SHALLOW DEPTH, COILED TUBING HORIZONTAL DRILLING SYSTEM

Inventors: Jeff Merecka, Cypress, TX (US); David Camp, Cypress, TX (US)

Correspondence Address:
Alan R. Thiele
JENKENS & GILCHRIST
3200 Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2799 (US)

Assignee: S & S Trust

Appl. No.: 10/299,450
Filed: Nov. 19, 2002

Related U.S. Application Data
Continuation-in-part of application No. 09/896,025, filed on Jun. 29, 2001.

Provisional application No. 60/215,534, filed on Jun. 30, 2000. Provisional application No. 60/233,358, filed on Sep. 18, 2000. Provisional application No. 60/258,119, filed on Dec. 22, 2000.

Publication Classification
Int. Cl. E21B 7/26
U.S. Cl. 175/19; 175/61

ABSTRACT
The invention relates to a system for coiled tubing drilling of substantially horizontal shallow depth boreholes for installation of transmission or conveyance lines. A mobile platform mounts a coiled tubing reel and an adjustably mounted injector head. On the leading end of the coiled tubing is a drilling assembly, including a drill, a drill motor, a tracking device, and an orienter. Once the borehole has been drilled by pushing the drilling assembly through the borehole and exiting the earth's surface, a back reamer may be attached for enlarging the borehole as the coiled tubing is pulled back through the borehole. Once the borehole has been properly sized, the transmission or conveyance line may be attached to the leading end of the coiled tubing and the transmission or conveyance pipe pulled back through the borehole.
SHALLOW DEPTH, COILED TUBING HORIZONTAL DRILLING SYSTEM


FIELD

[0002] The present invention involves horizontal directional drilling systems; more particularly, the present invention involves shallow depth, coiled tubing, horizontal directional drilling systems for the installation of transmission and conveyance lines—to include pipes, tubing, and cable.

BACKGROUND

[0003] Over the past fifteen years, methods for installing underground transmission and conveyance lines have advanced from digging trenches, laying lines in the trenches, and then refilling the trenches, to using horizontal directional drilling techniques to form subsurface boreholes and pulling pipes or tubing therethrough. The use of horizontal directional drilling techniques involves drilling horizontal boreholes beneath the earth’s surface using techniques similar to those perfected in the oil and gas exploration industry for drilling deep directional or horizontal wells in high pressure environments.

[0004] Shallow depth horizontal drilling is a method for the trenchless installation of underground pipelines. The purpose for the use of horizontal drilling techniques is to install shallow depth transmission and conveyance systems in a minimal pressure or non-pressure environment. Typically, such transmission and conveyance lines are used with various utilities such as electrical power, communications, natural gas, irrigation, petroleum, potable water, storm drains, and sewer service. Shallow depth horizontal directional drilling is accomplished by first causing the drill to penetrate the earth’s surface from above at a shallow angle, then drilling a pilot hole beneath the earth’s surface in a relatively horizontal plane with a cutting tool or drill bit, causing the cutting tool or drill bit to come back up through the earth’s surface, and then pulling the transmission or conveyance line; such as pipe or tubing, back through the pilot hole once the hole has been properly sized. Sizing is accomplished usually by the use of a backreaming tool such as disclosed in co-pending application Ser. No. 10/170,188, filed Jun. 20, 2002, to the same assignee.

[0005] The drilling equipment used in shallow depth horizontal direction drilling adapts oil field technology for the purpose of drilling horizontal boreholes through earthen materials versus traditional substantially vertical boreholes used in deep wells. However, unlike vertical well drilling, shallow depth horizontal drilling is not performed under the high pressure conditions typically found in deep wells.

[0006] The equipment generally in commercial use for shallow depth horizontal drilling is based on the use of a rotating segmented pipe string for drilling the borehole. Specifically, the drilling equipment includes either a piston/chain or rack and pinion drive mechanism which pushes or pulls a motor along a length of track. The length of track is slightly longer than the individual segment of drill pipe being used. During the borehole drilling process, an individual segment of pipe is loaded onto the track. The individual segment of pipe is then attached to the drill motor and to the previous pipe segment by rotating the drill motor and threading each coupling, or tool joint, together to form a long string. Once the individual segments have been threaded and locked together, the drill motor assembly is then thrust forward while rotating the string of all of the pipe segments, at a slight declining angle. The slight declining angle pushes the drill string, or series of threadably connected individual pipe segments, forward into the ground. Once the drill motor has reached the end of the track, the drill string is clamped and the drill motor is counter-rotated to enable disengagement of the drill motor from the drill string. The drill motor is then retracted (pulled back) and another segment of pipe is loaded on the track. This process is continued—pipe segment by pipe segment—throughout the entire length of the horizontal borehole that is to be produced.

[0007] During the boring or drilling process, the drill motor continually rotates. Accordingly, the entire drill string, including all of the connected individual pipe segments, is rotated. The drill motor is stopped only during times when it is necessary to change the direction of the drillstring through the ground, and add or remove individual drill pipe segments.

[0008] The actual downhole bend or turn of all of the individual drill pipe segments in the drill string, is typically accomplished using a bent housing assembly. The bent housing assembly enables the operator to push the drill string to follow the angle of the bent housing assembly. Once the turn of the drill string is completed, the operator engages the drill motor and the drill string is pushed forward while the drill motor continues to spin the entire drill string.

[0009] Once the initial borehole, or “pilot hole,” has been completed, the borehole is typically backreamed. In backreaming, the drilling process is effectively reversed by attaching a larger bit to the drill string, spinning the entire drill string, and reaming a larger hole while pulling the drill string back towards the drilling equipment, one individual pipe segment at a time.

[0010] Once the borehole has been backreamed, the drill string is reinserted into the borehole, individual pipe segment by individual pipe segment, and run out to the far end of the borehole. The pipeline to be installed is attached at the exit hole and then pulled back into the borehole by the drilling equipment. As with pushing the drill string into the hole, when pulling the drill string back through the borehole, each individual segment of pipe in the drill string is pulled back—one-by-one—through the borehole, and then detached from the next segment by the drill motor, and subsequently put aside for future use. The drill motor then locks onto the next segment of pipe and pulls that portion of the drill string remaining in the borehole back through the borehole. This segment-by-segment process continues until the new pipe is fully placed into the ground. All of this work is done without trenching.

[0011] The shallow depth horizontal directional drilling practices described above are parallel to the drilling methods performed in the oil and gas industry. However, today many drilling contractors in the oil and gas industry are utilizing
coiled tubing as a more efficient and diversified means of drilling vertical boreholes for the production of hydrocarbons from deep wells.

[0012] The technology of coiled tubing well drilling has been used for approximately 30 years. During the past 7-10 years there has been a dramatic increase in the use and applications of coiled tubing in the oil and gas industry for use in deep wells. In coiled tubing well drilling, a continuous line of flexible pipe is used. The coiled tubing is stored on a reel. The primary advantage of using coiled tubing for deep well drilling is the efficiency that is gained from the absence of individual segmented pipe joints that must be threadably connected, disconnected, and re-connected one from another. In such applications, the leading end of the coiled tubing never exits the earth’s surface.

[0013] Historically, individual segments of drill pipe were used for drilling and conducting operations inside an oil or gas well, usually several hundreds or thousands of feet under the earth’s surface. Each individual segment of pipe was required to be first positioned and then attached to the previous pipe segment and then lowered or drilled into the ground. This drilling process, although still frequently utilized, is at times laborious and time consuming. With the advent of coiled tubing drilling techniques, drilling contractors were able to supply more efficient and reliable methods of performing many downhole operations in deep wells. With the use of injector heads designed specifically for guiding coiled tubing into a substantially vertical borehole, and various other technologies, operators gained the capacity to continuously feed equipment and fluids into both existing wells and newly drilled wells. When working in deep wells under the pressures encountered in deep wells, the coiled tubing must be able to not only withstand tensile and flexural stresses associated with the drilling process; but also must be able to withstand the internal and external pressures experienced downhole in deep wells.

[0014] Many of the same drilling techniques that are utilized when drilling with individual pipe segments are also carried out with coiled tubing, but there are clear differences. In a typical coiled tubing well drilling application, the injector head is mounted or suspended in a vertical position above the existing well to be worked over or drilled. The coiled tubing is then guided off a storage reel and over a gooseneck. This gooseneck is utilized to position the coiled tubing for direct insertion into the injector head. The injector head controls the insertion and removal of the coiled tubing from the well. One example of a tubing injector head is described in U.S. Pat. No. 5,188,174 to the same assignee. A gooseneck is necessary to provide a means for maximizing the bending radius that the tubing must endure when making the transition from being substantially parallel to the ground, as it leaves the reel, to becoming perpendicular to the ground as it is “stabbed” into the injector head and injected substantially vertically down into the well. The coiled tubing drill string is injected or pushed some specific depth into an oil or gas well and the work-over or well drilling operation is performed. Once the drilling of the well is complete, the coiled tubing is retracted, pulled out of the well, and accumulated back onto the storage reel.

[0015] Experience in drilling oil and gas wells has shown that steel or metallic coiled tubing typically has a shorter life cycle than straight segmented pipe. This shorter life cycle is due to the bending that steel or metallic coiled tubing must endure as it is reeled on and off the reel and run over the gooseneck. The more bends the coiled tubing is put through, the more fatigued and brittle the steel or metallic coiled tubing becomes, and in turn the number of production cycles available to the user is reduced. If a non-metallic coiled tubing is used, such as tubing made from a high strength polymer, fiberglass, or composite materials, the problems associated with fatigue and brittleness from multiple bending are substantially reduced.

[0016] Coiled tubing had been predominantly utilized to clean out existing oil and gas wells. However, with advancements in new drilling technologies, the use of coiled tubing has been expanded to well operations such as re-entry and horizontal deviations (kick-offs). Recently, coiled tubing utilization has been expanded into shallow vertical gas well drilling operations by the use of downhole drilling motors. Modern coiled tubing drilling operations are used to drill substantially vertical slim hole wells (wells of smaller than normal diameter), deploy reeled completions, log high angle boreholes, and deploy treatment fluids downhole. The use of coiled tubing in deep directional wells or even in deep horizontal wells (i.e., wells that begin as vertical and then deviate to horizontal) continues to increase at a rapid rate.

[0017] The need remains, however, to adapt the coiled tubing drilling techniques used in the drilling of deep oil and gas wells to shallow depth horizontal drilling for the installation of transmission and conveyance lines.

SUMMARY

[0018] The present invention includes a system, a method, and an apparatus for utilizing coiled tubing drilling techniques to bore shallow depth, substantially horizontal, boreholes for the installation of transmission and conveyance lines.

[0019] The disclosed system, method, and apparatus includes a staging reel from which the coiled tubing is wound and unwound. After exiting the staging reel, the coiled tubing enters a tubing guide system which guides the tubing between the storage reel and the injector head and minimizes the bend radius of unsupported tubing. Controlling the insertion of the coiled tubing in the ground is a coiled tubing injector head. The coiled tubing injector head is adjustably mounted to guide the coiled tubing through the earth’s surface from above at an acute angle and push the tubing through the hole. The result is a shallow depth borehole substantially parallel to the earth’s surface.

[0020] Attached to the leading end of the coiled tubing is a drilling assembly. Conventional techniques are used to locate and guide the coiled tubing and the drilling assembly as they pass substantially horizontally through the earth at shallow depths beneath the earth’s surface. When the initially drilled borehole, sometimes called the pilot hole, reaches the desired length, the leading end of the drilling assembly passes back up through the earth’s surface. The completed pilot hole may then be back reamed to enlarge its diameter. Transmission and conveyance lines may be attached to the back reamer to follow the back reamer through the pilot hole. Alternatively, the transmission and conveyance lines may be installed in the borehole after the back reaming operation has been completed. Alternatively,
the coiled tubing used in the drilling operation may be left in the earth to act as a transmission or conveyance line.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0021] A better understanding of the system, method, and apparatus of the present invention may be had by reference to the drawing figures, wherein:

[0022] FIG. 1 is a side elevational view of the horizontal directional drilling system of the present invention mounted on a towed wheeled trailer;

[0023] FIG. 2 is a side elevational view of the horizontal directional drilling system mounted on a self propelled tracked platform;

[0024] FIG. 3 is a schematic diagram of the components of a drilling assembly with a rotating bit used for forming a pilot hole;

[0025] FIG. 4 is a schematic diagram of the components of a drilling assembly used for back reaming or enlarging a pilot hole;

[0026] FIG. 5 is a schematic diagram of the components of a drilling assembly including a deflection bit;

[0027] FIG. 6 is a schematic drawing of the components of a drilling assembly including an impact hammer; and

[0028] FIG. 7 is a schematic diagram of the components of a drilling assembly including a jetting tool.

DESCRIPTION OF THE EMBODIMENTS

[0029] As shown in FIG. 1 and FIG. 2 in the preferred embodiment 10, the leading end 102 of the coiled tubing 100, or the end which enters the borehole is fitted with the necessary connectors to enable the attachment of a variety of different tools and fittings, generically referred to as downhole tools. Such connectors and downhole tools are well known to those of ordinary skill in the art.

[0030] The downhole tools used with the coiled tubing include, but are not limited to, steering sensors (sometimes called steering tools, tracking devices, or tracking tools), orienters (for mechanically changing the direction of the tool), drilling motors, and drill bits. The combination of these downhole tools used with a drill bit at the leading end 102 of the coiled tubing 100 becomes the drilling assembly 18 which bores through the earthen environment encountered at the leading end 102 of the coiled tubing 100.

[0031] In the preferred embodiment 10, the drilling assembly 18 shown in FIG. 3 includes a drill motor 20. If the drill motor is an electric motor, power to the electric motor 20 is transmitted by wires placed within the internal diameter of the coiled tubing 100. The electric motor 20 is selected to have sufficient power to supply the necessary torque for drilling, or the drilling assembly may include a gearbox, speed reducer, or torque converter 22 for the purpose of amplifying the torque supplied by the motor 20 when hard soils or rocky conditions are encountered. Those of ordinary skill in the art will understand that the drill motor 20 and gearbox 22 may be combined. Alternatively, fluid motors driven by pressurized gas or liquid may be used to provide the necessary rotational torque for drilling. Such fluid motors shall include those driven by compressed air or mud motors which are caused to turn by the flow of drilling mud.

[0032] An alternate embodiment of a drilling assembly 118 is shown in FIG. 5. At the distal end of the assembly is a push steer tool 128. Such push steer tools 128 are well known to those of ordinary skill in the art. Following the push steer tool is a tracking device. Mechanically connected between the tracking device and the push steer tool 128 is the motor 120 which provides rotational torque to the push steer tool 128 when forming a relatively straight borehole.

[0033] When drilling mud is used, for example, with the drilling assembly shown in FIG. 3, the drilling mud is either pumped through the drill motor or around the drill motor 20, depending on the type of drill motor used. The drilling mud is then projected through the drill bit 28 for the purpose of cooling the drill bit 28 and washing away cutting debris from the cutting faces on the drill bit.

[0034] As the coiled tubing 100 is caused to penetrate the earth's surface from above and progresses forward along the desired horizontal path, the drilling assembly cuts a borehole through the earthen environment surrounding the drilling assembly. At some point during the drilling operation, it will become necessary to orient the drilling assembly to address the need to assure that the path of the borehole follows along a desired route substantially parallel to the earth's surface. Following a desired route is particularly critical when the transmission or conveyance lines are installed for utilities, as utility easements are sometimes quite narrow and tightly defined.

[0035] As shown in FIG. 3, adjustment of the path traveled by the drilling assembly 18 may be accomplished by the use of an orienter 30 located at the leading end 102 of the coiled tubing 100. When the orienter 30 is used with a drilling motor with a bent housing, the orienter is used to determine the clock position of the bend in the drilling motor housing or its position with respect to a 360° circle. When it is desired to change hole direction, the orienter rotates the bent housing of the drilling motor. For example, if it is desired to change the direction of the hole to move back toward the earth's surface, the orienter 30 turns the bent drilling motor housing to the 12 o'clock position.

[0036] An alternate type of navigational tool or orienter 30 may provide orientation in all three spatial directions. Specifically, the orienter 30 may provide horizontal inclination or pitch (i.e., up and down based on a horizontal plane), horizontal deviation or yaw, (i.e., left and right), and clock face orientation or roll. In this matter the orienter 30 acts like a wrist. Such orienters 30 are typically used with drilling motors having a straight housing.

[0037] In yet another implementation of the present invention, the orienter and tracking sensor may be combined into a single unit attached to the drill motor.

[0038] Orientation of the drilling assembly 118 shown in FIG. 5 is accomplished by stopping the rotation of the push tool 128 at a desired angular orientation, then using the injector head 16 to push the drilling assembly 118 forward. This pushing force on the tubing will cause the tip of the push tool 128 to dig into the earthen environment and thereby change the direction of the travel path of the drilling assembly 118. Once the direction of the drilling assembly...
has been changed, the motor 120 is caused to rotate again and formation of the borehole will begin along a relatively straight path.

[0039] The tracking of the underground position of the drilling assembly 18, 118 is accomplished using well-known techniques, including either beacon communication signals, such as GPS, RF, or sonic signals. These signals are sent from a tracking sensor 24 to a receiver at the surface, or the signals may be transmitted via a wire line placed within the coiled tubing 100. In the preferred embodiment, the use of a wire line through the coiled tubing 100 is preferred because of the better location accuracy provided.

[0040] During the entire drilling process, there is never the need to stop the drilling operation to add multiple sections of tubing. Once the continuous length of coiled tubing 100 is inserted into the earth, a continuously operational drilling process occurs. This continuously operational drilling process follows a predetermined underground shallow depth path until the bored hole is complete. Near the predetermined end of the bored hole, the orientation of the drilling assembly 18, 118 is caused to project upwardly toward the earth's surface, which causes the end of the drilling assembly 18, 118 to penetrate the earth's surface from below to complete the pilot hole. Upon the exiting of the drilling assembly 18, 118 through the earth's surface, the drilled pilot hole becomes complete. The drilled pilot hole may then be enlarged as described below, lined with a conveyance or transmission line, or both.

[0041] Alternatively, the drilling operation may be done from an entry pit to an exit pit. In this alternate method of drilling a pilot hole, a portion of the drilling system 10, such as the injector head 16 which has been removed from the vehicles shown in either FIG. 1 or FIG. 2, is placed in a pre-dug entry pit. The tubing injector head 16 then directs the coiled tubing 100 into the soil wall on the side of the entry pit. At the distal end of the desired underground travel path for the coiled tubing 100, a pre-dug exit pit may be used. When the hole is complete, the drilling assembly at the leading end of the coiled tubing 100 breaks through the wall at the side of the exit pit.

[0042] Once the drilling of the pilot hole is complete and the leading end 102 of the coiled tubing 100, with downhole tools attached, has come back up through the earth's surface E, the process of back reaming the pilot hole may begin if the need exists to enlarge the diameter of the pilot hole.

[0043] At the beginning of the back reaming operation, the operator may remove the orienter 30 and the tracking device 24. As shown in FIG. 4, an oversized bit, typically called a back reamer 32, is then attached to the drill motor 20, 120. Back reamers 32 are oversized drill bits with a cutting face directed toward the drilling unit so that the back reamer may enlarge the pilot hole while being pulled back through the borehole by the coiled tubing 100 already in the pilot hole. If desired, the back reamer 32 may include an internal mechanism such as a gearbox to amplify the output torque of the drill motor.

[0044] Once a back reamer is attached to the end of the coiled tubing drill string, the coiled tubing drill string 100 is then pulled back through the hole using the injector head 16. The injector head 16 still remains located at the point of entry of the coiled tubing drill string 100 into the ground. Providing power to the drill motor at the leading end of the coiled tubing 100 enables the back reamer 32 to begin rotation. As the back reamer 32 creates a larger hole as it passes through the pilot hole, drilling mud may still be pumped through the pilot hole. Drilling mud is supplied through the coiled tubing 100 to clean out the enlarged borehole.

[0045] If necessary, the pilot hole may be enlarged in steps. Enlarging the pilot hole in steps is accomplished by pulling the back reamer 32 into the entry pit and then pushing the tubing 100 back through the borehole to the exit pit where the next size larger reamer is attached to the end 102 of the tubing 100. A further advancement of the disclosed mechanized back reamer is that one back reamer may be capable of expanding the size of the pilot hole to multiple hole diameters. The back reamer 32 unit is either adjustable or modular, depending on its type and design. Once the final diameter back reamer is attached, a further coupling 34 may be attached. This last coupling 34 is utilized to attach the transmission or conveyance line that is to be installed. The transmission or conveyance line is pulled behind the back reamer 32 with the pulling energy being supplied by the injector head 16 itself at the entrance to the borehole. The transmission or conveyance line can be made from various types of materials, including but not limited to PVC, HDPE, steel, and fiberglass.

[0046] When the borehole is complete, the coiled tubing 100 and drilling assembly 18 are removed from the borehole. The coiled tubing 100 is wound back on the reel storage assembly 12. Once the drilling motor 20, 120 and back reamer 32 reach the entry pit or the entry point into the earth's surface, the transmission or conveyance line is disconnected from the coupling 34 and the back reamer assembly 32. The transmission or conveyance line may be left in the ground for the purpose designated by the customer, typically, a transmission or conveyance pipe used for a utility service.

[0047] The drilling assembly 18 and any other downhole tools mounted on the leading end of the coiled tubing 100 are then removed and prepared for use at the next borehole. Typically, the coiled tubing 100 will stay inserted in the injector head 16 as an effective means of transport of all the equipment and relocation of the present invention to the next job site.

[0048] In some applications, drilling operators may prefer to use conventional mud motor technology, which is typically found in the oil and gas industry and common horizontal drilling operations. When mud motors are used, the manner in which orientation may be accomplished, for example, as described by U.S. Pat. No. 5,485,889, is well known to those of ordinary skill in the art. The back reaming process can be carried out using the mud motor or by attaching an electric motor 20 if desired to be used in conjunction with a mechanized back reamer 32.

[0049] Another possible variation of the present invention is the use of percussion hammers 228 as shown in FIG. 6. Such percussion hammers 228 are driven by a fluid power motor 220 which uses either drilling mud or compressed air. The percussion hammer 228 may be removed if desired to facilitate back reaming.

[0050] Still another possible variation of the present invention is the use of a jetting tool 328 of the leading end
of the coiled tubing 100. Jetting tools 328, which utilize high pressure water streams 330 to cut through earthen materials, are often more effective in softer soils than conventional drill bits. Jetting tools may be used for either boring the pilot hole or back reaming.

[0051] As shown in FIG. 1, the unit may be mounted on a towed wheeled trailer system 40, or as shown in FIG. 2, the unit may be mounted on a self-propelled tracked platform 50. While the embodiments shown in FIG. 1 and FIG. 2 include an operator cab 26, those of ordinary skill in the art will understand that an umbilical cord attached to operator controls may be used where there is a need to distance the operator from the drilling system 10. The key features, as disclosed in both FIG. 1 and in FIG. 2, are described below:

[0052] 1. A staging reel assembly 12 which is used for spooling and unspooling the coiled tubing 100. The staging reel assembly 12 may be mounted to swirl on a horizontal axis or may be adjustably mounted 19 to be vertically raised and lowered as needed. Alternatively, on larger units the staging reel assembly 12 traverses laterally substantially perpendicular to the long axis of the coiled tubing to minimize tubing bends. On smaller units, a tubing level winder 36 may be used with the staging reel assembly.

[0053] 2. A drive mechanism which is used to project the tubing 100 forward and eventually pulls it backward. The drive mechanism is commonly referred to as a tubing injector head 16.

[0054] 3. A tubing level winder 36 which is used for the purpose of assisting the operation during which the coiled tubing 100 is wound or unwound from the staging reel 12. The tubing level winder 36 may be either part of the staging reel assembly 12 or mounted separately on the transport vehicle 40, 50.

[0055] 4. An injector head 16 which may be supported by an adjustable mounting to allow positioning of the injector head 16 at an acute angle with respect to the earth’s surface and moved closer to the entry point of the leading end of the coiled tubing 100 into the earth’s surface.

[0056] 5. A guide 14 which conveys the tubing 100 from the staging reel assembly 12 and inserts the leading end of the coiled tubing centrally into the injector head 16.

[0057] 6. A triplex pump which is utilized for pumping drilling muds through the tubing.

[0058] 7. An engine which provides the necessary power to operate the complete unit.

[0059] 8. An operator station or driller’s console or cab 26 which allows the operator to perform all necessary functions required to accomplish the drilling operation.

[0060] 9. Support devices which stabilize the equipment and, if necessary, are used to make angle adjustments. This equipment is also referred to as outriggers 42.

[0061] In operation, the system of the present invention 100 is transported to the jobsite or the entry point for the shallow depth horizontal borehole. The trailer 40 shown in FIG. 1 is towed to the jobsite and positioned near the entry point for the borehole. The tracked vehicle 50 shown in FIG. 2 may be transported on a flat bed trailer to the jobsite, then moved into position near the entry point for the borehole. If the unit shown in FIG. 1 is used, then the unit may either be operated from the wheeled trailer 40 or individual components may be skid mounted to assist in removal and placement.

[0062] Once the system of the present invention is off-loaded, it is positioned to target a desired drilling path. The outriggers 42 on the system may be positioned and extended to stabilize the system. The injector head 16, which is mounted on an adjustable support at an acute angle, is then placed into position at the desired drilling angle and as close to the ground as possible. The drilling angle is typically not less than 10° or no greater than 45° from horizontal. The operator’s console 26 on either the wheeled platform 40 or the self-propelled tracked platform 50 may be adjusted to provide the operator with the greatest amount of visibility to perform all necessary drilling operations.

[0063] Typically, the coiled tubing 100 is guided into and inserted into the injector head 16 before arrival at the jobsite. But if the coiled tubing 100 is not inserted into the injector head 16, a stabbing operation is required. Once the coiled tubing 100 is inside the injector head 16 and has begun to exit at the opposite end of the injector head 16, the necessary downhole tools are attached to the leading end of the coiled tubing 100. As previously indicated, a variety of tools may be attached to the leading end of the coiled tubing 100.

[0064] Once all downhole tools required for the specific drilling operation are attached to the leading end 102 of the coiled tubing drill string 100, the drilling operation is started. The operator begins the drilling operation by activating the downhole motor. The activation of the downhole motor in turn rotates the drill bit at the end of the drilling assembly. The coiled tubing 100 itself does not rotate. Once the downhole motor has engaged, the injector head 16 begins driving the leading end 102 of the coiled tubing 100 forward. The angle at which the coiled tubing 100 enters the ground is chosen so that the drilling assembly and the coiled tubing 100 are allowed to move along a shallow depth, horizontal path as soon as practicable. In the preferred embodiment, it has been shown that the horizontal path ranges from, but is not limited to, 6 feet to 50 feet depending on the jobsite. As the coiled tubing drill string 100 is pushed into the ground by the injector head 16, the drilling assembly continuously causes a pilot hole to be cut into the earth. The cuttings formed as a result of the drilling operation may be returned to the proximal end of the pilot hole by use of the drilling fluid. During the drilling operation, the borehole is continuously monitored by communication signals received from the tracking sensor 24. These communication signals are transmitted and received either by a wire line signal or some form of radio or beacon signal. The operator then makes the necessary corrections in drilling direction. This drilling operation continues along the shallow depth, horizontal path until the desired exit point from the borehole is reached. At this point the operator then positions the drilling assembly in such a manner so that the end of the drilling assembly and the other downhole tools move
upward toward the earth's surface and actually penetrate the earth's surface from below. This completes the drilling of the pilot hole.

[0065] Once the pilot hole has been completely drilled, the downhole tools are removed. Typically, all that is left on the leading end of the coiled tubing 100 is the drilling motor. The orienter 30 is not generally needed, and the tracking device 24 is also generally not needed unless it is necessary to track the back reaming operation. At this point, a back reaming bit 32 is then attached to the downhole motor. This back reamer bit 32 is typically oversized and designed to enlarge the hole during the pullback operation to expand the hole to a diameter which will allow the installation of whatever size or type of transmission or conveyance line is desired. In some cases it may be necessary to enlarge the borehole in multiple stages. In this scenario, one back reaming operation occurs and then the back reamer 32 is conveyed back through the enlarged hole and the next size back reamer is placed on the end of the coiled tubing drill string. Once the final size back reamer has been applied to the leading edge of the tubing for enlarging the hole, the tubing product is typically attached behind the back reamer through the use of a coupling 34. The operator then engages the injector head 16 to pull the coiled tubing 100 back through the pilot hole and activates the downhole motor so as rotate the back reamer 32. The back reamer 32 begins to cut the hole to the desired diameter, and the pipe to be installed is pulled behind the back reamer 32. The combination of the coiled tubing 100 with the equipment attached to the end 102 of the coiled tubing (downhole motor, reamer, coupling, transmission or conveyance line) is then pulled back through the borehole. If desired, the coiled tubing 100 used to push the drilling assembly through the borehole may become the transmission or conveyance line by removing the drilling assembly from the leading end of the coiled tubing 100 and leaving the coiled tubing 100 in the borehole.

[0066] When the drilling is complete, all downhole tools are removed from the coiled tubing 100 and set aside. The coiled tubing 100 itself is then checked for integrity and prepared for final connections. This completes the description of the drilling of the bore hole and the installation of the transmission or conveyance line.

[0067] In an alternative application, the apparatus, method, and system of the present invention may be used for enlarging existing underground transmission or conveyance lines where it is possible to place an enlarger or pipe bursting tool on the leading end of the coiled tubing once the coiled tubing has passed through the existing transmission or conveyance line. Specifically, the coiled tubing is pushed through an existing transmission or conveyance line by the tubing injector head. Once the leading end of the coiled tubing exits the existing transmission or conveyance line and becomes accessible, a pipe bursting tool, a reaming tool, or other similar tools known by those of ordinary skill in the art may be attached to the leading end of the coiled tubing and pulled back through the existing transmission or conveyance line. If desired, a new transmission or conveyance line may be pulled behind the pipe bursting or back reaming tool. Or, the existing transmission or conveyance line may be removed before a new transmission or conveyance line is installed.

[0068] In yet another alternative application, the system, method and apparatus of the present invention may be used to temporarily place cables at a shallow depth, under an object to be lifted from the earth's surface. In such applications, a pilot hole is first drilled under the object to be lifted and the lifting cable is then drawn back through the pilot hole.

[0069] While the system, apparatus, and method have been described according to the preferred and alternate embodiments, those of ordinary skill in the art will understand that numerous other embodiments of the disclosed invention may be made. Such other embodiments shall be included within the scope and meaning of the appended claims.

What is claimed is:
1. A coiled tubing drilling and reaming apparatus for creating substantially horizontal, shallow depth boreholes beneath the earth's surface and for the installation of transmission or conveyance lines, said apparatus comprising:
   a mobile platform;
   a staging reel mounted on a first end of said mobile platform, said staging reel constructed and arranged for storage, spooling and unspooling of the coiled tubing;
   a coiled tubing injector head for exerting both push and pull forces on the coiled tubing and for causing the coiled tubing to penetrate the earth's surface and moving the coiled tubing through the shallow depth borehole;
   means for guiding the coiled tubing from said staging reel to the coiled tubing injector head;
   means for adjustably mounting said coiled tubing injector head at an acute angle with respect to the earth's surface;
   a drilling assembly for drilling a borehole through the earth, said drilling assembly being mounted on the end of the coiled tubing entering the borehole;
   means for orienting said drilling assembly, said means for orienting said drilling assembly being co-located with said drilling assembly; and
   means for back reaming the borehole to a diameter which allows for the pulling of the transmission or conveyance line therethrough when pull forces are being exerted on the coiled tubing.
2. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said coiled tubing injector head is mounted on a second end of said mobile platform.
3. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said mobile platform is wheeled.
4. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said mobile platform is a self-propelled tracked vehicle.
5. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said staging reel swivels on a horizontal axis.
6. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said staging reel traverses from one side to another on a travel path substantially perpendicular to the long axis of the coiled tubing.
7. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said staging reel is mounted to be vertically adjustable.
8. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said drilling assembly includes a drill bit and a drill motor.

9. The coiled tubing drilling and reaming apparatus as defined in claim 8 wherein said drilling motor is a fluid motor and wherein fluid is supplied to said fluid motor through the coiled tubing.

10. The coiled tubing drilling and reaming apparatus as defined in claim 8 wherein said drilling motor is an electric motor.

11. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein the coiled tubing includes a wire line for controlling the operation of said drilling assembly.

12. The coiled tubing drilling and reaming apparatus as defined in claim 11 further including a gearbox.

13. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein said means for orienting said drilling assembly includes means for remotely changing the angular orientation of said drilling assembly with respect to the long axis of said borehole.

14. The coiled tubing drilling and reaming apparatus as defined in claim 1 further including means for tracking the location of said drilling assembly.

15. The coiled tubing drilling and reaming apparatus as defined in claim 14 wherein said means for tracking is selected from a group including GPS, radio signal, and sonic.

16. The coiled tubing drilling and reaming apparatus as defined in claim 1 wherein control of the dispensing and retraction of the coiled tubing from this staging reel is assisted by a tubing level winder.

17. The coiled tubing drilling and reaming apparatus as defined in claim 13 wherein said means for orienting is remotely controlled from above the earth's surface.

18. The coiled tubing drilling and reaming apparatus as defined in claim 17 wherein said remote control is provided by radio signals.

19. The coiled tubing drilling and reaming apparatus as defined in claim 17 wherein said remote control is provided by a wire line.

20. A method for using coiled tubing to drill and backream a substantially horizontal shallow depth borehole through the earth for the placement of transmission or conveyance lines therein, said method comprising the steps of:

   storing a length of coiled tubing on a storage reel;

   unwinding the coiled tubing from said storage reel;

   guiding one end of said length of coiled tubing from said storage reel to a coiled tubing injector head;

   guiding the free end of said coiled tubing through said coiled tubing injector head;

   attaching an orienting tool to the free end of said coiled tubing;

   attaching a tracking device to said orienting tool;

   attaching a drill bit and drill motor to said orienting tool;

   inserting said drill bit, drill motor, orienting tool and tracking device through the earth's surface from above at an acute angle;

   causing said drill bit, drill motor, orienting tool, tracking device, and the coiled tubing to be pushed through the earth in a first direction by said coiled tubing injector head and rotating said drill motor to create a substantially horizontal shallow depth borehole;

   causing said drill bit, drill motor, orienting tool, and tracking device to pass back through the earth's surface from below;

   causing an attached back reamer, said drill and drill motor, said guide tool, and the coiled tubing to be pulled through the earth in a second direction, opposite to said first direction, by said coiled tubing injector head to enlarge the substantially horizontal shallow depth borehole.

21. The method as defined in claim 20 wherein the unwinding of the coiled tubing from said storage reel is assisted by a level winder.

22. The method as defined in claim 20 wherein the unwinding of the coiled tubing from said storage reel is assisted by laterally traversing said storage reel.

23. The method as defined in claim 20 wherein said acute angle of insertion is controlled by the angular position of said coiled tubing injector head.

24. The method as defined in claim 20 wherein said orienting tool is remotely controlled from a position above the earth's surface.

25. The method as defined in claim 20 wherein said storage reel and said coiled tubing injection tool are mounted on separate platforms.

26. The method as defined in claim 20 wherein said borehole is backreamed with an enlarged bit following the pushing of the coiled tubing in a first direction and while the coiled tubing is being pulled in a second direction.

27. The method as defined in claim 20 wherein a transmission or conveyance line is pulled in said second direction through the borehole.

28. The method as defined in claim 20 wherein the coiled tubing is left in the borehole to become a transmission or conveyance line.

29. A system for creating a substantially horizontal shallow depth borehole lined by a transmission or conveyance line through the earth, said system comprising:

   a coiled tubing drill string having a leading end;

   a reel assembly for winding, storing, and unwinding said coiled tubing drill string;

   a drilling assembly mounted to the leading end of said coiled tubing drill string, said drilling assembly including a tracking device, a drill motor, and a drill bit;

   an injector head for guiding said coiled tubing drill string into the borehole at an acute angle to the earth's surface, for pushing said coiled tubing through the earth and to exit the earth's surface, for pulling said coiled tubing from the borehole, and for lining the borehole with a transmission or conveyance line;

   a connector for connecting said transmission or conveyance pipe to the leading end of the coiled tubing drill string to enable the transmission or conveyance pipe to be drawn into the borehole as said coiled tubing is pulled from the borehole.
30. The system as defined in claim 29 wherein said reel and said injector head are mounted on a mobile platform.

31. The system as defined in claim 29 wherein said mobile platform is a wheeled trailer.

32. The system as defined in claim 29 wherein said mobile platform is a tracked vehicle.

33. The system as defined in claim 29 wherein said drill bit is replaced with an enlarging back reamer when said transmission or conveyance line is pulled back through the borehole.

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