34, 164, 152; 175/87, 422

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[57] ABSTRACT

Rotary drilling equipment and a mounting frame therefor are advanced and retracted by means of hydraulic cylinders which surround and travel along guide columns. The guide columns are rigidly interconnected between two end frame members. Each end member is connectable to a ground emplaced base structure. The end member towards which the drill head is directed includes a first holding wrench retainer on its drill head or inboard side which is used during downward drilling. It also includes a second holding wrench retainer on its opposite or outboard side which is used during upward drilling.

4 Claims, 10 Drawing Figures

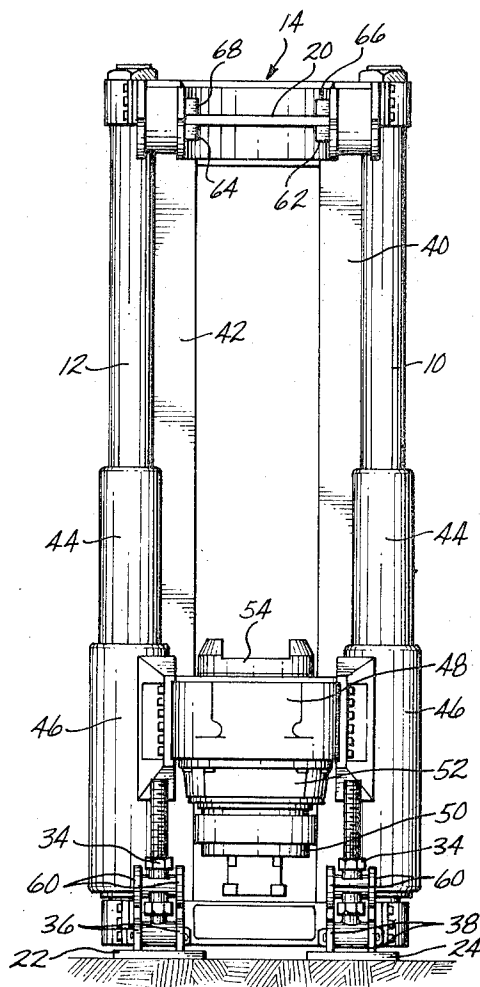
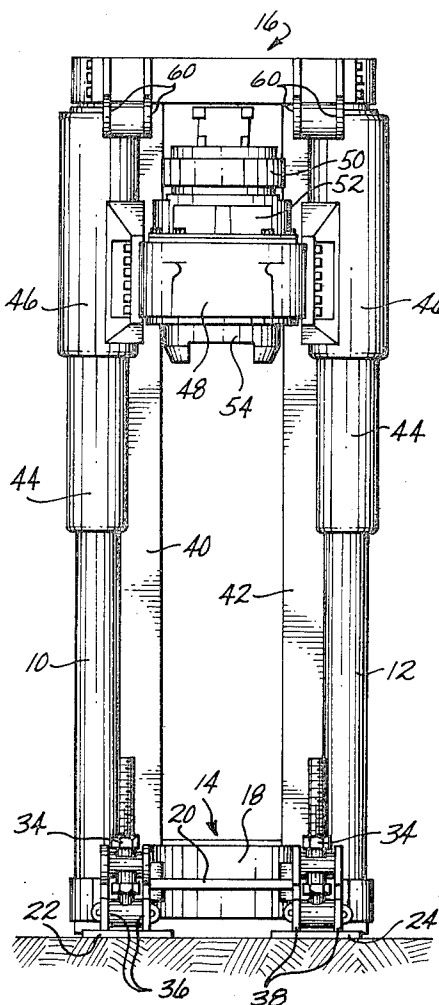


Fig. 1

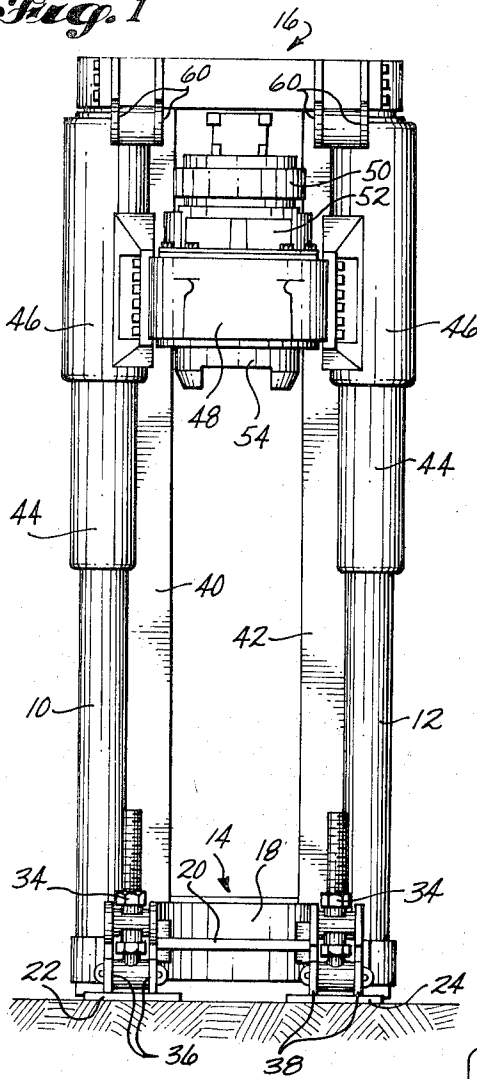


Fig. 2

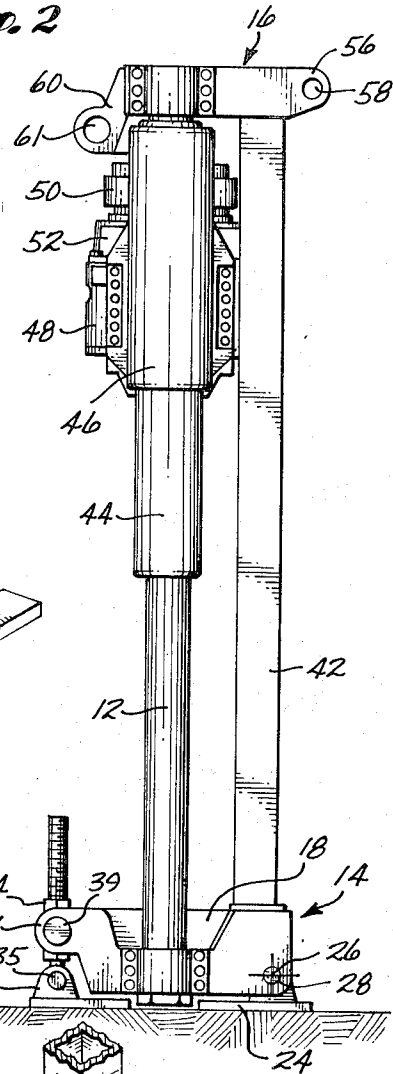


Fig. 3

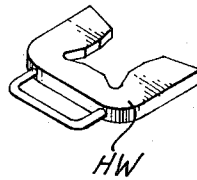


Fig. 4

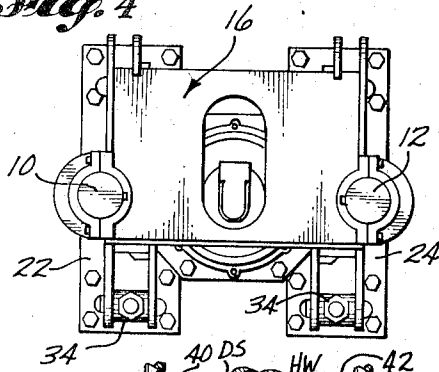


Fig. 5

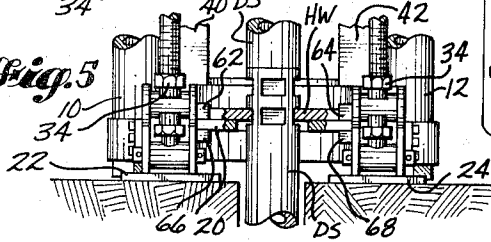


Fig. 6

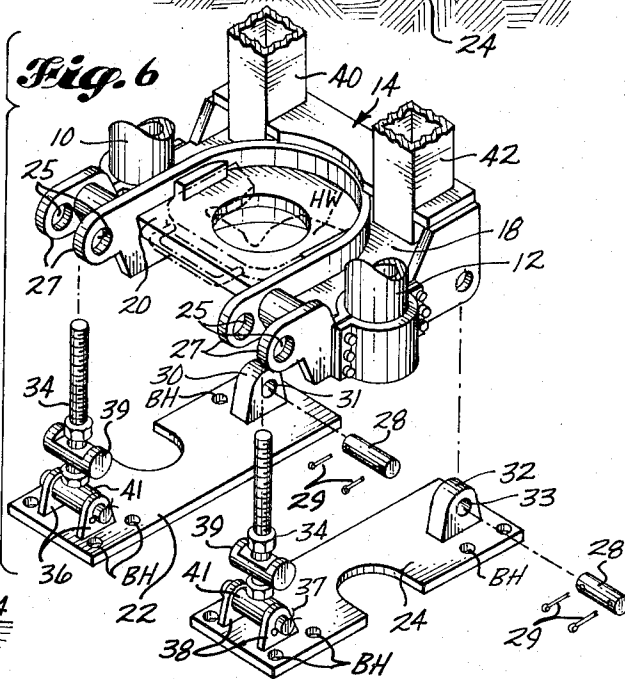


Fig. 7

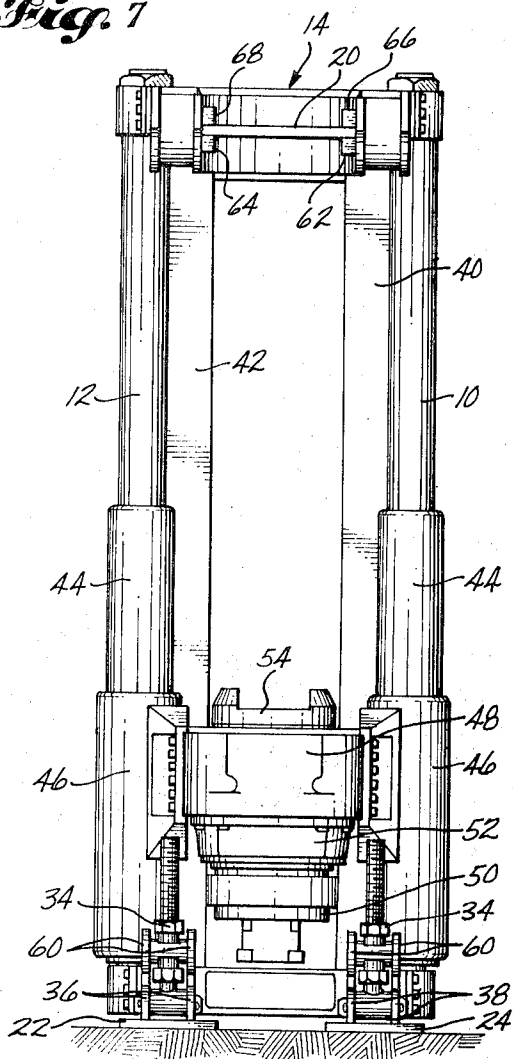


Fig. 8

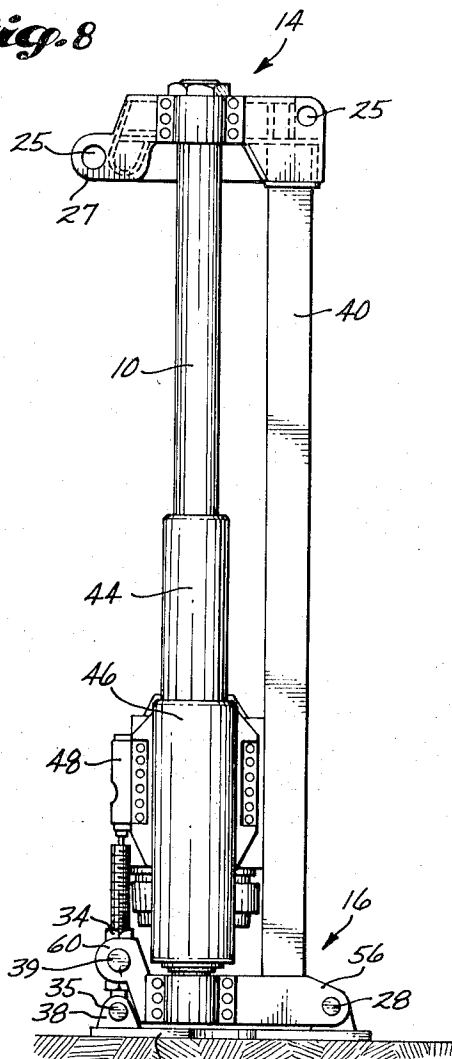


Fig. 9

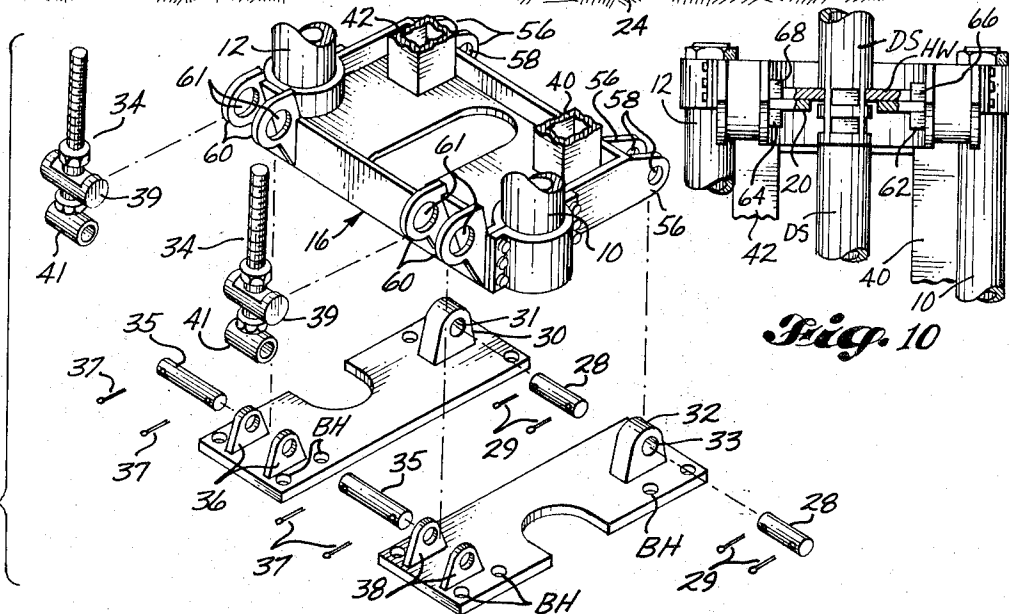
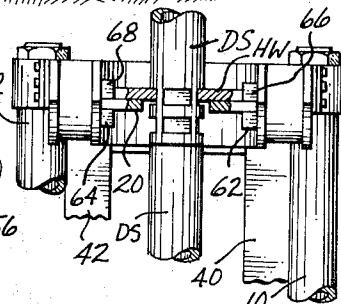


Fig. 10



INVERTIBLE DRILLING MACHINE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a companion to the Harold T. Klein U.S. application Ser. No. 214,813, filed Jan. 3, 1972, entitled Sleeve Cylinder Powered Drilling Machine, and now U.S. Pat. No. 3,797,587, granted Mar. 19, 1974. U.S. Patent No. 3,797,587 and this application are both owned by The Robbins Company, by virtue of assignments from the inventors.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to earth drilling machines, and in particular relates to the provision of an earth drilling machine including an invertible mast structure, enabling the machine to be simply turned end-for-end in order to adapt it for drilling in the opposite direction.

2. Description of the Prior Art

It is known to provide a drilling machine which includes a supporting mast structure and drilling equipment which is reversably mountable onto said mast structure, so that the drilling machine can be set up for drilling either upwardly or downwardly. Examples of drilling machines of this type are disclosed by U.S. Pat. Nos. 3,220,494 and 3,490,546. This type of arrangement is also shown by the aforementioned Harold T. Klein U.S. Pat. No. 3,797,587.

SUMMARY OF THE INVENTION

The drilling machine of this invention includes a mast or support frame for the rotary drilling equipment which is itself invertible and includes an end frame member at each of its ends which is adapted for connection to a ground emplaced mounting structure. The end member towards which the drill head faces includes a worktable having both an inboard and an outboard holding wrench retainer.

According to the present invention, it is unnecessary to disconnect the rotary drilling equipment from its support and then re-mount it onto its support facing in the opposite direction. The entire machine is merely turned end-for-end to adapt it for drilling in the opposite direction.

These and other features, advantages and characteristics of the earth drilling equipment of this invention will be apparent from the following detailed description of a typical and therefore non-limitative embodiment of the invention, and from the accompanying illustrations.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a front elevational view of an embodiment of the drilling machine of this invention, showing the machine mounted for downward drilling and showing the rotary drilling mechanism in a raised position;

FIG. 2 is a side elevational view of the drilling machine shown by FIG. 1;

FIG. 3 is an isometric view of a pipe holding wrench which is used at the work table;

FIG. 4 is a top plan view of the drilling machine of FIGS. 1 and 2;

FIG. 5 is a fragmentary front elevational view, showing the holding wrench engaging a set of wrench flats on a section of drill pipe and the wrench itself being held by the inboard retainer on the worktable;

FIG. 6 is a fragmentary perspective view taken from above and looking towards the front and one side of the lower portion of the machine as it appears when it is mounted for downward drilling, including a broken line showing of the holding wrench engaged by the inboard retainer;

FIG. 7 is a view like FIG. 1, but showing the drilling machine mounted for upward drilling and showing the rotary drilling equipment in a lowered position;

FIG. 8 is a view like FIG. 2, but showing the drilling machine mounted for upward drilling like in FIG. 7;

FIG. 9 is a view similar to FIG. 6, but of the lower portion of the machine when it is mounted for upward drilling;

and

FIG. 10 is a fragmentary front elevational view of the worktable end of the machine when such machine is mounted for upward drilling, showing the holding wrench engaged by the outboard retainer on the worktable.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The illustrated embodiment of this invention comprises a pair of laterally spaced apart, parallel, upstanding piston columns 10, 12. At one end of the machine these columns 10, 12 are connected to a first or base end frame member 14 and at the opposite end of the machine to a second or head end frame member 16. Member 14 comprises a generally U-shaped frame portion 18 supporting a worktable 20. Worktable 20 includes a central drill pipe avenue through which the drill stem extends. The frame portion 18 includes integral rear and side portions. Each member 14 is pivotally mounted to rear portions of a pair of mounting feet 22, 24 for pivotal tilting about a transverse axis 26 established by pivot shafts 28. Shafts 28 extend through aligned openings, 19, 31, 33 in rear corner side wall portions of the frame 14 and in upstanding rear lugs 30, 32 on the mounting feet 22, 24 (FIG. 4). Colter pins 29 or the like are provided for holding the shafts 28 in place.

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. Anchor bolts (not shown) insertable through openings BH may be used for securing the members 22, 24 in place. A pair of turnbuckles 34 are interconnected between forward side portions 27 of the frame member 14 and a forward set of upstanding lugs 36, 38 on the members 22, 24. These turnbuckles 34 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. Pivot pins 35 extend through lower cylindrical portions 41 of the turnbuckles 34 and through openings in the lugs 36, 38. Colter pins 37 or the like hold the pins 35 in place. Upper shaft portions 39 of the turnbuckles 34 are received in the openings 25 formed in the lugs 27.

The illustrated embodiment also comprises a pair of laterally spaced apart, parallel rear support columns 40, 42. These columns 40, 42 are rigidly connected between rearward corner portions of the frame member 14 and rearward corner portions of the opposite end member 16. End members 14, 16, the piston columns 10, 12 and the rear support columns 40, 42 all together form a rigid closed box frame or mast structure which

supports the rotary drilling equipment and permits transportation of the machine without disassembly. It is to be understood, however, that the drilling forces can be taken by the piston columns and the end members alone, and in some machines it may be desirable to eliminate the rear columns 40, 42.

A first travelling cylinder 44 surrounds each of the piston columns, 10, 12. A second cylinder 46 surrounds each first cylinder 44.

A travelling cross frame 48 spans between and is rigidly connected to the two cylinder 46. This cross frame 48 carries the rotary drilling equipment comprising a drive motor 50, a drive box 52, and drill head 54.

In operation, the cross frame 48 and the drilling equipment 50, 52, 54 carried thereby, are powered up and down by the cylinders 44, 46. Selective supply and exhaust of fluid into the fluid chambers of the first cylinders 44 causes movement of the first cylinders 44 up and down along the piston column 10, 12. Selective supply and exhaust of fluid to and from the fluid chambers of the second cylinders 46 causes axial travel of the second cylinders 46 relative to both the first cylinders 44 and the columns 10, 12.

The internal details of the first and second cylinders 44, 46 are disclosed in the aforementioned Harold T. Klein application Ser. No. 214,813. The contents of which application are hereby incorporated into this application by this express reference thereto.

Because of its compact design and its rigid closed box frame construction, the machine of this invention is light weight and is structurally able to be lifted and transported by almost any method, including by skidding it on the rear columns 38, 40.

The drill head 54 includes either an internally threaded box member (not shown) for receiving the externally threaded pin end of each section of the drill stem DS, or to receive the box end of the drill pipe. Reference is made to U.S. Pat. No. 3,463,247 for a disclosure of a suitable box member of the drill head 54.

The rotary drive equipment 50, 52, 54 is operated to supply rotative torque to the drill stem DS during thrusting of the drilling equipment 50, 52, 54 by means of the dual cylinder assemblies 44, 46. The cylinder 44, 46 serve to accurately guide such drilling equipment along the piston columns 10, 12, to establish a precision drilling line. The drilling machine may be anchored in place by ground emplacement alone, or the machine may be provided with roof jacks for additional 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 if used, may be housed within the columns 40, 42.

The machine may be positioned for upward drilling by inverting it in its entirety and then mounting the end frame 16 onto a set of floor emplaced members 22, 24 in the same way that end frame member 14 was attached to them.

To accomplish this, the end member 16 is provided with a set of mounting lugs 56 including openings 58 for receiving the pivot pins 28 (FIGS. 7-9). It also includes a set of appetured lugs 60 for receiving the upper mounting pin portions 39 of adjustable connectors, viz. the turnbuckles 34. When the machine is inverted the appetured lugs 30, 32 on the members 22, 24 are positioned between the mounting ears 56 and the pivot pins 28 are inserted through the openings 58

and through the openings in the lugs 30, 32, so as to pivotally connect the rear corner portions of the end member 16 to the lugs 30, 32. The upper mounting pins 39 of the turnbuckles 34 are installed into the openings of the turnbuckle mounting ears 60 as shown by FIGS. 7 and 8.

A sectional drill stem is used with the drilling machine of this invention. Accordingly, it is necessary to provide a holding wrench at the worktable 20, for holding the portion of the drill stem which is in the ground while sections DS of the drill stem are added to or are subtracted from the machine.

According to the invention, the worktable is adapted to engage a holding wrench and through it support the dead weight of the drill stem regardless of the direction of drilling. A first holding wrench retainer maybe provided on the inboard side of worktable 20 and a second identical retainer provided on the opposite or outboard side of the worktable 20. As shown by FIGS. 5, 6 and 10 these retainers may be provided by securing a first set of laterally spaced apart brace blocks 62, 64 onto the inboard side of table 20 and an identical second set of such brace blocks 66, 68 onto the outboard side of table 20. As shown by FIGS. 5 and 6, when the drilling machine is mounted for downward drilling, the holding wrench HW rests on the inboard side of table 20 snugly between the brace blocks 62, 64 which served to prevent the holding wrench HW from rotating when torque is applied to the drill stem. When the machine is mounted for upward drilling, the holding wrench HW rests on the outboard side of worktable 20, snugly between brace blocks 66, 68, and in identical fashion is restrained against rotation by such brace blocks 66, 68 (FIG. 10). Herein the term "drilling direction" is used to mean the direction in which the drill stem extends. An understanding of this is important because in some installations the drill pipe may actually be "pulled" or drawn (e.g. when reaming) in the opposite direction during drilling.

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 end mounted invertible drilling machine that is detachably mountable onto a floor emplaced base structure, said machine comprising:

first and second opposite end frame members, each said end frame member including pivot pin receiving means to receive a pivot pin for pivotally attaching it to the base structure and connector means spaced therefrom, for connection to an end of at least one adjustable connector which is interconnectable between the base structure and the end frame member that is selected for connection to the base structure, to provide a way of adjusting the angle of the drilling line regardless of which end frame member is mounted onto the base structure, said first end frame member including a worktable, a drill pipe avenue formed through said worktable, an inboard holding wrench retainer on said worktable for use during down drilling, and an outboard holding wrench retainer on said worktable for use during up drilling;

guide column means including at least two laterally spaced apart guide columns which are rigidly interconnected between said end frame members;

rotary drive means including a drive head connectable to drill pipe sections, said drive head being directed towards the drill pipe avenue in said first end frame member, and motor means for rotating said drive head and any drill pipe connected thereto;

travelling cross-frame means mounting said rotary drive means onto said guide column means for travel therealong; and

linear drive means for moving said cross-frame means along said guide column means both towards and away from said first end frame member.

2. An invertible drilling machine according to claim 1, wherein in addition to said guide columns the machine includes at least one additional support column which is offset from said guide columns and is rigidly interconnected between the two end frame members.

3. An end mounted invertible earth drilling machine for rotating and translating a sectional drill stem which carries cutter means at its end distal the machine, and which is detachably mounted onto a floor emplaced base structure, said machine comprising:

at least one 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 both being rigidly interconnected between the first and second end frame members, each said end frame member including pivot pin receiving means to receive a pivot pin for pivotally attaching it to the base structure and connector means spaced therefrom for connection to an end of at least one adjustable connector which is interconnectable between said base structure and the end frame member that is selected for connection to the base structure, to provide a way for adjusting the angle of the drilling line regardless of which end frame member is mounted onto the base structure, said first end frame member including a worktable, a drill pipe avenue opening through said worktable, an inboard holding wrench retainer on said worktable for use during down drilling, and an outboard holding wrench retainer on said worktable for use during up drilling;

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 carried by 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.

4. An end mounted invertible earth drilling machine that is detachably mountable onto a floor emplaced base structure, said machine comprising:

a base end frame member including at least one pivot pin receiving means, a worktable, a drill pipe avenue formed through said worktable, an inboard holding wrench retainer on said worktable for supporting a holding wrench during down drilling, and an outboard holding wrench retainer on said worktable for supporting a holding wrench during up drilling;

a pair of laterally spaced apart guide columns, both being rigidly secured to said base end 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 extending between said guide columns, and means mounting said cross frame on 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, said equipment including a drive head connectable to drill pipe sections, said drive head being directed towards the drill pipe avenue in said base end frame member;

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 end frame member rigidly interconnecting the ends of the two guide columns opposite the base frame member, said head end frame member including at least one pivot pin receiving opening like the said opening in said base end frame member;

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;

a pivot pin engageable with a selected one of the pivot pin openings in the base and head end frame members;

and

at least one adjustable connector which is interconnectable between the base structure and the end frame member that is selected for connection to the base structure, to provide a way of adjusting the angle of the drilling line regardless of which end frame member is mounted onto the base structure.

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