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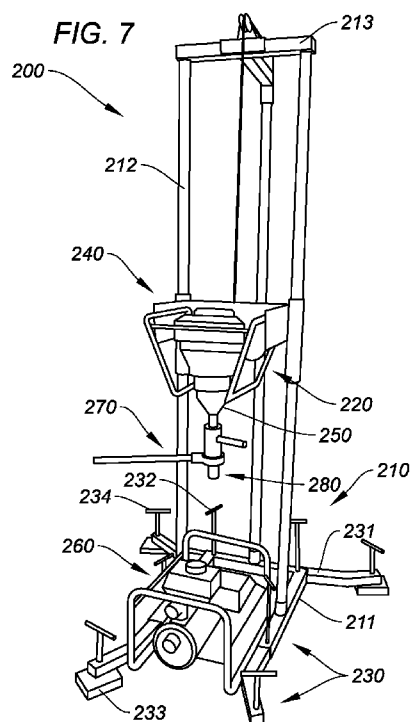
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(54) Title: SHALLOW WELL-DRILLING APPARATUS



(57) Abstract: A portable, shallow well-drilling apparatus (200) is described. The apparatus (200) is lightweight, modular, and easy to transport to and assemble at a remote drill site. The apparatus (200) includes a generally rectangular frame (210) having a plurality of multi-segment support beams (212) in spaced relation extending vertically from a lower base (211) to a top cap (213), no component of which exceeds five feet in length, a winch assembly (220) attached to the frame (210), and a motor (248) removably mounted on the frame (210) and slidable up and down the beams (212) via the winch assembly (220). The apparatus (200) further includes a transmission (250) removably coupled to the motor (248), and a drill pipe assembly (290) removably coupled to the transmission (250).



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SHALLOW WELL-DRILLING APPARATUS

BACKGROUND

[0001] Field.

[0002] The example embodiments in general are directed to a well-drilling rig configured in a miniature, lightweight profile for ease of transportation, assembly, and storage, and more particularly to a modular, transportable, shallow well-drilling apparatus adapted to drill wells up to 300 feet in depth so as to reach an underground aquifer.

[0003] Related Art.

[0004] The Centers for Disease Control & Prevention, in a June 2015 online publication entitled “Global Water, Sanitation & Hygiene (WASH)”, which may be found at the link http://www.cdc.gov/healthywater/global/wash_statistics.html, states that worldwide, 780 million people do not have access to an improved water source. An improved water source may be understood as a source that provides safe drinking water, examples being a piped household water connection, a public standpipe, a borehole, a protected dug well, a protected spring, and rainwater collection. Namely, these people only have access to unimproved drinking water sources such as an unprotected dug well, an unprotected spring, surface water (i.e., a river, dam, lake, pond, stream, canal, and/or an irrigation channel), vendor-provided water (e.g., a cart with small tank/drum, tanker truck), and bottled water.

[0005] Moreover, due to a lack of safe drinking water, the CDC estimates that approximately 2.5 billion people lack access to improved sanitation (more than 35% of the world’s population). According to the World Health Organization (WHO) and UNICEF, regions with the lowest coverage of “improved” sanitation in 2006 (see for example the link <http://www.cdc.gov/healthywater/global/assessing.html>) were sub-Saharan Africa (31%), Southern Asia (33%) and Eastern Asia (65%). In 2006, 7 out of 10 people without access to improved sanitation were rural inhabitants.

[0006] FIG. 1 is a photograph taken in 2015 of a spring-fed ditch which also acts as a cistern for collecting rainwater, which serves as a primary source of drinking water for a mountain Indian village in Panama. FIG. 2 is a photograph of the primary source of drinking water for a village in remote Manipur, India; a tanker truck of water. The villagers are permitted to fill up to two (2) containers twice weekly for their families. FIG.

3 is a photograph of another water source taken from the Zambezi River for a village near Livingstone, Zambia. This water source is untreated.

[0007] As evident from FIGS. 1-3, the dearth of an adequate safe drinking water supply, coupled with a lack of sanitation and hygiene, may typically lead to unnecessary disease and death. A 2010 report by Liu et al. of the Child Health Epidemiology Reference Group of WHO and UNICEF, entitled “Global, Regional, and National Causes of Child Mortality: An Updated Systematic Analysis for 2010 with Time Trends Since 2000” notes that an estimated 801,000 children younger than 5 years of age perish from diarrhea each year, mostly in developing countries. This amounts to 11% of the 7.6 million deaths of children under the age of five and means that about 2,200 children are dying daily as a result of diarrheal diseases. Additionally, a 2008 report by Prüss-Üstün, et al. of the WHO, entitled “Safer Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health” suggests that unsafe drinking water, inadequate availability of water for hygiene, and lack of access to sanitation together contribute to about 88% of deaths globally from diarrheal diseases.

[0008] This WHO report further notes that worldwide, millions of people are infected with neglected tropical diseases (NTDs), many of which are water and/or hygiene-related, such as Guinea Worm Disease, Buruli Ulcer, Trachoma, and Schistosomiasis. These diseases are most often found in places with unsafe drinking water, poor sanitation, and insufficient hygiene practices. For example, trachoma is the world’s leading cause of preventable blindness and results from poor hygiene and sanitation. Approximately 41 million people suffer from active trachoma and nearly 10 million people are visually impaired or irreversibly blind as a result of trachoma. Trachoma infection can be prevented through increased facial cleanliness with soap and clean water, and improved sanitation. The report further states that water, sanitation and hygiene has the potential to prevent at least 9.1% of the global disease burden and 6.3% of all deaths

[0009] A 2005 publication by Lenton, et al. of the UN Millennium Project Task Force on Water & Sanitation reports that improved water sources reduce diarrhea morbidity by 21%; improved sanitation reduces diarrhea morbidity by 37.5%; and the simple act of washing hands at critical times can reduce the number of diarrhea cases by as much as 35%. Improvement of drinking-water quality, such as point-of-use disinfection, would lead to a 45% reduction of diarrhea episodes.

[0010] Therefore, improved water sources are critically needed on a global scale. Perhaps the most cost effective way to create a clean drinking source for these populations is to provide shallow protected wells (approx. 50 to 300 feet in depth from ground surface). These wells have a borehole and piping that penetrate deeper than at least about 20 feet (to avoid accessing unclean surface or groundwater). However, as much of these 780 million people live in undeveloped areas, such a well must be easily built and maintained, utilizing simple but effective well-drilling technologies.

[0011] Harry L. Westmoreland, Jr. of Sugarland, TX was the inventor of one of the first known portable water well-drilling rigs in the early 1990's, currently sold as the LS-100 mud rotary drill rig by Lone Star Drills and manufactured by Little Beaver Inc. out of Livingston, TX. FIGS. 4 and 5 are provided to illustrate the components and setup for this drill to conduct shallow well-drilling operations. As shown in FIG. 4, Westmoreland's drill rig 10 generally includes an engine and transmission (generally shown by 11) secured by supporting structure (comprising table legs 16, motor mount 17, and drill mast 18) on a ground surface and configured to power a connected length of drill pipe stems 13 with a drill bit 14 at a terminal end thereof so as to drill a borehole 50 to a depth that breaches an underground aquifer. Referring to FIGS. 4 and 5, and prior to drilling, a plurality of 55-gallon drums 20 are filled with water and maintained full during the drilling process. These drums 20 are arranged near a suction mud pit 22 and a settling mud pit 24 which are to be dug. Typically, an agent such as chlorine is added to each drum 20 of water to ensure that bacteria are not injected into the groundwater during drilling.

[0012] The suction and settling pits 22, 24 are typically dug about 7-10 feet away from the well guide hole 15 so that, when the well is finished, the resultant pump pad does not need to be built on the unstable filled-in pits 22, 24. These pits 22, 24 collectively should have at least three times the volume of the borehole 50 being drilled, each pit being approximately 2 ft. deep, 2 ft. wide and 3-4 ft. long, with the long axis parallel to the direction of flow. Next a first channel 25 is dug between the well guide hole 15 and the settling pit 24, and a second return ditch 26 between the two pits 22, 24. A mud pump 30 is then set between the drill rig 10 and the suction mud pit 22. The pump 30 includes a high pressure suction hose 31, and feed hose 33 which ports high pressure drilling fluid 27 from the suction pit 22 down a swivel between the transmission and drill pipe 13, along the drill pipe 13 so as to remove debris associated with drilling operations to form the

borehole 50. This debris drains off via channel 25 and ditch 26 into the settling pit 24 and suction pit 22; a drain hose 35 ports excess drilling fluid 27 into the settling pit 24.

[0013] The drill rig 10 is then erected over the guide hole 15 and leveled on boards 19 (such as 2" x 6" planks), with the hoses 31, 33, 35 over the pits 22, 24, and with table legs 16 arranged parallel to the return ditch 26 between the mud pits 22, 24. Guy ropes 40 are attached between the drill mast 18 and the ground in a triangular fashion and tightened. Next, the drill head is raised up the mast 18 so as to permit ease of starting the LS-100 engine 11 in an idle position. Once running, the drill head is raised additionally to a sufficient height to allow the installation of a drill pipe 13 section with the drill bit 14 secured to an end thereof, and the drilling process may commence.

[0014] The borehole 50 is drilled by rotating the bit 14 at the end of drill pipe 13. Borehole 50 cuttings are removed by continuous circulation of a drilling fluid 27 from suction pit 22 as the bit 14 penetrates the formation. One end of a drill pipe 13 is connected to the LS-100 engine 11. Drilling fluid 27 is pumped down through the hollow drill pipe 13 using the centrifugal pump (mud pump 30) to the drill bit 14. The fluid 27 flows upward in the annular space between the drill pipe 13 and the borehole 50 to the surface, where it is channeled via channel 25 into the settling pit 24 so that most of the cuttings drop out. Used drilling fluid 27 from the settling pit 24 overflows via ditch 26 into the suction pit 22. Relatively clean drilling fluid 27 from the suction pit 22 is then pumped back through the drill pipe 13 and the cycle repeats. Water is added as necessary to top-up the pits 22, 24.

[0015] In very hard rock, a drilling rate of about 30-150 cm/hr (1 - 5 ft/hr) can be expected. The drill string (connected drill pipe stems 13 and bit 14) are left at the bottom of the borehole 50 and the drilling fluid 27 continues circulating until all cuttings are removed from the borehole 50. This cleaning process is increasingly important as the hole 50 is deepened: if not fully done in the manner described, cuttings may settle to the bottom of the borehole 50 and make it impossible to add another length of drill pipe 13, causing the borehole 50 to cave-in or plug-up or the drill bit 14 to jamb. The deeper the drill depth, the longer it takes the cuttings to be removed from the borehole 50.

[0016] After about a 10 cm (4 in) "pilot" borehole 15 is completed to a desired depth, the drilling fluid 27 circulates another 10 minutes to remove as much cuttings as possible from the well. Next, the drill head is raised until a slip clamp on the drill table 16 can be engaged at a coupling of the next length of drill pipe 13 with the mud pump 30 turned off.

[0017] Once the borehole 50 has penetrated the aquifer and flowrate is determined acceptable, a larger reamer bit may replace or be added behind the drill bit 14, and the borehole 50 is re-drilled to widen it. While this is being done, the screen interval, length of casing, volume of gravel pack, grout, etc. can be planned, materials cut to size, etc. This is helpful to do since time is of the essence when the drill pipe 13 and bit 14 are pulled from the completed borehole 50 and the screen and casing installed.

[0018] After the operator has decided to stop drilling, the drilling fluid 27 is allowed to circulate for another 10 minutes to remove as much cuttings as possible from the well. Then the "mud" is circulated out of the borehole 50 by replacing it with fresh (clean) water. The drill piping 13 and bit 14 are then removed, with the bit 14 rotating and water circulating, so the surface of the borehole 50 remains smooth. The casing, gravel pack, annular seal, cement pad and hand pump can then be installed.

[0019] While this drill rig 10 has been employed many times in various developing countries, there have been several problems. First, mechanical breakdowns at the drill site and a limited ability to purchase replacement parts for drill rig 10 in their country have made sustaining the well extremely difficult for these native peoples. Also, and assuming the drill rig 10 was donated to the local populace, each drilled well typically cost at least \$2,000, namely because a vehicle was often required to transport the rig 10 to the drill site and oil and fuel were needed to operate the equipment. This cost is typically a sum well beyond the means of the local community to make this a self-sustaining project. Thus, in many of these remote areas, the number of times that a well could be drilled with drill rig 10 were typically limited to a couple of times per year. Further, the actual purchase price costs of a complete LS-100 drill rig package may be prohibitive for many outreach and humanitarian programs, with a starting cost of at least \$9,000.00 USD.

[0020] Moreover, difficulties with the LS-100 have been encountered when drilling the pilot borehole 15 where the formation consisted primarily of fine to coarse sand, or where the first 10 feet or so of the borehole 50 consisted of hard rock (laterite), which was difficult to penetrate. Often, after breaking through the hard rock layer, there were fractures in the formation below the laterite, which resulted in a loss of drilling fluid 27 to the formation and difficulties in keeping the drilling fluid 27 in the borehole 50 for the drilling process.

[0021] Another prior art well-drilling rig is the "Village Drill", a human-powered drill rig with a purchase cost of \$18,000.00 USD. FIG. 6 is a perspective view of this prior art

well-drilling rig, which is offered online by the Freeman Institute Foundation (<http://www.freemaninstitute.com/water.htmnd>) and which has been developed by Renouard, et al., as described in U.S. Pat. Appl. Pub. No. 2013/0206480, (hereafter, the “480 publication”). As shown in FIG. 6, the ‘480 publication describes a human-powered borehole drill 100, e.g., the “Village Drill”, which includes a rotatable wheel 116 supported on a wheel support 114 above a ground surface at a height sufficient to permit a section of drill pipe 128 to be inserted between the ground and the wheel 116. The wheel 116 is composed of a central aperture to facilitate transfer of torque from the wheel 116 to a Kelly bar 146, and includes a hub 160 with spokes 162 extending therefrom. The wheel support 114 includes a base 120 with a vertical columns 122, 124 attached thereto, and a cantilevered beam 126 on the columns 122, 124 for lifting the drill pipe 128. Both ends of the beam 126 have a pulley 142 inside, and a winch 144 is attached to the low end of the beam 126. The wire rope or cable from the winch 144 goes through the beam 126 and can then hook onto the pipe 128 or the Kelly bar 146 for lifting.

[0022] In a basic drilling operation to dig the borehole for the well, the Kelly bar 146 is positioned above the wheel 116. As the drill cuts, the Kelly bar 146 and pipe 128 will lower until the top of the Kelly bar 146 is level with the top of the wheel hub 160. Then a winch operator lifts the pipe 128 until the slip plate (not shown) can fit under a coupler (not shown) between sections of pipe 128 and over legs of the base 120. After unthreading the Kelly bar 146 from the drill pipe 128, the Kelly bar 146 is raised until it reaches the top of the cantilever beam 126. Then a new three-foot pipe section of pipe 128 may be fit between the Kelly bar 146 and the top of the previous section of pipe 128, as is known, and threaded onto the pipe 128 (such as by a pipe wrench) using the coupler, and then onto the Kelly bar 146. Then the pipe 128 is lifted slightly until the slip plate is removed so drilling can continue.

[0023] Unfortunately, the cost of the Village Drill is substantially more than even that of the LS-100, and may have similar problems regarding replacement parts and difficulty in sandy and hard rock layer conditions. As such, those people living in undeveloped areas need another option for building and maintaining the well with ease, utilizing simple but effective well-drilling technologies with minimal cost and ease of replacement parts.

SUMMARY

[0024] An example embodiment of the present invention is directed to a well-drilling apparatus. The apparatus includes The apparatus includes a generally rectangular frame

having a plurality of multi-segment support beams in spaced relation extending vertically from a lower base to a top cap, no component of which exceeds five feet in length, a winch assembly attached to the frame, and a motor removably mounted on the frame and slidable up and down the beams via the winch assembly. The apparatus further includes a transmission removably coupled to the motor, and a drill pipe assembly removably coupled to the transmission.

[0025] Another example embodiment is directed to a well-drilling apparatus having a frame, the weight of which does not exceed 175 pounds, a winch assembly attached to the frame, and a motor removably mounted on the frame and slidable up and down the frame via the winch assembly. The apparatus further includes a transmission removably coupled to the motor, and a drill pipe assembly removably coupled to the transmission.

[0026] Another example embodiment is directed to a well-drilling apparatus having a frame, a winch assembly attached to the frame, and a motor removably mounted on the frame and slidable up and down the frame via the winch assembly. The apparatus further includes a transmission removably coupled to the motor, and a drill pipe assembly removably coupled to the transmission. The weight of the apparatus does not exceed 650 pounds.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Example embodiments will become more fully understood from the detailed description given herein below and the accompanying drawings, wherein like elements are represented by like reference numerals, which are given by way of illustration only and thus are not limitative of the example embodiments herein.

[0028] FIG. 1 is a photograph of a spring-fed ditch in Panama.

[0029] FIG. 2 is a photograph of a tanker truck of water in India.

[0030] FIG. 3 is a photograph of a drinking water source in Zambia.

[0031] FIG. 4 is a top perspective view of a prior art portable, well-drilling rig.

[0032] FIG. 5 is a side view of the rig shown in FIG. 4 to illustrate operation thereof.

[0033] FIG. 6 is a perspective view of another prior art portable, well-drilling rig.

[0034] FIG. 7 is a perspective view of a portable well – drilling apparatus in accordance with the example embodiments.

[0035] FIG. 8 is a front plan view of the apparatus shown in FIG. 7.

[0036] FIG. 9 is a side perspective view of the apparatus shown in FIG. 7.

[0037] FIG. 10 is an exploded parts view of the apparatus of FIG 7.

- [0038] FIG. 11 is a top plan view of the base shown in the apparatus of FIG. 7.
- [0039] FIG. 12 is a right side elevational view of the base in FIG. 11.
- [0040] FIG. 13 is a top plan view of the outrigger shown in the apparatus of FIG. 7.
- [0041] FIG. 14 is a front plan view of the outrigger in FIG. 13.
- [0042] FIG. 15 is a top plan view of the motor mount shown in the apparatus of FIG. 7.
- [0043] FIG. 16 is a right side elevational view of the motor mount in FIG. 15.
- [0044] FIG. 17 is an enlarged perspective view showing a portion of the apparatus including the motor, motor mount, transmission, and drill swivel.
- [0045] FIG. 18 is a perspective view of the top cap shown in the apparatus of FIG. 7.
- [0046] FIG. 19 is a top plan view of the cap of FIG. 18.
- [0047] FIG. 20 is an elevational view of the drill pipe assembly shown in the apparatus of FIG. 7.
- [0048] FIG. 21 is a photograph illustrating the preparation of the suction/settling pit and leveling of the apparatus prior to drilling operations.
- [0049] FIG. 22 is a photograph illustrating the lifting of the motor assembly using the winch assembly, in preparation for connecting drill pipe.
- [0050] FIG. 23 is a photograph illustrating the removal of the protective cap off the threads of the drill swivel, in preparation for connecting one or more lengths of drill pipe stems.
- [0051] FIG. 24 is a photograph illustrating the complete installation of the apparatus at a drill site, ready to conduct drilling operations to access an underground aquifer.
- [0052] FIG. 25 is a photograph illustrating the working of the rock drill bit to form the pilot borehole.
- [0053] FIG. 26 is a photograph illustrating the deepening of the borehole during drilling operations.
- [0054] FIG. 27 is a photograph illustrating the drainage of the debris and drilling fluid exiting the apparatus into the suction/settling pit during drilling operations.
- [0055] FIG. 28 is a photograph illustrating a completed borehole with the drill bit and stem therein; the well is now ready for casing and tapping.

DETAILED DESCRIPTION

- [0056] In the following description, certain specific details are set forth in order to provide a thorough understanding of various example embodiments of the disclosure.

However, one skilled in the art will understand that the disclosure may be practiced without these specific details. In other instances, well-known structures associated with manufacturing techniques have not been described in detail to avoid unnecessarily obscuring the descriptions of the example embodiments of the present disclosure.

[0057] Unless the context requires otherwise, throughout the specification and claims that follow, the word "comprise" and variations thereof, such as "comprises" and "comprising," are to be construed in an open, inclusive sense, that is, as "including, but not limited to."

[0058] Reference throughout this specification to "one example embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the appearances of the phrases "in one example embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Further, the particular features, structures or characteristics may be combined in any suitable manner in one or more example embodiments.

[0059] As used in this specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the content clearly dictates otherwise. The term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

[0060] As used in the specification and appended claims, the terms "correspond," "corresponds," and "corresponding" are intended to describe a ratio of or a similarity between referenced objects. The use of "correspond" or one of its forms should not be construed to mean the exact shape or size. In the drawings, identical reference numbers identify similar elements or acts. The size and relative positions of elements in the drawings are not necessarily drawn to scale.

[0061] The example embodiments hereafter describe a portable, shallow well-drilling apparatus that is lightweight, modular, and easy to transport to and assemble at a remote drill site. In reference to FIGS. 7 – 20, the portable, shallow well – drilling apparatus 200 is comprised of just a few modular, connectable assemblies. As shown, apparatus 200 includes a generally rectangular frame 210 composed of a base 211, and a plurality of vertically-oriented, multi-segment support beams 212 connected at one end to the base 211 and at the other ends to a top cap 213. Apparatus 200 further includes a winch assembly 220 attachable to frame 210 and adapted to raise and lower a motor assembly 240 along

the support tubes 212, so as to connect a plurality of drill pipe stems 291, one of which terminates in a drill bit 294A/B (FIG. 20).

[0062] Apparatus 200 further includes a stabilizer assembly 230 which is configured to secure the apparatus 200 to a ground surface at a drill site preparation for drilling operations. A removable motor 248 supported within a motor mount 241 of the motor assembly 240 is removably coupled to a transmission 250, which in turn is connected to a hollow drill pipe swivel 280 that is configured to be operatively connected to the drill pipe assembly 290, namely to a female end/coupling 293 of a 1" OD steel drill pipe stem 291 (FIG. 20). Additionally, the drill pipe swivel 280 is adapted to be connected to a high pressure feed hose 264 of a pump assembly 260, namely to a mud pump 263. Pump 263 has a high-strength suction house 262 connected thereto which is designed to suck, under pump 263 power, from a water-filled suction/settling pit 261 so as to provide a high-pressure source of drilling fluid to the drill pipe assembly 290 via the swivel 280, as is known.

[0063] In apparatus 200, the total weight of the frame 210 alone does not exceed 175 pounds, and the total weight of the apparatus 200 does not exceed 650 pounds. Additionally, as the apparatus 200 is erected from smaller, modular components, such facilitates transport of all components thereof within a single shipping container that does not exceed five (5) feet in length and three (3) feet in width. To achieve this, none of the constituent components of apparatus 200, inclusive of the support beams 212 and pipe stems 291, exceeds five (5) feet in length.

[0064] As will be shown in further detail below, apparatus 200 is configured to create at least a 1" diameter borehole 205 up to 300 feet in depth from the ground surface, so as to breach an underground aquifer. In one example, apparatus 200 is configured to create a borehole 205 depth in a range of about 50 to 300 feet, so as to reach an underground fresh water source below a lowest depth of groundwater, which as noted above is about 20 feet below ground surface. Further, the frame 210 is extremely robust, as each of the base 211, top cap 213 and support beams 212 are formed of a plurality of welded elongate schedule 40 steel sections having a pipe wall thickness of at least 0.25".

[0065] The base 211 is composed of a plurality of welded-together truncated square – shape steel tubing sections, whereby tubing sections 214A are 2.5" x 2.5" square steel tubing, and cross-tube section 214B is formed of 2" x 2" square steel tubing. The base 211 further includes three (3) truncated steel support collars 215 (2.375" x 3" steel tubing),

each adapted to receive a lower end of a corresponding support beam 212. Each collar 215 includes a hole 216 that aligns with the corresponding hole in the support beam 212, with the beam 212 being secured to the collar 215 via a fastener (not shown) secured therethrough. The support beams 212 are composed of a plurality of connected segments 217 (FIG. 10), none of which exceeds 5' in length. The top cap 213 (see FIGS. 18, 19) includes two (2) 2.5" x 2.5" square steel tubing sections 218A/B welded together in the shape of a T, and further includes pulleys 223 of the winch assembly 220 thereon, with one pulley 223 that takes most of the weight welded to a bracket 226 on tube section 218B. A collar 215 is welded to an end of tube section 218A for coupling to a top end of a support beam 212.

[0066] The stabilizer assembly 230 includes a plurality of outriggers 231, each outrigger 231 secured at one end to the base 211. As best shown in FIGS. 9, 13 and 14, each outrigger 231 includes an aperture 237 at the other end that is adapted to receive a threaded bottom of a screw jack 234. Each screw jack 234 is inserted through its corresponding aperture 237, and additionally engages a nut 238, with each foot of the screw jack 234 engaging a support pad 233. As each of the screw jacks 234 are adjustable, this allows ease of leveling of the frame 210 on the ground surface at the drilling site. To further assist in securing apparatus 200 on a ground surface in preparation for drilling operations, the stabilizer assembly 230 further includes a plurality of rebar elements 232, as shown extending through apertures in the base 211 and into the ground surface. Additionally a pair of comealongs 235 are employed to further stabilize the frame 210. Each comealong 235 has its proximal end connected to the motor mount 241, and a distal end connected to a coiled auger pin 236 that is adapted to be screwed into the ground surface.

[0067] Referring to FIGS. 15-17, the motor assembly 240 includes a motor mount 241 supporting a removable motor 248. Motor 248, in an example, may be embodied as a 6.75 HP BRIGGS & STRATTON® 675 SERIES e™, 190cc engine, with transmission 250 embodied as an Aries 30:1 ratio transmission. Motor mount 241 comprises a pair of steel plates 242 in spaced relation to one another with a steel hanger 246 extending therebetween, the components welded to one another. The motor mount 241 is configured so that each steel support sleeve 244 thereof is welded to a corresponding bracket 243, which in turn is welded to an outer surface of its corresponding plate 242. A central connector bracket 225 is welded to the hanger 246 and configured to attach to one end of a

steel cable 224 of the winch assembly 220 for raising and lowering the motor assembly 240.

[0068] Pump assembly 260 includes a hi-strength 2" OD suction hose hooked up to the inlet of mud pump 263, and a 1 1/4" high pressure feed hose 264 connected between the pump 263 outlet and a hollow connector element 285 that is welded to the drill swivel 280 (FIG. 17). Drill swivel 280 may include a protective cap 282 placed over a threaded portion 281 when not in use/connected to a drill pipe stem 291. As is well known, the suction hose 262 takes a suck on a water-filled suction/settling pit 261, under pump 263 power, which serves as the drilling fluid ported through connector element 285 and drill swivel 280 to the hollow drill pipe stems 291. In an example, the mud pump 263 may be embodied as a POWERHORSE, 2" Semi-Trash pump with a 5 HP, 208 cc engine that pumps 1750 gallons per hour.

[0069] The ratchet arm assembly 270 includes a connected 271 for attachment to the drill swivel 280, with an arm 272 attached thereto and a handle 273. The ratchet arm assembly 270 has idle and lock positions, see lock 274. The drill pipe assembly includes a plurality of connectable pipe stems 291 with coupling/female ends 293 for attachment to one another's male end 292 or to the threaded portion 281 of the drill swivel 280.

[0070] FIGS. 21-28 are photographs provided to help understand the general setup and operation of apparatus 200. The steps shown in FIGS. 21-28 are similar to those previously described with the LS-100 setup and operation, thus a detailed explanation is omitted for purposes of brevity. Referring now to FIGS. 21 to 28, and assuming that the proper location for the drill site has been determined, the suction/settling pit 261 is dug out, and the frame 210 of the apparatus 200 is oriented and leveled at the drill site location for making the eventual borehole 205 as shown in FIG. 21, a drain ditch 265 is created between the location where the borehole 205 will be dug and the suction/settling pit 261.

[0071] Next, an operator 203 operates the winch assembly 220 (FIG. 22) so as to raise the motor assembly 242 up along beams 212 a sufficient height so that the drill pipe assembly 290 may be attached to the threaded portion 281 of the drill swivel 280. To attach a length of pipe stem 291, the protective cap 282 is removed from the threaded portion 281 of the drill swivel 280. To do this, a pipe wrench 202 is employed, and will also be used to rotate the female end 293 of the drill pipe stem 291 onto the threaded portion 281. Once complete, one of the bits 294 A/B is attached at the male end 292 of a drill pipe stem 291. Depending on rock or soil conditions, one of a rock bit 294A or a soil

bit 294B is attached to the pipe stem 291. Additionally, after drill pipe 291 connection and prior to drilling operations, the suction/settling pit 261 is topped off with fresh water, and the pump 263 is started once the feed hose 264 is attached to the drill swivel 280. FIG. 24 illustrates an example set up in Zambia. Note that a strainer 266 is utilized at the terminus of the drain ditch 265 to filter out larger debris being removed as the borehole 205 is created. In this particular evolution, as comealongs 235 were not readily available, weight bags 235' were utilized to stabilize frame 210, in addition to the stabilizer assembly 230.

[0072] The drilling operation may be explained with reference to FIGS. 25 to 28. Initially, a guide hole 204 is formed; in this photograph a rock bit 294A is being used. Once the guide hole 204 has been completed, it is reamed out or widened so that creation of the borehole 205 can be begun in earnest. FIG. 26 shows an active operation of forming the borehole 205; and FIG. 27 illustrates the excess cuttings, used drilling fluid and debris removed by the apparatus 200, running down ditch 265 and through strainer 266 into the suction/settling pit 261. FIG. 28 show the completed borehole 205, ready for installation of the screen and casing, gravel pack, annular seal, cement pad, and hand pump to complete the protected well, as is known.

[0073] The example embodiments having been described, it is apparent that such have many varied applications. For example, the example embodiments may be applicable but not limited to connection to various devices, structures and articles.

[0074] The present invention, in its various embodiments, configurations, and aspects, includes components, systems and/or apparatuses substantially as depicted and described herein, including various embodiments, sub-combinations, and subsets thereof. Those of skill in the art will understand how to make and use the present invention after understanding the present disclosure. The present invention, in its various embodiments, configurations, and aspects, includes providing devices in the absence of items not depicted and/or described herein or in various embodiments, configurations, or aspects hereof, including in the absence of such items as may have been used in previous devices, e.g., for improving performance, achieving ease and/or reducing cost of implementation.

[0075] The foregoing discussion of the invention has been presented for purposes of illustration and description. The foregoing is not intended to limit the invention to the form or forms disclosed herein. In the foregoing Detailed Description for example, various features of the invention are grouped together in one or more embodiments, configurations, or aspects for the purpose of streamlining the disclosure. The features of

the embodiments, configurations, or aspects of the invention may be combined in alternate embodiments, configurations, or aspects other than those discussed above. This method of disclosure is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment, configuration, or aspect. Thus, the following claims are hereby incorporated into this Detailed Description, with each claim standing on its own as a separate preferred embodiment of the invention.

[0076] Moreover, though the description of the invention has included description of one or more embodiments, configurations, or aspects and certain variations and modifications, other variations, combinations, and modifications are within the skill and knowledge of those in the art, after understanding the present disclosure. It is intended to obtain rights which include alternative embodiments, configurations, or aspects to the extent permitted, including alternate, interchangeable and/or equivalent structures to those claimed, whether or not such alternate, interchangeable and/or equivalent structures disclosed herein, and without intending to publicly dedicate any patentable subject matter.

I claim:

1. A well-drilling apparatus (200), comprising:
 - a generally rectangular frame (210) having a plurality of multi-segment support beams (212) in spaced relation extending vertically from a lower base (211) to a top cap (213), no component of which exceeds five feet in length,
 - a winch assembly (220) attached to the frame (210),
 - a motor (248) removably mounted on the frame (210) and slidable up and down the beams (212) via the winch assembly (220),
 - a transmission (250) removably coupled to the motor (248), and
 - a drill pipe assembly (290) removably coupled to the transmission (250).
2. The apparatus (200) of claim 1, wherein total weight of the frame (210) alone does not exceed 175 pounds.
3. The apparatus (200) of claim 1, wherein total weight thereof does not exceed 650 pounds.
4. The apparatus (200) of claim 1, wherein the apparatus (200) is modular so as to facilitate transport of all components thereof within a single shipping container that does not exceed five feet in length and three feet in width.
5. The apparatus (200) of claim 1, wherein the apparatus (200) is configured to create at least a 1" diameter borehole (205) up to 300 feet in depth from the ground surface so as to breach an underground aquifer.
6. The apparatus (200) of claim 1, wherein the apparatus (200) is configured to create a borehole depth in a range of about 50 to 300 feet so as to reach an underground fresh water source below a lowest depth of groundwater.
7. The apparatus (200) of claim 1, wherein each of the base (211), top cap (213) and support beams (212) are formed of a plurality of elongate schedule 40 steel sections having a wall thickness of at least 0.25".

8. The apparatus (200) of claim 1, further comprising a stabilizer assembly (230) for securing the frame (210) of the apparatus (200) to a ground surface, the stabilizer assembly (230) further including:

- a plurality of steel outrigger (231) sections connected at one end to the base (211),
- a plurality of screw jacks (234), each securing the other end of a corresponding outrigger (231) to the ground surface, and
- a pair of comealongs (235) secured between the motor (248) assembly and ground surface.

9. The apparatus (200) of claim 8, the stabilizer assembly (230) further including:

- a plurality of rebar elements (232) adapted to be inserted through the base (211) into the ground surface, and
- a pair of coiled auger pins (236), each pin (236) attached to a distal end of a corresponding comealong (235) and adapted to be screwed into the ground surface.

10. A well-drilling apparatus (200), comprising:

- a frame (210), the weight of which does not exceed 175 pounds,
- a winch assembly (220) attached to the frame (210),
- a motor (248) removably mounted on the frame (210) and slidable up and down the frame (210) via the winch assembly (220),
- a transmission (250) removably coupled to the motor (248), and
- a drill pipe assembly (290) removably coupled to the transmission (250).

11. A well-drilling apparatus (200), comprising:

- a frame (210),
- a winch assembly (220) attached to the frame (210),
- a motor (248) slidable up and down the frame (210) via the winch assembly (220),
- a transmission (250) removably coupled to the motor (248), and
- a drill pipe assembly (290) removably coupled to the transmission (250), wherein total weight of the apparatus (200) does not exceed 650 pounds.



FIG. 2



FIG. 1

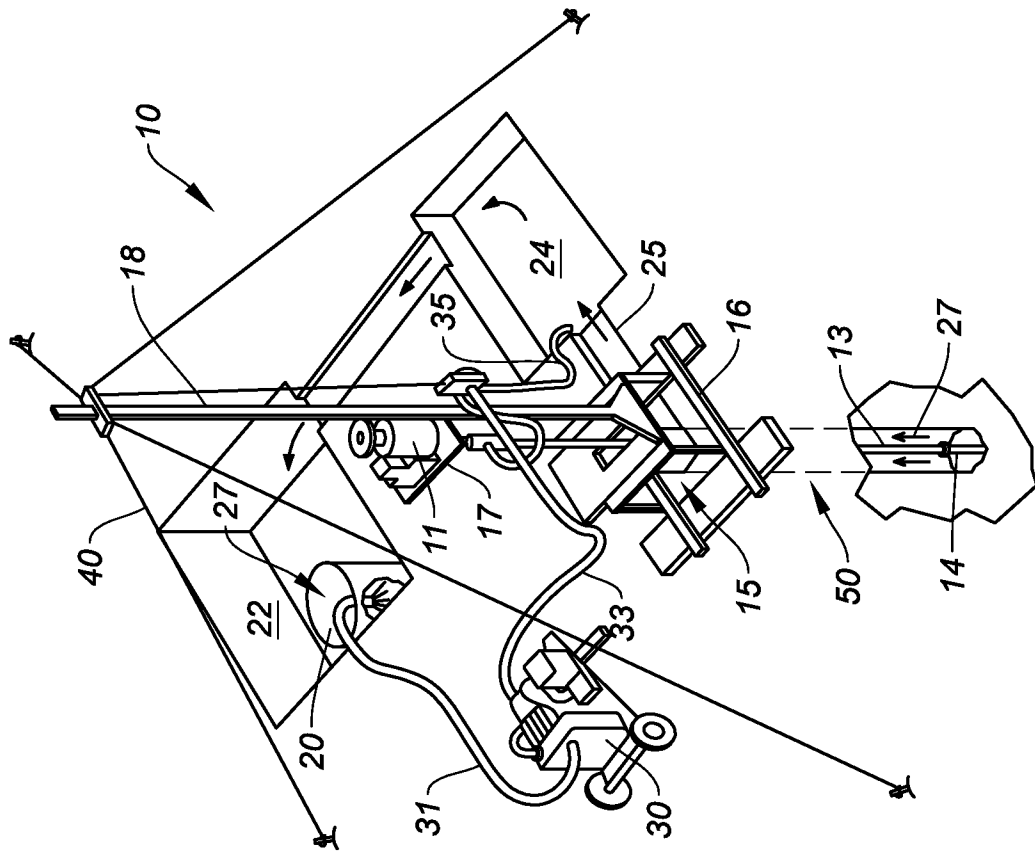


FIG. 4
(Prior Art)



FIG. 3

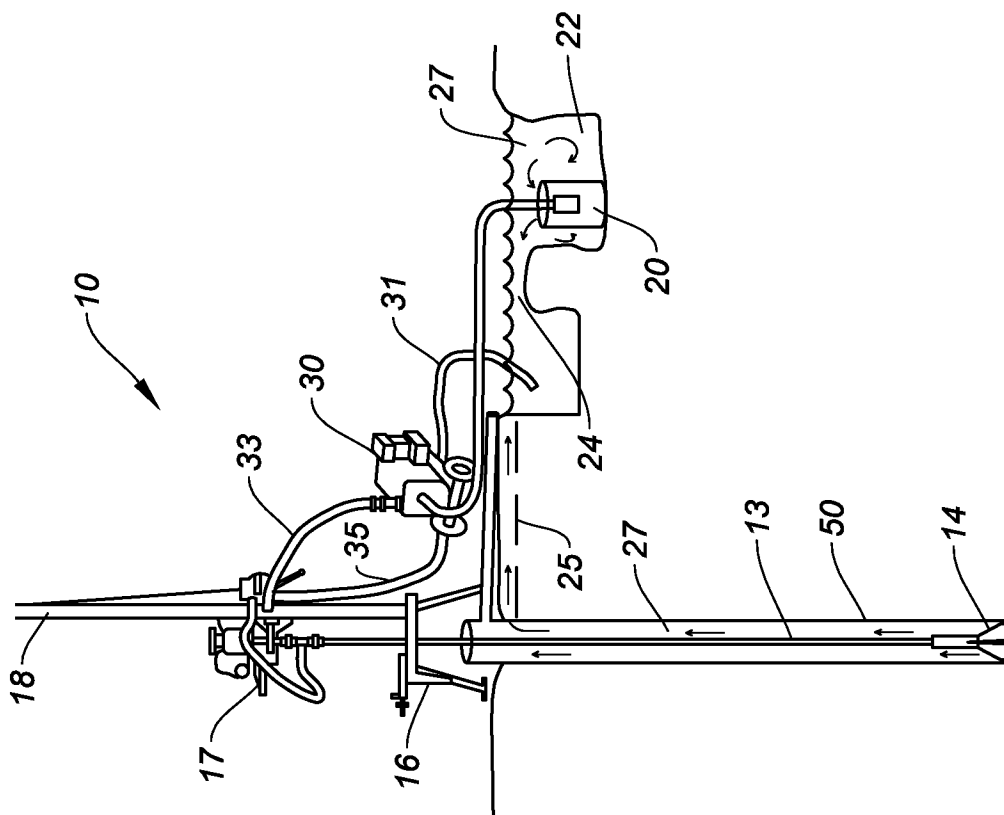


FIG. 5
(Prior Art)

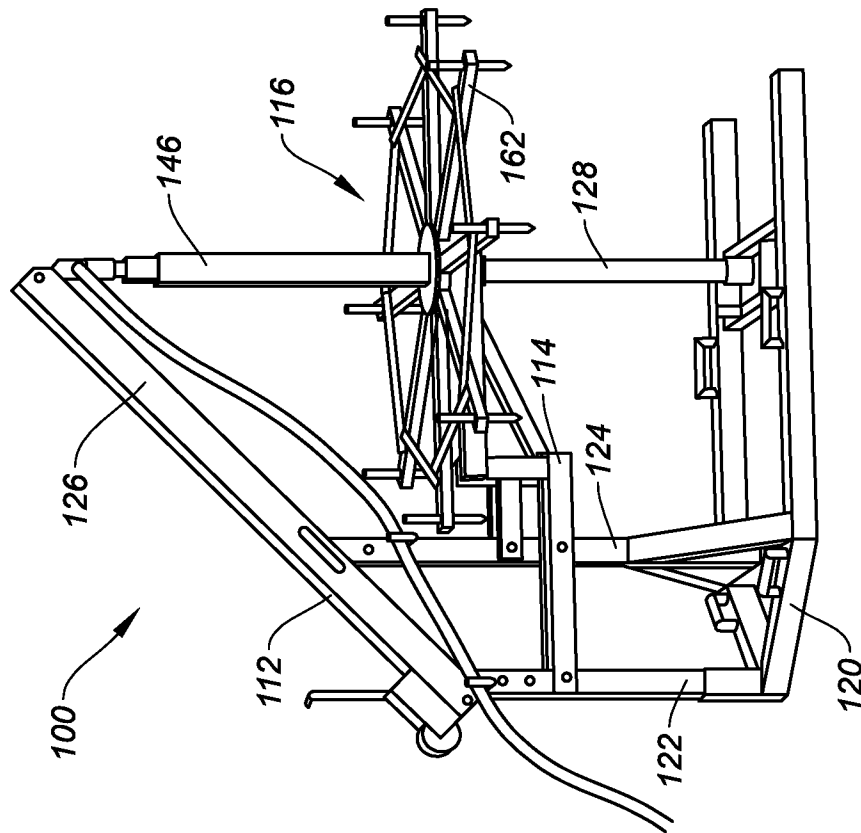
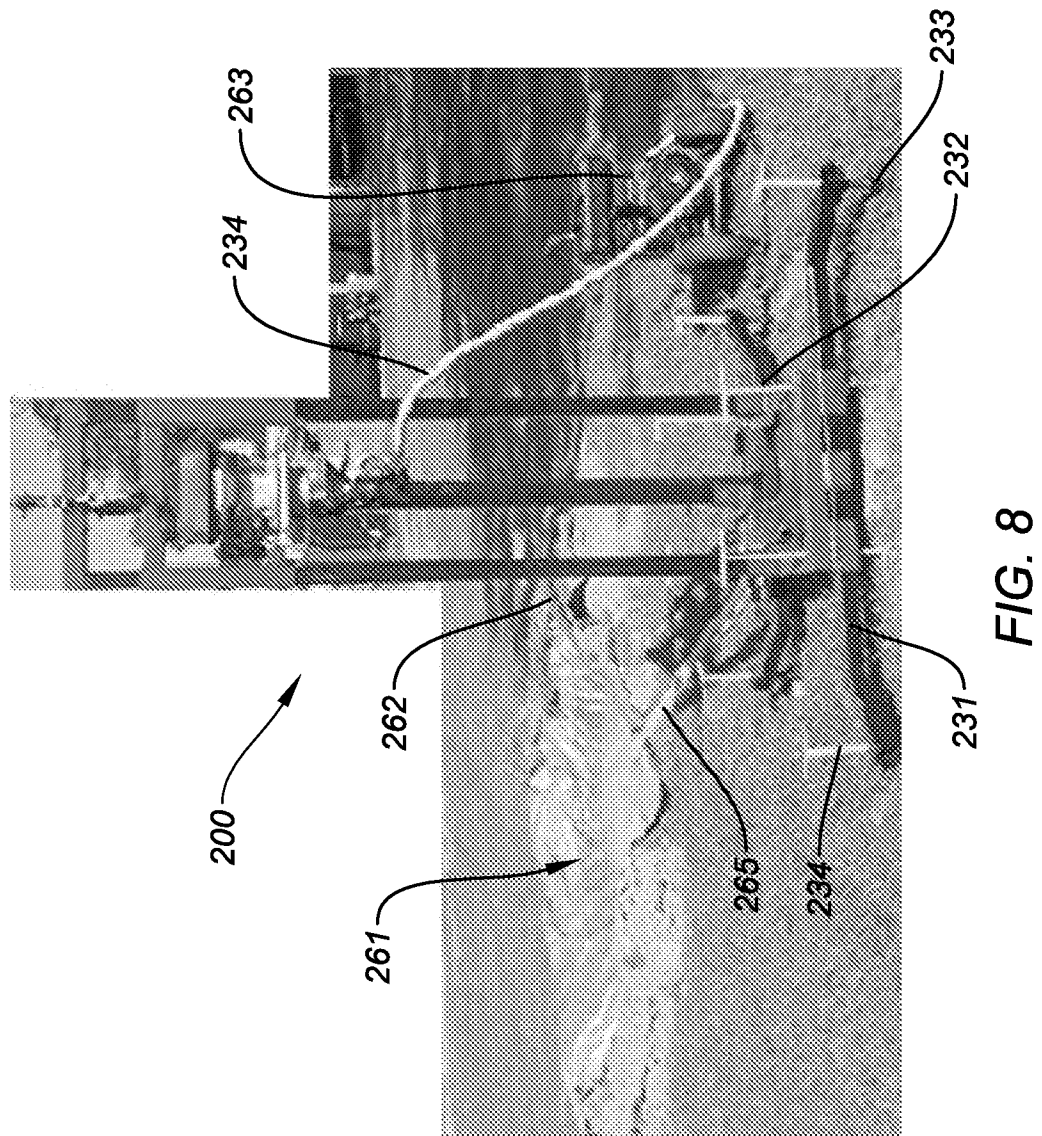
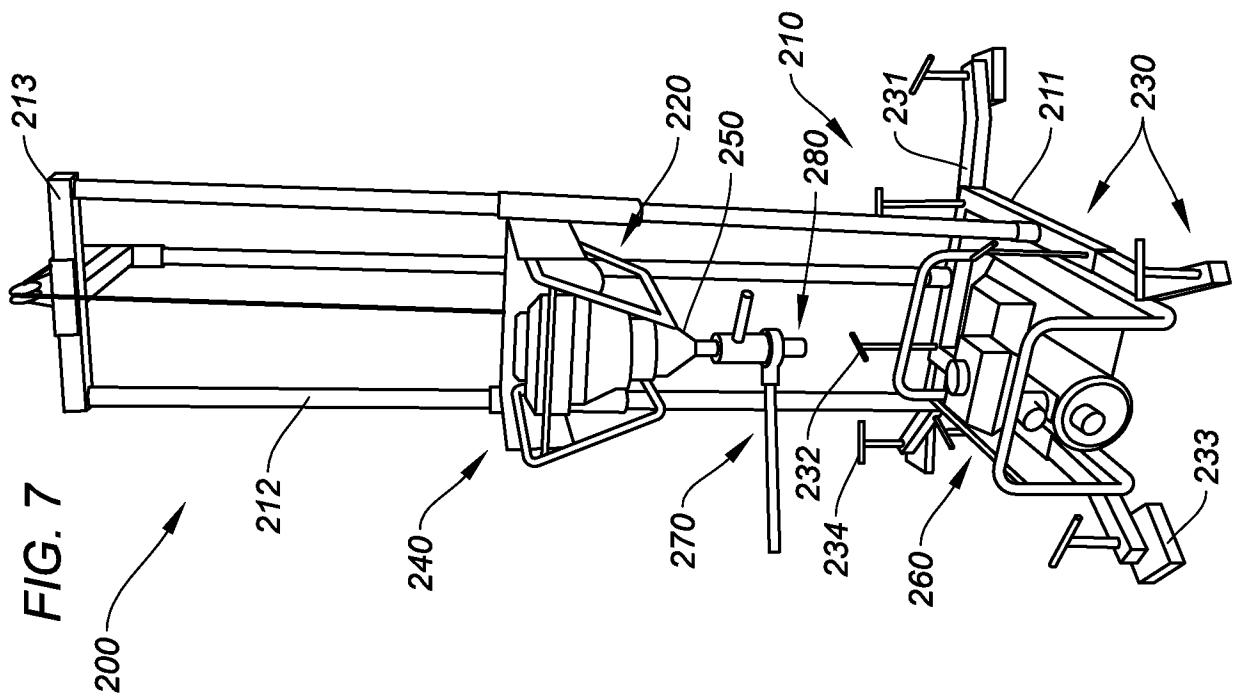
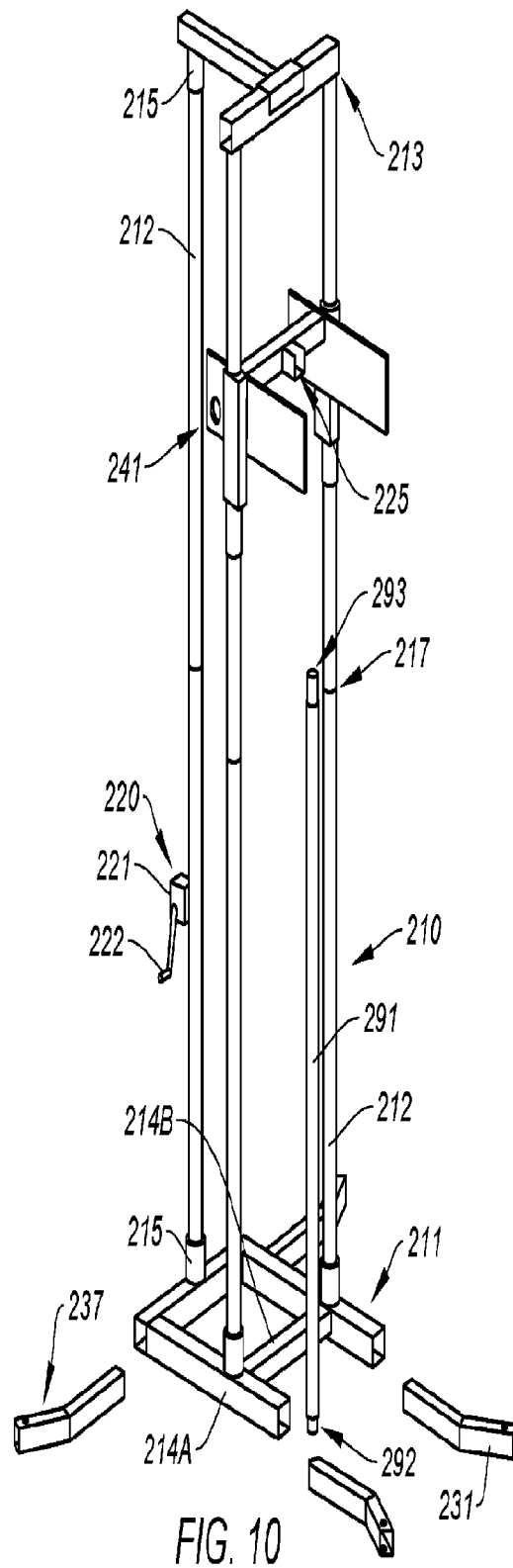
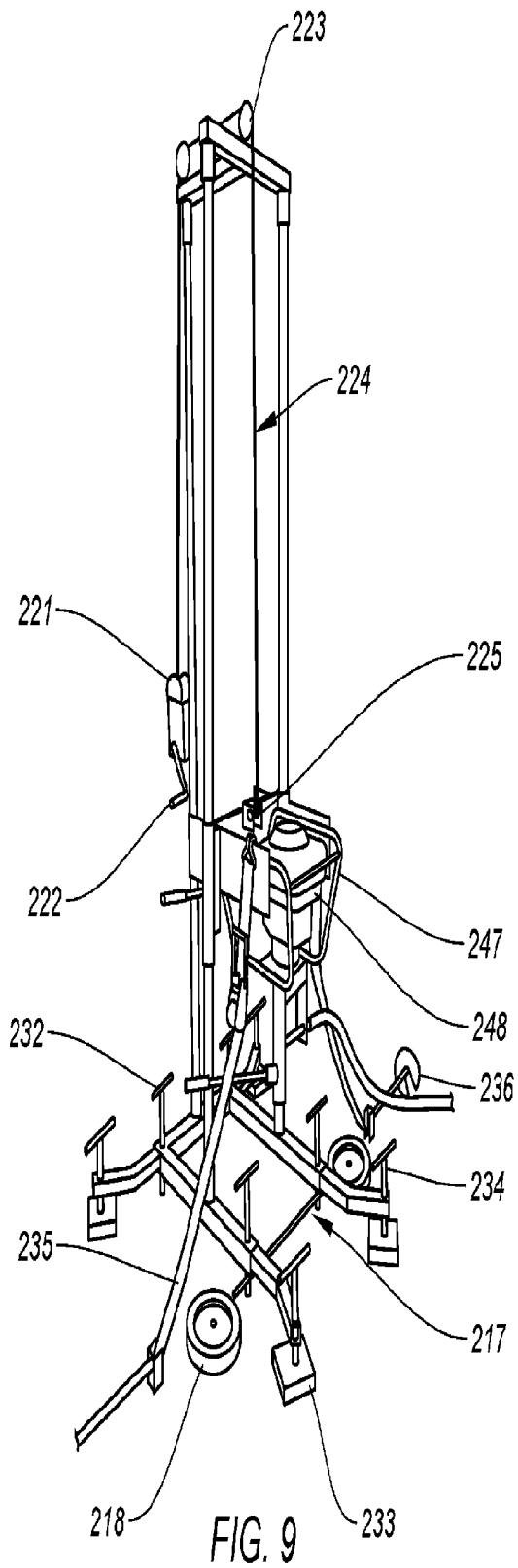


FIG. 6
(Prior Art)





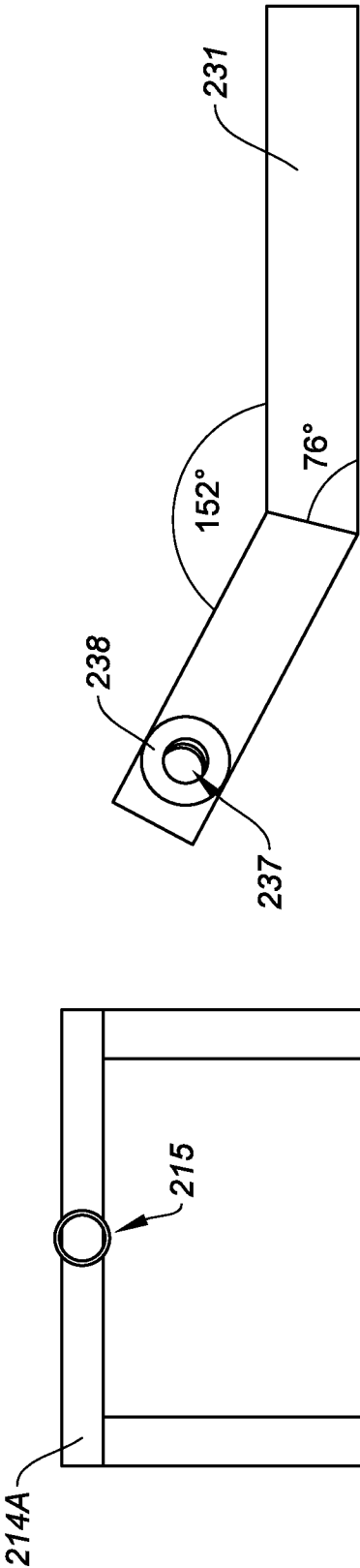


FIG. 13

FIG. 11

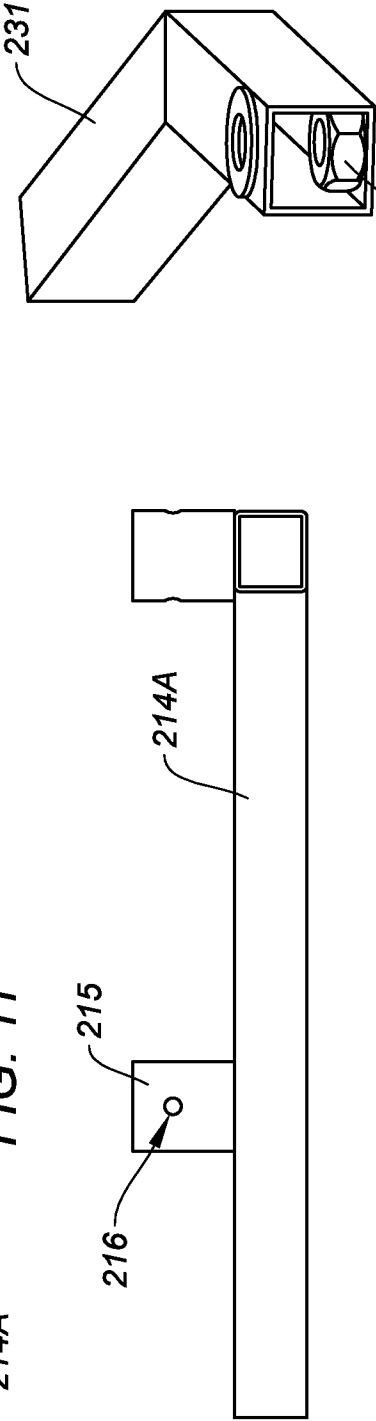
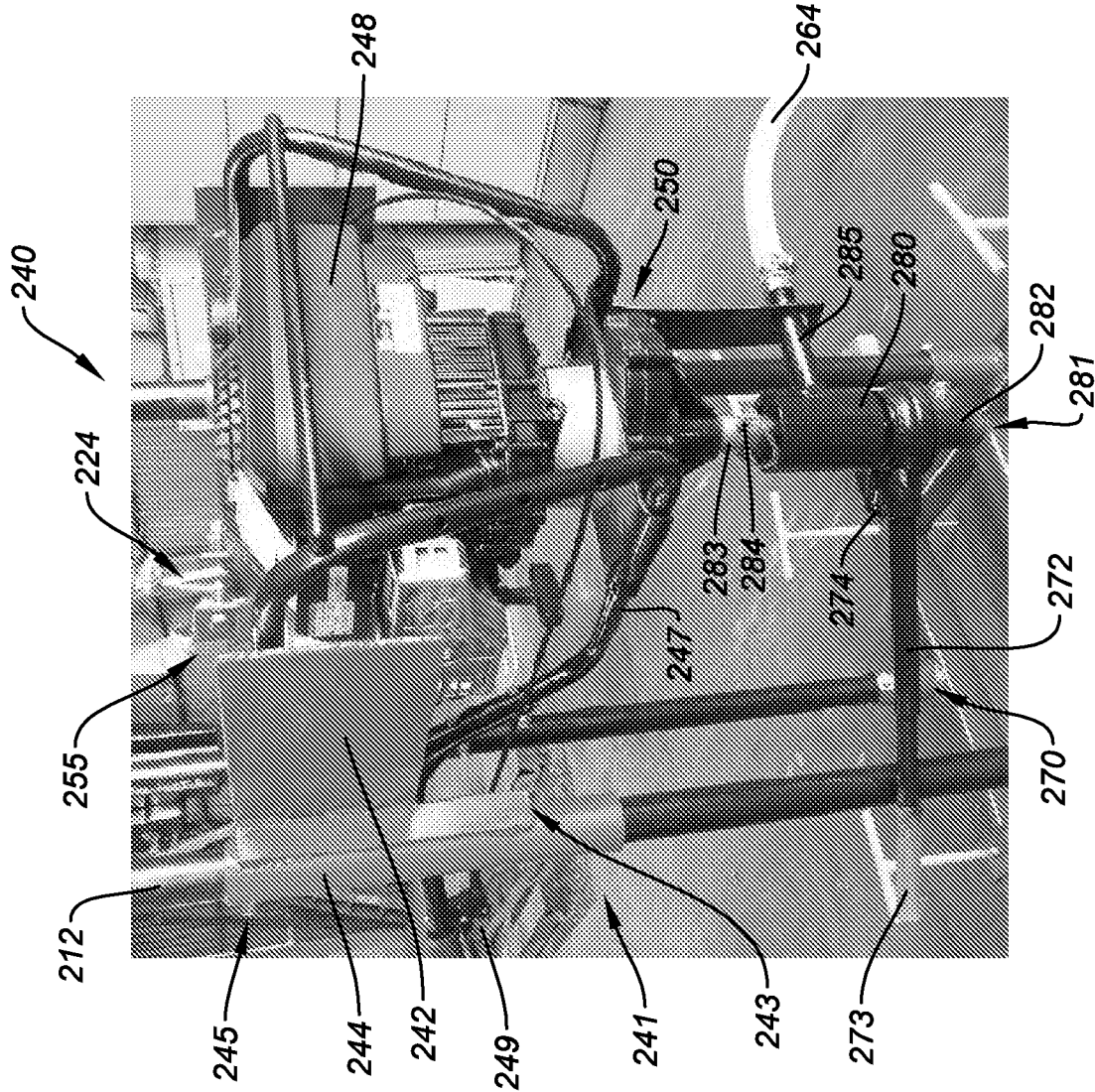
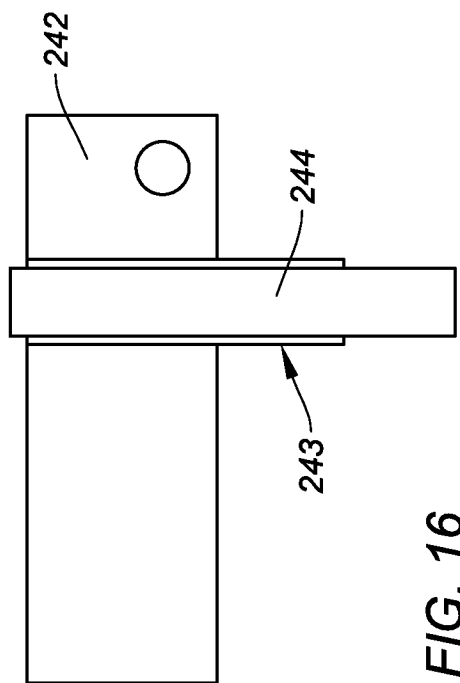
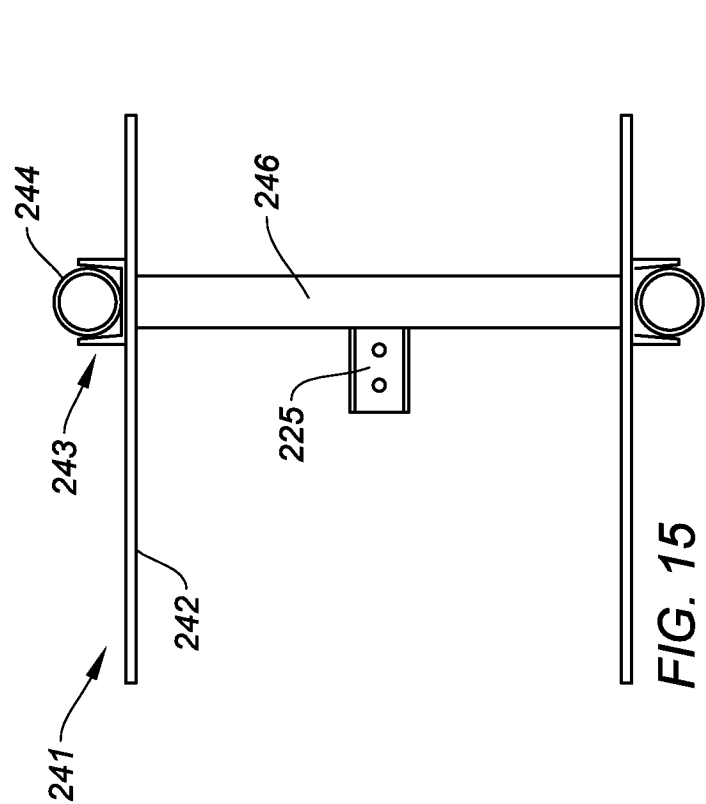


FIG. 12

FIG. 14



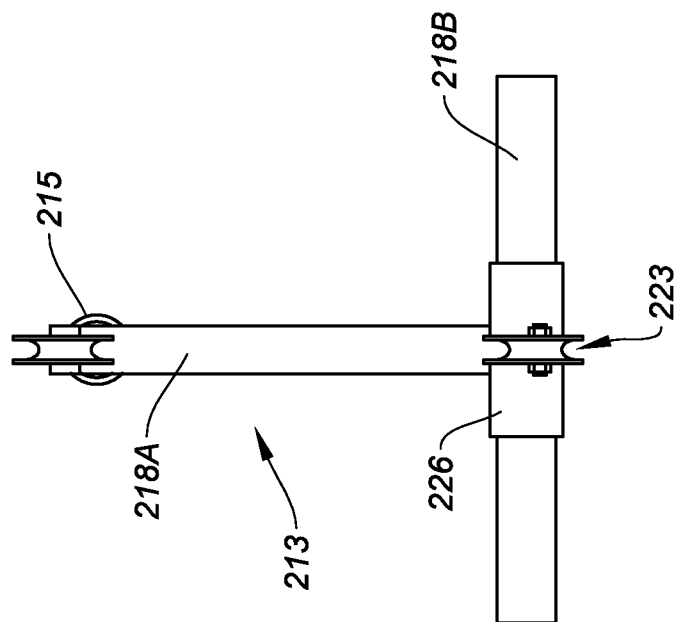


FIG. 19

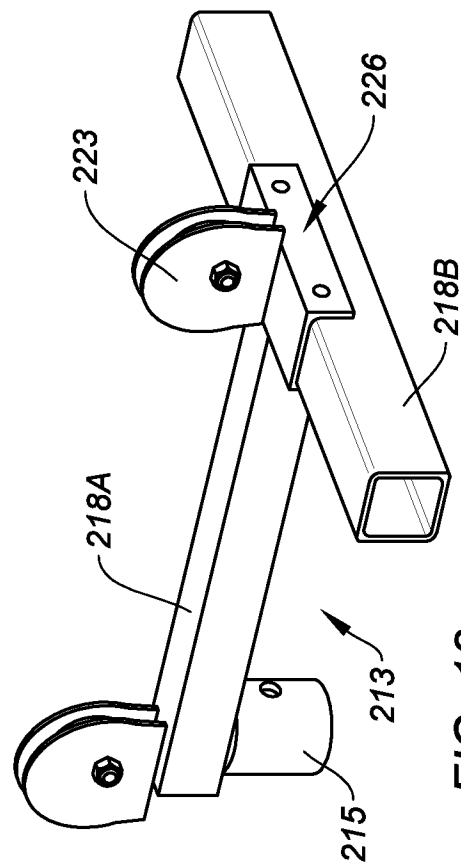


FIG. 18

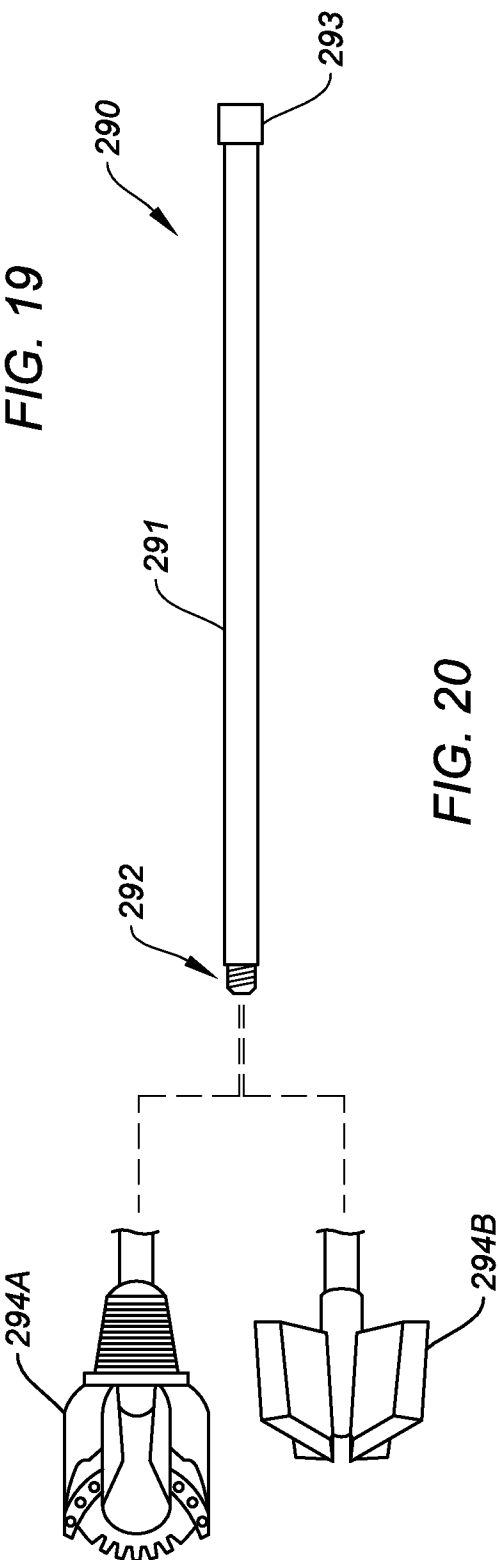


FIG. 20



FIG. 21

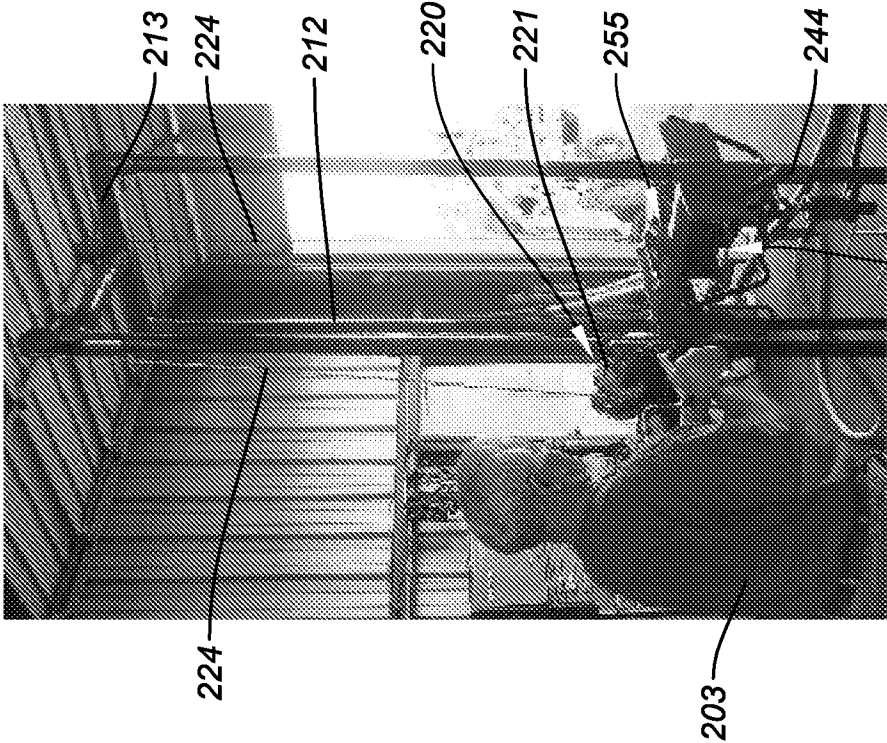


FIG. 22

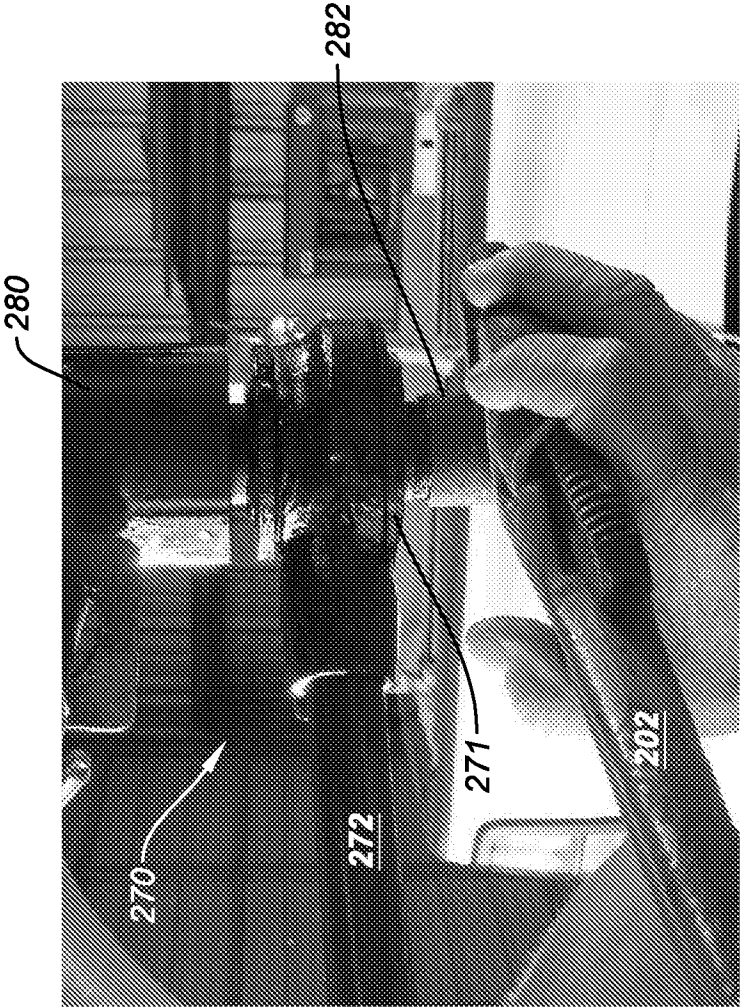


FIG. 23

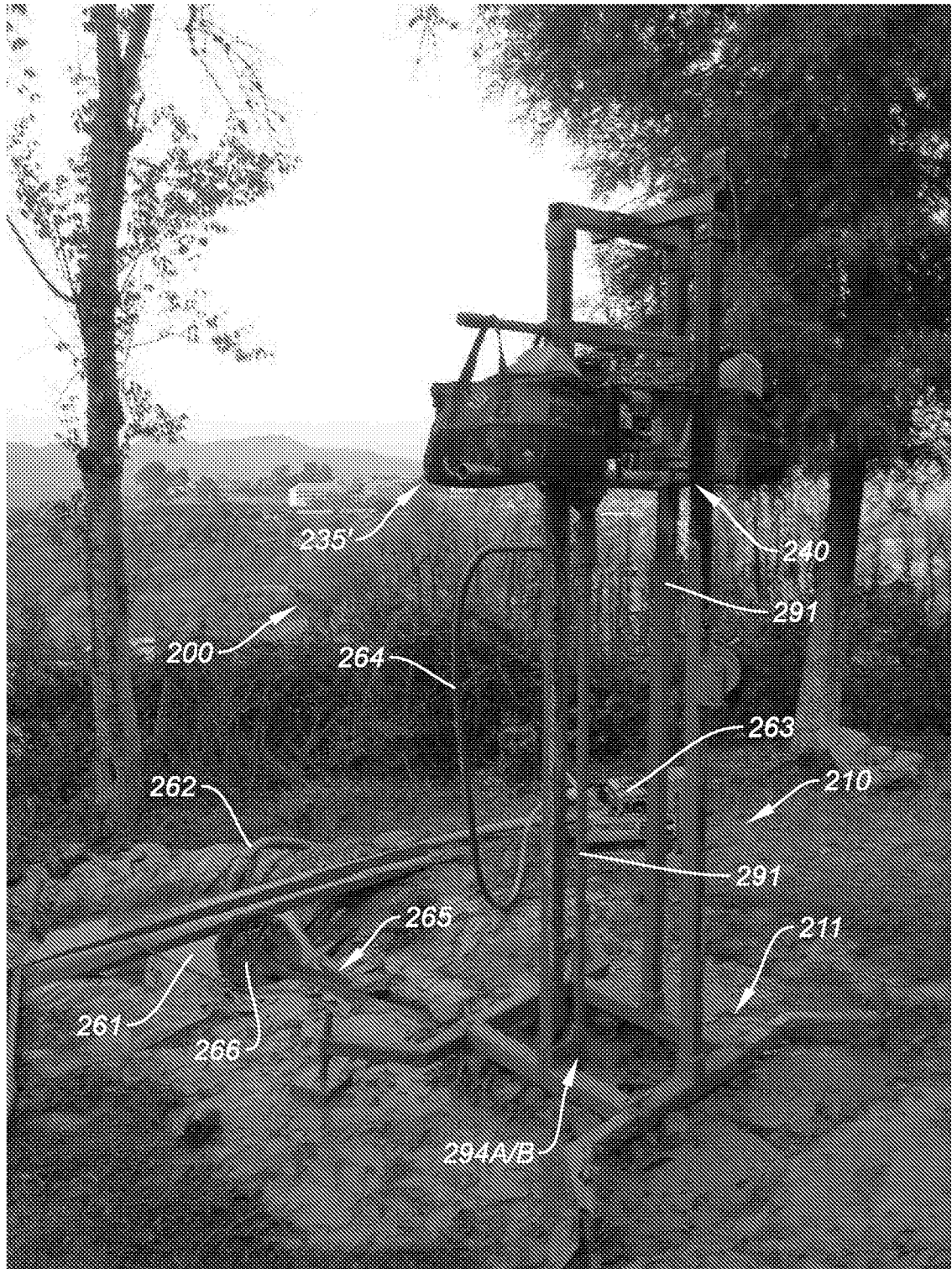


FIG. 24

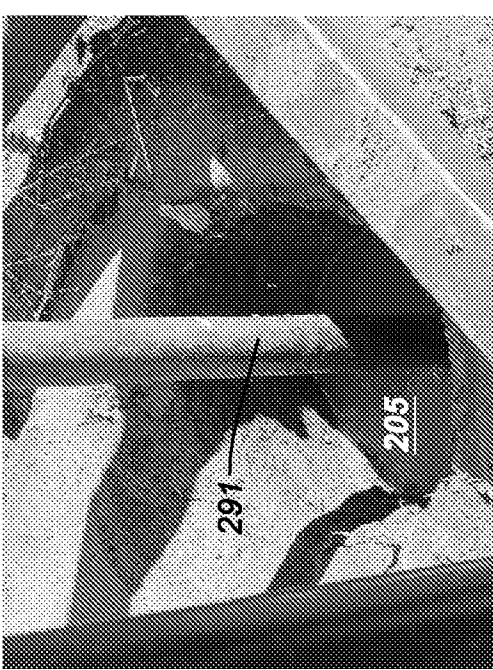


FIG. 26

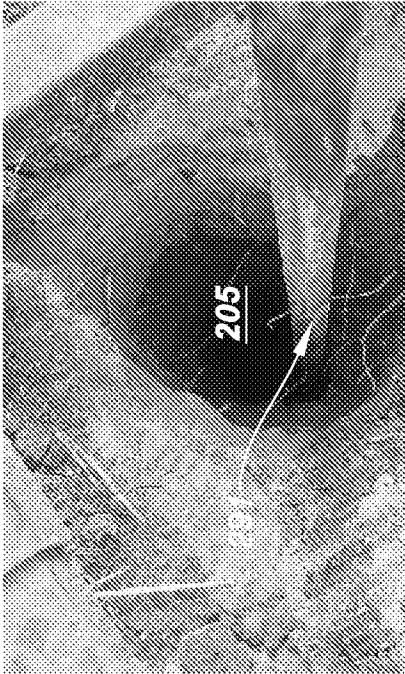


FIG. 28

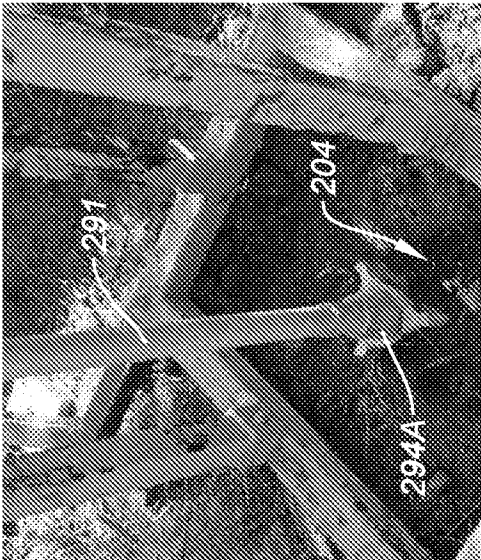


FIG. 25

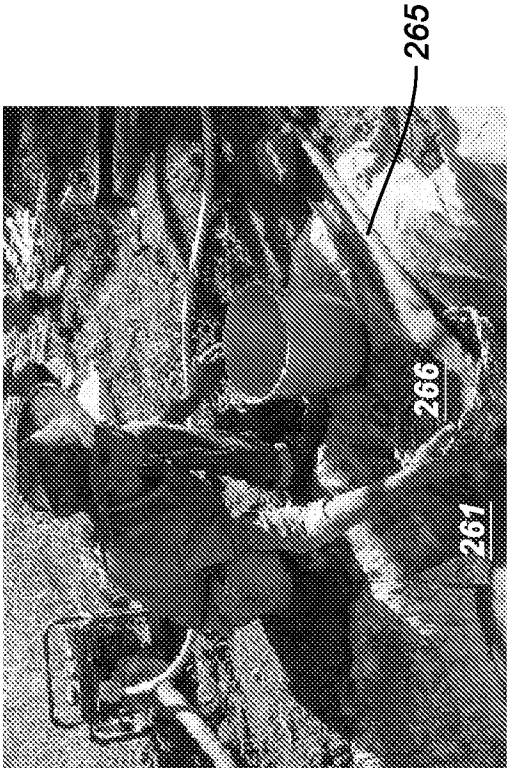


FIG. 27