United States Patent [19]

Busby et al.

[11] **3,830,318**

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[54] **EXCAVATING MACHINE**

[75] Inventors: **Donald Wayne Busby**, Denver; **Joseph L. Busby, Jr.**, Aurora, both of Colo.

[73] Assignee: **Subterranean Tools Inc.**, Commerce City, Colo.

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[52] **U.S. Cl.**..... **175/122**, 175/53, 175/203, 175/220, 175/323, 175/394

[51] **Int. Cl.**..... **E21b 3/02**, E21b 19/08, E21b 17/10

[58] **Field of Search**..... 166/173; 175/52, 53, 85, 175/122, 162, 203, 207, 323, 334, 220, 394

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Primary Examiner—David H. Brown

Attorney, Agent, or Firm—Melvin A. Crosby

[57] **ABSTRACT**

An excavating machine, particularly for excavating raises in the upward direction from an underground location in which the machine has a base with a pivot frame and with guide columns upstanding therefrom and a gear box slidable on the columns and having an upwardly facing rotatable chuck therein which is driven by a gear train in the gear box. The chuck receives the lower end of a sectioned string of pipe, the upper end of which carries a drilling and reaming head. Fluid cylinders between the base and gear box drive the gear box in the upward direction to perform excavating operations. A hopper is provided on the upper end of the machine to receive the material dislodged by the drilling and reaming head. An arrangement is provided for supporting the drilling and reaming head and the pipe dependent therefrom while the gear box and chuck are retracted and a new length of pipe is put in place.

17 Claims, 13 Drawing Figures

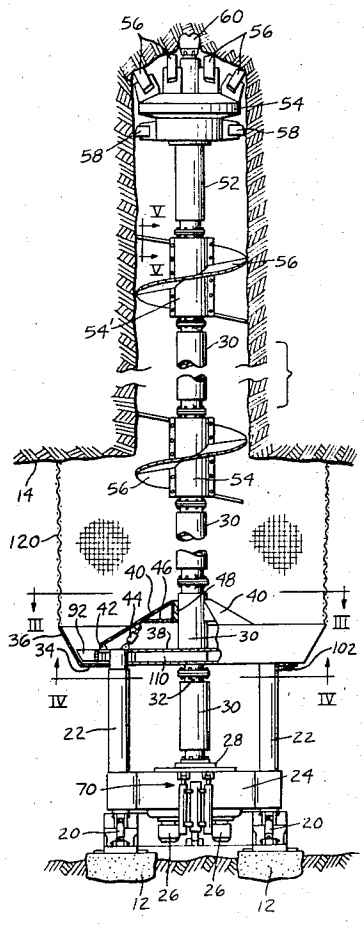


FIG-1

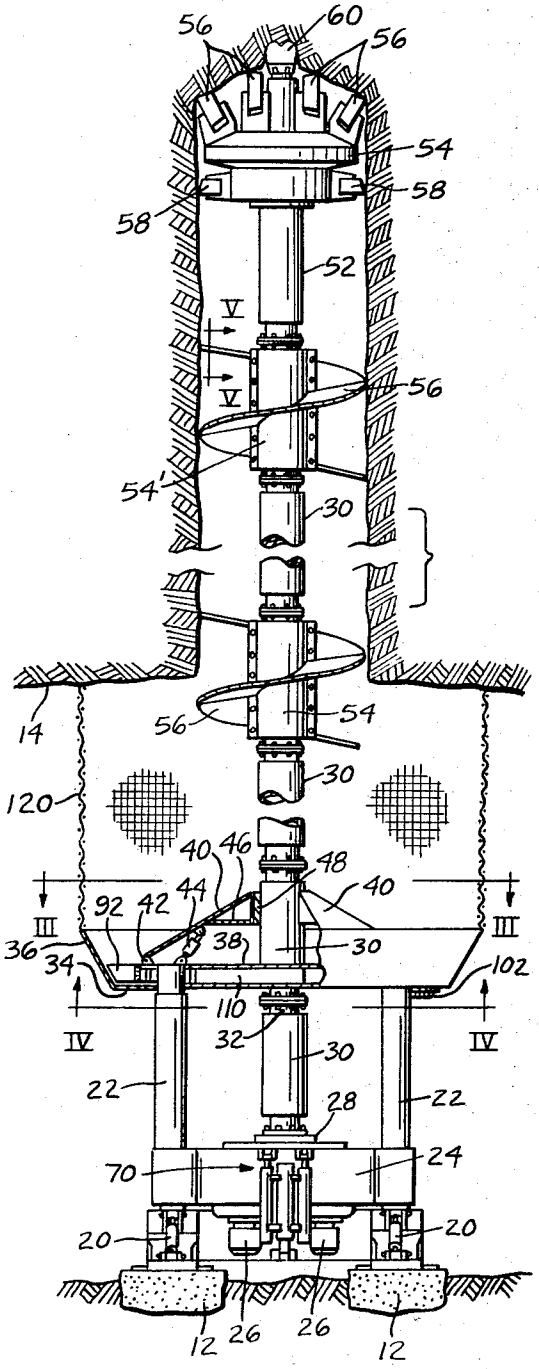


FIG-3

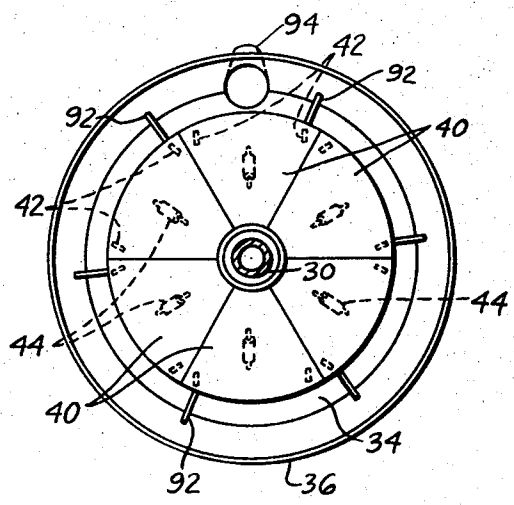


FIG-5

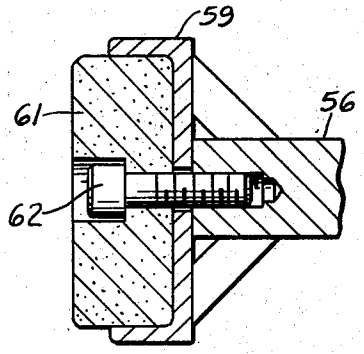


FIG-2

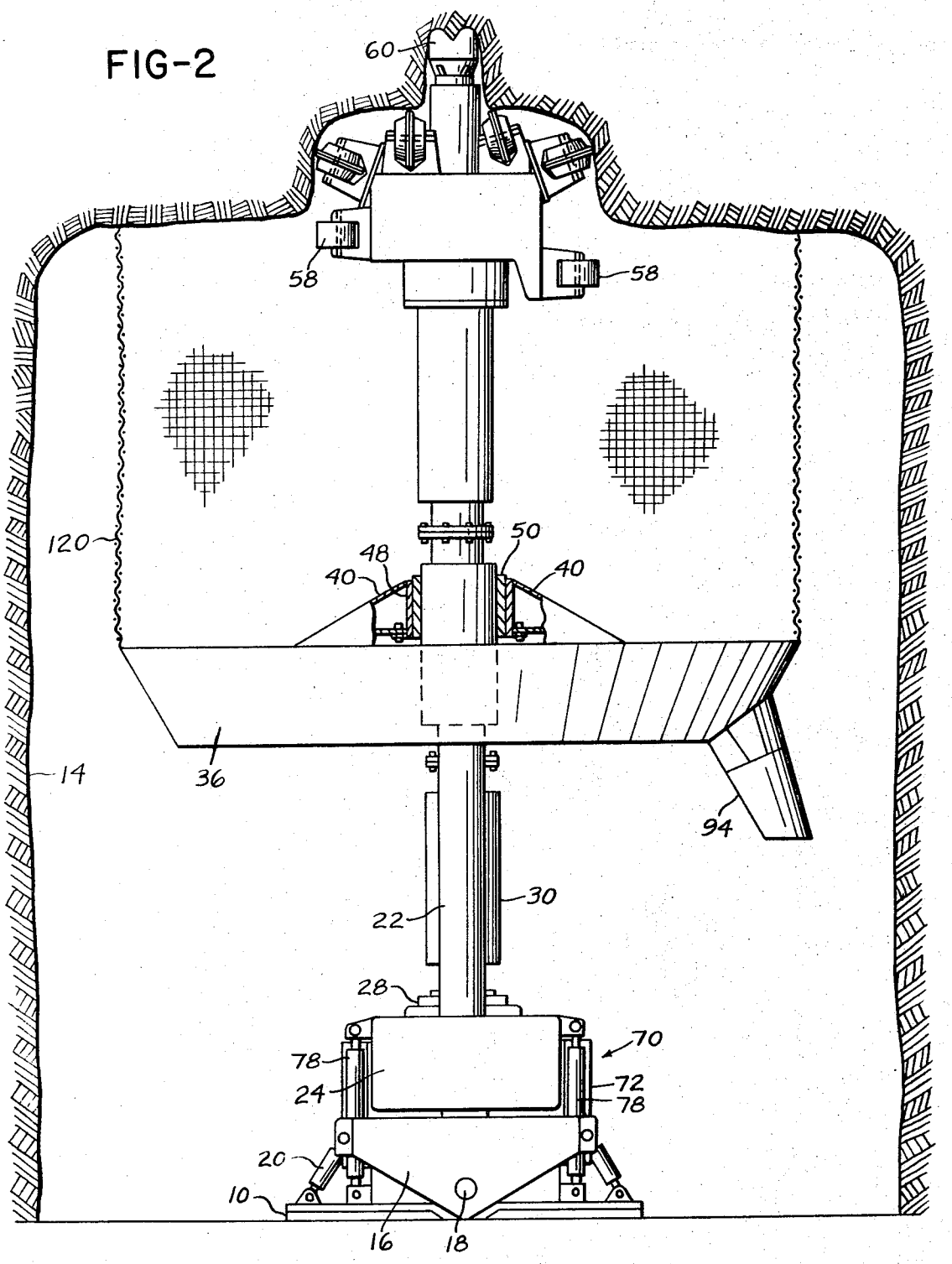


FIG-6

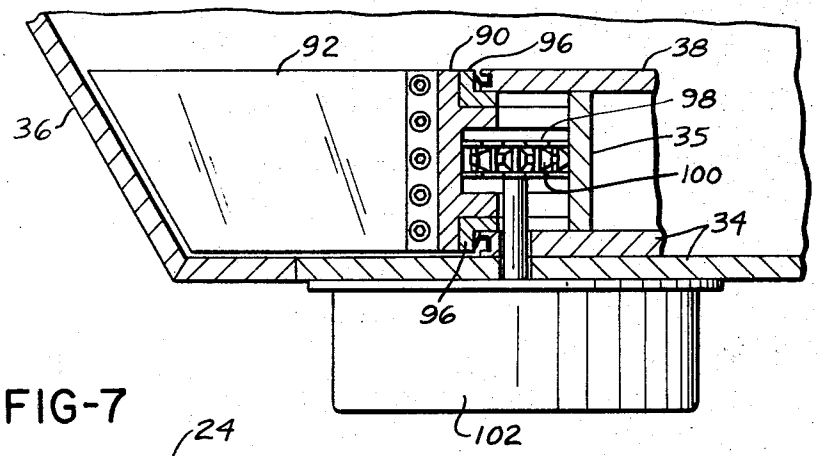


FIG-7

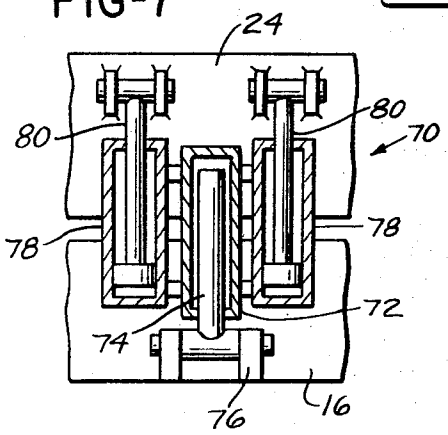


FIG-4

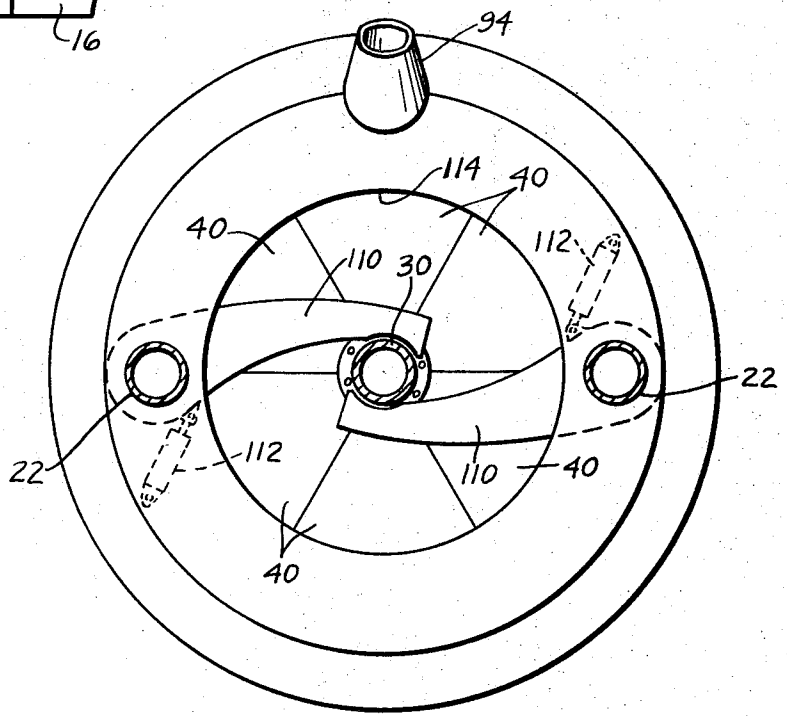


FIG-8

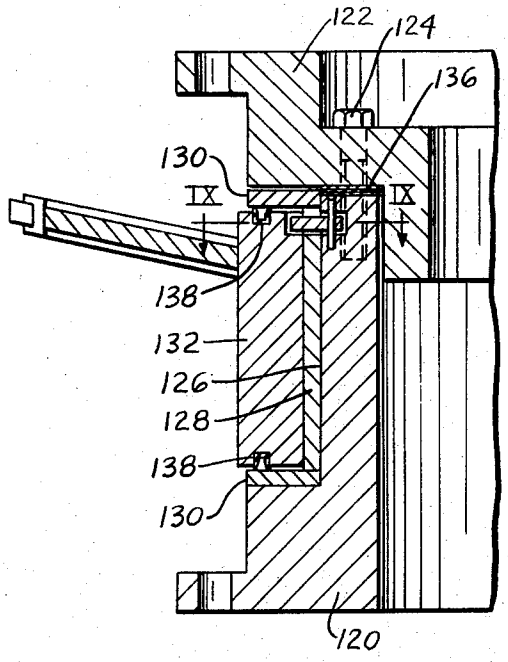


FIG-9

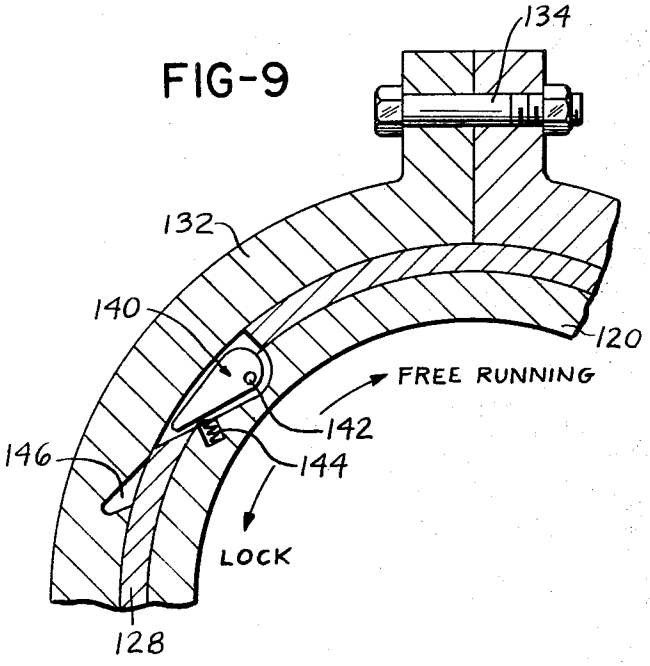


FIG-10

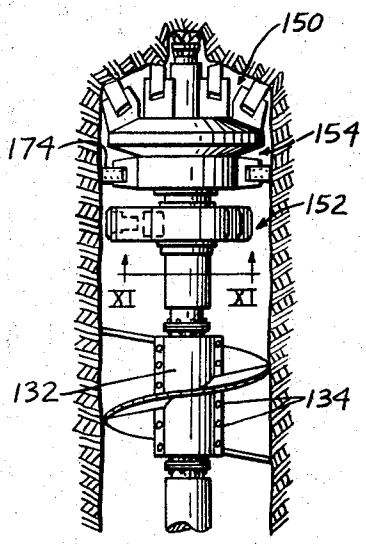


FIG-11

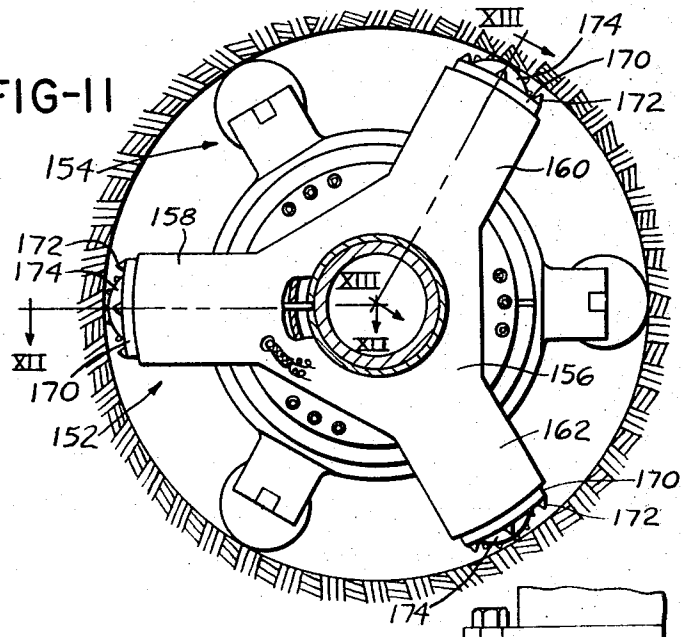


FIG-12

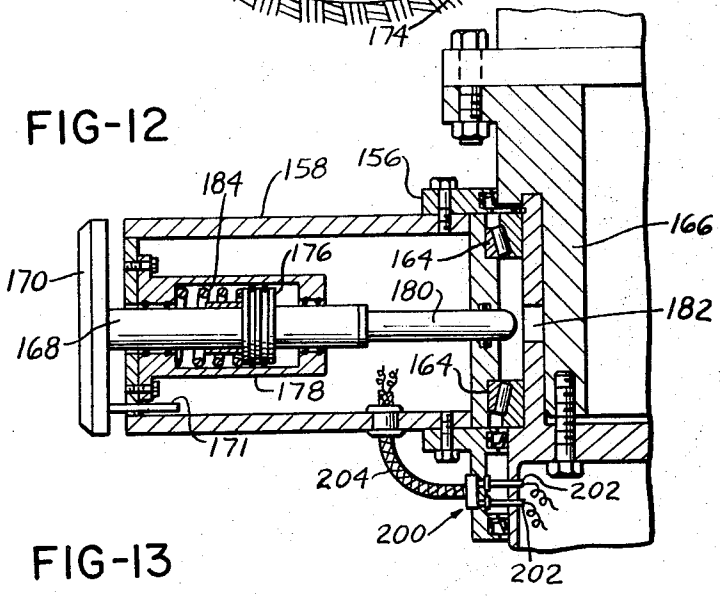
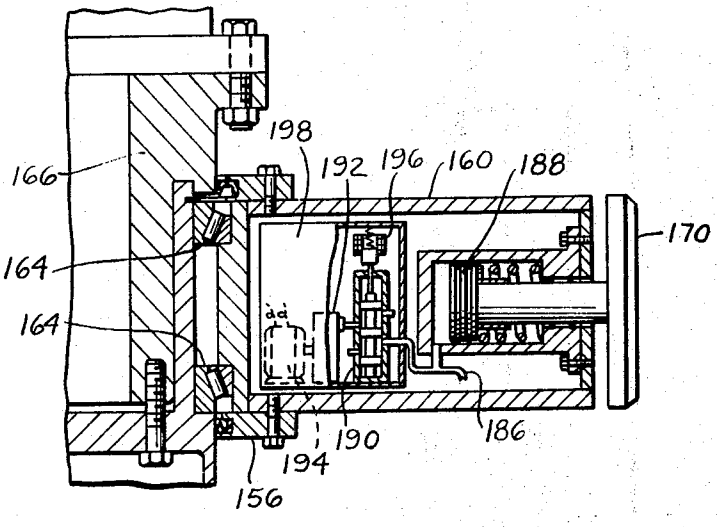


FIG-13



EXCAVATING MACHINE

The present invention relates to excavating machines and is particularly concerned with the type of machine which is referred to as a box hole machine.

An excavating machine of the nature with which the present invention is concerned, namely, a box hole machine, is adapted for placement in a shaft or other underground location and is operable for drilling upwardly, to form, for example, a raise between two shafts, or from a shaft to the surface, or to expose an ore vein above the shaft in which the machine is located. Machines of this nature are highly important because the opening of passages from the bottom upwardly, either vertically or on an incline, is extremely hazardous when accomplished manually or by blasting or other techniques of this nature.

The object of the present invention is to construct an improved machine of the nature referred to which will operate efficiently and provide for the safe forming of passages leading upwardly from an underground location.

Another object of this invention is the provision of a machine of the nature referred to which can form long upwardly extending passages without creating any hazard and during which the drill pipe is adequately supported against deflection at all times.

Another object is the provision of a machine of the nature referred to which is quite compact so that it can readily be moved along underground passages.

Still another object is the provision of a machine of the nature referred to which is easy to put into operation and in which the drive machinery for rotating and advancing the drill pipe is protected at all times.

These and other objects and advantages of the present invention will become more apparent upon reference to the following detailed specification taken in connection with the accompanying drawings in which:

FIG. **1** is a view partly in section and partly in elevation showing a machine according to the present invention drilling an upward passage from an underground location.

FIG. **2** is a view similar to FIG. **1** but looking in from the side of the machine and showing the machine with a different type of tool on the upper end of the drill string and at the beginning of a drilling operation.

FIG. **3** is a plan view indicated by line III—III on FIG. **1.**

FIG. **4** is a plan view indicated by line IV—IV on FIG. **1.**

FIG. **5** is a fragmentary sectional view indicated by line V—V on FIG. **1.**

FIG. **6** is a fragmentary sectional view through one side of the hopper on top of the machine.

FIG. **7** schematically illustrates the arrangement of the fluid motors that drive the drill pipe during a drilling operation.

FIG. **8** is a partial vertical section showing a modified arrangement of the spiral stabilizer.

FIG. **9** is a fragmentary plan sectional view indicated by line IX—IX on FIG. **8.**

FIG. **10** is an elevational view showing a guidance device mounted on the pipe immediately beneath the reaming head.

FIG. **11** is a sectional view indicated by line XI—XI on FIG. **10** and is a view looking up at the bottom of the guidance device.

FIG. **12** is a fragmentary sectional view indicated by line XII—XII on FIG. **11.**

FIG. **13** is a sectional view indicated by line XIII—XIII on FIG. **11.**

BRIEF SUMMARY OF THE INVENTION

The machine according to the present invention comprises a base adapted for being fixed to a firm foundation, such as concrete pad, and which base has a pivot frame pivotal thereon and guide columns fixed to the pivot frame and extending upwardly therefrom. A gear box is slidably guided on the guide columns and has a rotary chuck therein to which drill pipe can be connected while projecting upwardly from the gear box. Fluid cylinders between the base and gear box provide for upwardly advancing the gear box during a drilling operation.

A hopper is mounted on the upper ends of the columns to catch material falling from the passage being drilled and the center part of the hopper is in the form of moveable gates which can be swung outwardly to permit a raise cutter to be moved upwardly therethrough and which can then be moved inwardly so as supportingly to engage the drill pipe and to seal thereabout.

The machine of the present invention has spiral flights adapted for connection to the drill pipe in axially spaced relation therealong and which flights stabilize the drill string against deflection and also break the fall of dislodged material so that the material never falls freely for any appreciable distance and, thus, does not fall into the shaft at great velocity.

The hopper into which the dislodged material falls may have a rotating paddle arrangement therein which moves material in the hopper around to a discharge opening from which the material can fall into a truck, or on a conveyor belt, or the like.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings somewhat more in detail, the machine shown in FIGS. **1** and **2** comprises a lower base member **10** adapted for being firmly bolted to a solid support and which may take the form of a concrete pad, or pads, **12** poured in situ on the floor of the underground shaft **14** in which the machine is located.

Base member **10** has pivotally mounted thereon another base member **16** as by the pivots shown at **18** in FIG. **2.** Between the lower base member **10** and the upper base member **16,** there are provided turnbuckles, or jack screws, **20** so that the upper base member **16** can be adjusted to the proper angle relative to the base member **10** and fixed at that angle.

Connected to and upstanding from base member **16** is a pair of spaced columns **22** which may consist, for example, of heavy tubing. Slidable on columns **22** is the frame of a gear box **24** having drive motors **26,** fluid or electric, mounted on the lower side. The gear box contains gear means which are operable for rotating a chuck **28** when motors **26** are energized. Chuck **28** is adapted for having bolted thereto flanged pipe sections of which a typical section is indicated at **30.** These sections are flanged at both ends and have undercut re-

gions 32 adjacent the flanges for a purpose to be described hereinafter.

Mounted on top of columns 22 is a hopper consisting of a ring-like bottom made up of a lower plate 34 and an upper plate 38 and connected by a ring 35 (FIG. 6). The hopper also includes an upwardly and outwardly inclined rim or side wall member 36 supported on the hopper bottom.

Pivotally mounted on plate 38 near the periphery thereof is a plurality of segmental gates 40. The gates are pivoted at 42 on plate 38 and fluid cylinder piston means 44 are provided between each gate and plate 38 so that the gates can be tilted upwardly and downwardly about pivots 42. There are six of the gates as will be seen in FIG. 3 and, when the gates are tilted upwardly, an opening is provided through the bottom of the hopper of ample size to move the drilling and reaming head upwardly and downwardly therethrough.

The gates 40 are reinforced near the radially inner ends thereof as by plate means 46 and are adapted to receive a sectioned seal ring 48 which will sealingly engage a pipe extending along the axis of the hopper. Such a seal ring 48 is shown in FIG. 1.

The radially inner ends of the gates 40 are also adapted to receive a guide bushing 50, shown in FIG. 2, and which is provided at the beginning of a drilling operation for the purpose of guiding the pipe in a straight line until the passage being formed by the drilling tool has advanced far enough that lateral support for the drilling tool is provided by the walls of the passage.

Returning to FIG. 1, it will be seen that the drill pipe consists of a plurality of sections of drill pipe 30 connected in end to end relation by the flanges thereon while at the uppermost end the upper pipe section is bolted to a stem 52 projecting downwardly from a cutter head 54 which may be of substantially conventional design. This cutter head comprises rolling cutters 56 distributed radially and circumferentially thereon on the upper side, and stabilizing rollers 58 distributed peripherally about the cutter head. The cutter head also includes a starting drill which may take the form of a conventional conical bit 60 which is mounted on the axis of the drill pipe and engages the formation in advance of the rolling cutters.

According to the present invention, as the drill pipe advances upwardly into the formation, short spiral flights are connected thereto at intervals of, say, twelve feet and which serve to break the fall of material dislodged by the cutter so that it proceeds down the passage being formed at reduced velocity and finally falls into the hopper on top of the machine.

Each spiral section comprises two half round support portions 54', each having a respective part 56 of the spiral flight connected thereto. The two portions are bolted together about a length of drill pipe and thereby form a substantially continuous spiral of about one and one-half turns.

The peripherally outer edge of the spiral is advantageously formed as shown in FIG. 5, wherein it will be seen that, secured to the outer end of the spiral member, is an outwardly opening channel 59 which may be fixed in position on the spiral member by welding. This channel, which may be about one inch deep and three inches wide, is adapted for receiving inserts 61 which may be bolted therein as by the machine screws 62. Each element 61 is in the form of plastic material with pieces of ceramic or similar hard material distributed therein.

This combination material absorbs shocks, but is, nevertheless, wear resistant and the spiral members connected to the drill pipe thus not only break the fall of dislodged material, but also stabilize the drill pipe so that extremely long passages can be drilled without there being any danger of the drill pipe buckling.

As mentioned, the spiral members, or stabilizers, are put on the drill pipe at intervals of about twelve feet. Each length 30 of drill pipe may be about four feet long or at least not longer than the range of movement of gear box 24 on columns 22.

For moving gear box 24 on columns 22, there is provided a cylinder arrangement generally indicated at 70 in FIGS. 1 and 2 and shown schematically in section in FIG. 7. The hydraulic cylinder arrangement comprises a central cylinder 72 into which a ram 74 extends from the bottom. Ram 74 is connected to bed member 16 as at 76.

On each side of central cylinder 10 is another cylinder 78 into which double acting pistons 80 extend from the top with the pistons connected to the outer wall of gear box 24. The arrangement of the cylinders as shown on the drawings provides for a substantial range of movement of gear box 24 without, however, requiring the provision of extremely long cylinders and pistons.

The cutter head shown on the upper end of the drill pipe in FIG. 2 is a somewhat different type than that shown in FIG. 1 but accomplishes substantially the same purpose. Slightly different rolling cutters are employed but the same conical opening drill 60 is utilized at the upper end and the same stabilizer roller arrangement 58 is also provided.

Mounted in the hopper and rotatably confined between the marginal edges of plates 34 and 38 is a ring 90 having substantially radially extending paddles 92 fixed thereto which will sweep material in the hopper circumferentially around the hopper when ring 90 is driven in rotation. Material, thus swept around the hopper, will fall from the discharge 94 provided at one side of the hopper as will be seen in FIGS. 2 and 4.

Ring 90 is supported on upper and lower bearing elements 96 and on the radially inner side has a chain ring 98 welded thereto which is drivingly engaged by a sprocket 100 mounted on the output shaft of a fluid motor 102 carried on the underside of the hopper.

Also carried between plates 34 and 38 are a pair of arms 110 which may be pivoted on the upper ends of columns 22 and which are swingable thereon, or by fluid cylinder piston means 112, so as to bring the free ends of the arms together about a pipe 30, or to swing the arms outwardly away from the pipe and to expose the opening 114 which is coaxially arranged with pipe 30. This opening, as will be seen in FIG. 4, is normally closed by the gates 40 previously referred to.

The guide columns 22, it will be noted, are spaced far enough apart to allow the cutter 54 to be received therebetween.

In operation, the machine is set in position with the cutter head supported on the gear box and beneath the hopper. To initiate operation of the machine, the gear box and the cutter head are moved upwardly toward the top of the machine by availing of the cylinder means at 70. The gripper arms 110 are then availed of

to hold the cutter head in position and the gear box is retracted downwardly.

A length of starter pipe is then interposed between the chuck and the cutter head and is secured in position. The starter pipe has a cylindrical outer surface adapted for supporting engagement by a bearing.

The gates **40** of the hopper are then opened and the gear box is moved upwardly to dispose the cutter head above the hopper doors. The hopper doors are then closed beneath the cutter head and the pipe grippers again swing in and engage the cutter head and the length of starter pipe connected thereto and hold it in position while the gear box is again lowered and a second length of starter pipe is inserted between the chuck and the lower end of the piece of starter pipe that is fastened to the stem of the cutter head.

Advantageously, the guide bushing **50** is mounted on the second length of starter pipe. At this time, with the bushing **50** in position, the pipe grippers are swung away from the pipe and the hopper gates are closed and the bushing **50** is bolted to the inner ends of the hopper gates. The reaming of the hole to be formed can now be started. The bushing **50,** at this time, will support the drill pipe against lateral deflection.

It will be noted that it is of advantage to fasten a heavy screen **120,** such as flexible chain link wire screen, between the top of the shaft **14** and the top edge of the side wall of the hopper to confine dislodged material to the hopper.

As the drilling proceeds, the gear box moves upwardly to the top of the machine and the pipe grippers **110** are then availed of to support the drill string and cutter head while the gear box is lowered to receive a new length of pipe. When three lengths of starter pipe have been interposed between the chuck and the stem on the cutter head, the lower two lengths of starter pipe are removed and bushing **50** is also removed. Conventional pipe is then placed between the chuck and the lower end of the starter pipe attached to the stem of the drilling tool. The bushing **50** is at this time replaced by the sectioned seal ring **48** which is bolted to the inner ends of gates **40.**

The drilling can now continue with further lengths of standard pipe being put in place one by one with the spiral stabilizers being bolted on to the drill pipe about every twelve feet, namely, on about every third length of pipe. Each time a length of pipe is to be added, the pipe gripper arms are availed of to support the cutter and the pipe dependent therefrom while the gear box and chuck are lowered to permit a further length of pipe to be put in place.

When a hole is completely drilled, the reverse procedure is followed until the cutter head is again returned to its lowermost position beneath the hopper, whereupon the machine can be moved to a new location for a further drilling operation.

FIGS. **8** and **9** show a modified arrangement for the spiral stabilizer in which the stabilizer is rotatably mounted on the pipe. In FIGS. **8** and **9, 120** indicates a length of pipe in which one flanged end **122** is held in place by bolts **124** on the other portion of the pipe. The portions of the pipe define therebetween a cylindrical region **126** having mounted thereon a bearing bushing **128.** Thrust washers **130** are disposed at the opposite ends of bushing **128** and disposed therebetween are the two parts **132** of the hub of the stabilizer. These two parts are interconnected as by bolts **134** as will be seen in FIG. **9.**

The hub portion **132** is insured of free rotation about bushing **128** by the provision of shims **136** interposed between the parts of the pipe at the time of bolting the parts together.

Lip seals **138** are advantageously provided between the opposite ends of hub portion **132** of the stabilizer and the adjacent thrust washers **130.**

The spiral stabilizer is adapted to rotate freely on the pipe when the pipe is turning in a clockwise direction but is locked to the pipe when the pipe is rotating in the counterclockwise direction. This is accomplished by the provision of pawl means **140** distributed about the pipe and pivoted thereto as by pivot pins **142.** A spring **144** urges the outer end of each pawl outwardly against the inside of hub **132** of the stabilizer and the hub is provided with pockets **146** for receiving the outer ends of the pawls.

It will be evident that when the pipe **120** is rotating clockwise, the pawls **140** will pass freely over the pockets in the hub of the stabilizer, but when pipe **120** is rotating in the counterclockwise direction, pawls **140** will engage in the respective pockets **146** and will cause the stabilizer to rotate with the pipe.

FIGS. **10** through **13** show a guidance device adapted for being secured to the drill pipe immediately beneath the reaming head. In these figures, the reaming head is generally indicated at **150** and mounted directly therebeneath is the guidance device according to the present invention and indicated at **152.**

The guidance device is disposed immediately below a peripherally distributed row of rollers generally indicated at **154** and which may consist of stabilizing rollers or cutting rollers or both. The purpose of the guidance device is to cause deflection in the lateral direction of the reaming head in case the raise being formed drifts laterally from the axis of the chuck on the machine at the bottom of the raise.

The guidance device comprises a housing **156** which, as will be seen in FIG. **11,** comprises three radial arms **158, 160** and **162.** The housing **156** of the device is journaled as by the antifriction bearing means **164** on a central body member **166** which is adapted at its upper end to be secured to the stem or bottom of the reaming head while at the lower end body **166** is adapted for connection to the upper end of the pipe next beneath the reaming head.

Each of the arms **158, 160** and **162** has a radially reciprocable plunger element **168** mounted therein on the outer end of which is carried a shoe **170** which is advantageously formed with vertically extending knife edges **172** for engagement with the wall of the raise being formed. In retracted position, shoes **170** are spaced from the wall of the raise but in outwardly projected advanced position will engage the wall of the raise. Each shoe has a rod **171** attached thereto and extending through a hole in the end of the respective arm of the housing **156** to prevent rotation of the shoes.

The device is usable as a guiding device because each plunger has a fluid motor connected thereto and the plungers in arms **158** and **162** develop a certain radial thrust, say, 2000 pounds each, whereas the plunger in radial arm **160** will develop a substantially greater thrust, say, 5250 pounds. When all of the plungers are actuated into the radially outward position, the drill string will be thrust radially in a direction away from

the shoe carried by radial arm **160** and in this manner the reaming head can be brought back on the axis on which it is desired for the reaming head to form the shaft.

The guidance device must necessarily remain stationary while the shoes thereof are in engagement with the wall of the raise being formed, and this is accomplished by the bearing means **164.** When the shoes are retracted, the guidance device may rotate with the drill pipe and, at that time, it is advantageous for the radial arms **158, 160** and **162** to be disposed beneath cutting rollers **174** forming a part of the group of rollers previously referred to and generally identified by reference numeral **154.**

The shoes in arms **158** and **162,** and which are connected to respective plungers **168,** have pistons **176** of a certain size thereon mounted in cylinders **178.** One of these pistons has an extension **180** projecting therefrom toward the axis of the pipe and adapted to enter a socket **182** formed in the pipe when the respective piston is retracted. Each piston is biased toward retracting position by a spring **184** and is moved in the advancing direction by fluid supplied to the radially inwardly facing side of the respective piston by a conduit **186.** Only one of the pistons **176** has the rod portion **180** formed thereon and the other piston is identical except for the said rod **180.**

The piston connected to the shoe in arm **160** is indicated at **188** in FIG. **13** and will be seen to be substantially larger as to the radially inner area than pistons **176.** Piston **188** is urged in retracting direction by a spring and is also adapted to be supplied with pressure fluid on the radially inwardly facing side by conduit **186.** Conduit **186** leads to the service port of a two way valve **190** which is supplied with fluid from the outlet of a pump **192** which is driven by an electric motor **194.**

Valve **190** may be solenoid operated as by solenoid **196** and is spring biased in the opposite direction. When solenoid **196** is deenergized, both pump **192** and conduit **186** are connected to the reservoir **198** but when valve **190** is shifted by energization of solenoid **196,** pump **192** is connected to conduit **186** and supplies pressure to the several pistons of the guidance device.

The above described unit is entirely self-contained except for the supply of electrical energy thereto and this can be accomplished by means of a slip ring arrangement generally indicated at **200** which is engaged by brush means **202** carried on the supporting structure **164** and which is connected by cable means **204** with the interior of housing **156.** The electrical connections may include a motor energizing circuit and a solenoid energizing circuit if so desired or the motor may be energized simultaneously with solenoid **196** in which case valve **190** can be somewhat more simple in construction.

In any case, selective control is had of the radial movement of the plungers **168** and the shoes connected thereto for effective selective guiding of the drill string. It will be evident that in view of the locking of the housing of the guiding device to the drill string, the device can be rotated to any desired position so that guidance of the drill string by the device can be effected in any radial direction. It will also be evident that the knife edges **172** will permit upward movement of the guidance device together with the reaming head even while the guidance device is in actuated position.

Modifications may be made within the scope of the appended claims.

What is claimed is:

1. In an excavating machine, especially for driving large diameter cutter heads from beneath in the upward direction; a frame, a gear box guided by said frame for traversing movement therein, thrust means for driving said gear box in said traversing movement in said frame, rotatable chuck means carried by said gear box adapted for detachable connection to the lower end of sectional drill pipe means which extends upwardly from said chuck means and which has cutter means mounted on the upper end, power operable means carried by said gear box for driving said chuck means in rotation on an axis parallel to the direction of traverse of said gear box in said frame, gripper means in the frame moveable therein for selectively supportingly engaging the drill pipe means to permit said chuck means to be disconnected therefrom and to be traversed in said frame independently of the drill pipe means thereby to permit a section of drill pipe to be added to or removed from the lower end of the drill pipe means, and stabilizer means adapted for detachable mounting on the drill pipe means and having helical rib means extending radially therefrom for stabilizing engagement with the wall of a hole being formed by the cutter means, said stabilizer means comprising a pair of support members adapted for being secured together about a length of pipe in said drill pipe means so as to be fixed to the length of pipe, each support member having a respective portion of said helical web means thereon, the said portion of the web means on the respective support members registering when the support members are secured together to form a continuous helical web of at least one turn.

2. An excavating machine according to claim **1** in which said stabilizer means comprise two or more individual stabilizers mounted in axially spaced relation on the drill pipe means.

3. An excavating machine according to claim **1** which includes cylindrical bushing means on a section of pipe of said sectioned drill pipe means, said stabilizer means being rotatably mounted on said bushing means, and cooperating elements of a one way clutch means on said section of pipe and said stabilizer means permitting rotation of said stabilizer means on said pipe section in only one direction of relative rotation.

4. An excavating machine according to claim **1** in which the radially outer edge of said helical web means is in the form of a radially outwardly opening channel, and wear resistant means mounted in said channel.

5. An excavating machine according to claim **4** in which said wear resistant means comprise inserts receivable in said channel and means for securing the inserts in place in the channel, each insert comprising a body of synthetic material and particles of hard wear resistant material distributed in the body.

6. In an excavating machine; a frame, a gear box guided by said frame for traversing movement therein, fluid motor means connected between said gear box and said frame for driving said gear box in said traversing movement in said frame, rotatable chuck means carried by said gear box adapted for detachable connection to the lower end of sectional drill pipe means which extends upwardly from said chuck means and

which has cutter means mounted on the upper end, power operable means carried by said gear box for driving said chuck means in rotation on an axis parallel to the direction of traverse of said gear box in said frame, and gripper means in the frame moveable therein for selectively supportingly engaging the drill pipe means to permit said chuck means to be disconnected therefrom and to be traversed in said frame independently of the drill pipe means thereby to permit a section of drill pipe to be added to or removed from the lower end of the drill pipe means, said fluid motor means comprising first and second cylinder means fixed together, first piston means reciprocal in said first cylinder means and projecting downwardly therefrom and connected to said frame, and second piston means reciprocal in said second cylinder means and projecting upwardly therefrom and connected to said gear box, said first cylinder means comprising a respective first cylinder at each side of the frame coplanar with the axis of said chuck means, said second cylinder means comprising a respective second cylinder on each side of each said first cylinder.

7. An excavating machine according to claim **6** which includes base means adapted for fixed emplacement at the bottom of said frame, pivot means connecting the frame at the bottom to said base means for pivotal movement of the frame on the base means, and adjustable means connected between said frame and base means for tilting the frame on the base means and for holding the frame in angularly adjusted position on the base means.

8. An excavating machine according to claim **7** in which said pivot means are substantially coplanar with the axis of said chuck means, said adjustable means being disposed on both sides of the vertical plane of said pivot means.

9. In an excavating machine; a frame, a gear box guided by said frame for traversing movement therein, thrust means for driving said gear box in said traversing movement in said frame, rotatable chuck means carried by said gear box adapted for detachable connection to the lower end of sectional drill pipe means which extends upwardly from said chuck means and which has cutter means mounted on the upper end, power operable means carried by said gear box for driving said chuck means in rotation on an axis parallel to the direction of traverse of said gear box in said frame, and gripper means in the frame moveable therein for selectively supportingly engaging the drill pipe means to permit said chuck means to be disconnected therefrom and to be traversed in said frame independently of the drill pipe means thereby to permit a section of drill pipe to be added to or removed from the lower end of the drill pipe means, an upwardly opening hopper on the top of said frame for receiving the material dislodged by the cutter means, said hopper having a discharge opening in the bottom, and pusher means moveable in the hopper to move material therein toward said discharge opening.

10. An excavating machine according to claim **9** in which said pusher means comprises a ring in said hopper, paddles on the ring extending radially in the hopper, and means on the hopper to drive said ring in rotation.

11. An excavating machine according to claim **9** in which said hopper comprises a ring-like bottom, an outer wall inclined radially outwardly in the upward direction and upstanding from the outer periphery of said bottom, and an inner wall inclined radially inwardly in the upward direction and upstanding from the inner periphery of said bottom.

12. An excavating machine according to claim **11** in which said inner wall is segmented and each segment at the radially outer end is pivotally supported for swinging movement of the respective segment in a vertical plane, said segments when in lowered position having the radially inner ends thereof disposed in surrounding relation to the axis of the drill pipe means.

13. An excavating machine according to claim **12** which includes a fluid motor means operatively connected to said segments to actuate the segments in swinging movement about the pivotal supports therefor.

14. An excavating machine according to claim **12** in which the radially inner end of each segment comprises a curved plate portion which is parallel to the axis of the drill pipe means when the respective segment is in lowered position, said plate portion registering when all of the segments are in lowered position to define a cylinder coaxial with the drill pipe means.

15. An excavating machine according to claim **14** in which said cylinder is adapted to receive bushing means of a size to engage the outside of the drill pipe means.

16. An excavating machine according to claim **12** in which said segments in raised position providing an opening substantially as large in diameter as the cutter means.

17. An excavating machine according to claim **16** in which said gripper means comprises a pair of arms each pivoted at one end on a vertical axis beneath said hopper near the top of said frame and each swingable inwardly to dispose the other end in supporting engagement with the drill pipe means, said arms being swingable outwardly to move said other ends away from the drill pipe means.

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