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Holberg

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[54] **METHOD AND APPARATUS FOR LAYING A PIPE LINE**

[76] Inventor: **Robert E. Holberg,** 608 W. Bough Lane, Houston, Tex. 77024

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[51] **Int. Cl.** **E02f 5/02**

[58] **Field of Search** 61/72.4, 72.1, 72.5, 72.6, 61/72.7; 37/193; 172/699, 700, 730

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Primary Examiner—Jacob Shapiro
Attorney, Agent, or Firm—Pravel, Wilson & Matthews

[57] **ABSTRACT**

The present invention relates to a method and apparatus for laying a pipe line including a weighted sled having a vertical blade extending therebelow with an extruder cone affixed to its lower end for forming a subterranean tunnel for receiving a pipe. The blade is provided with a plurality of spaced jet nozzles connected to a fluid manifold for providing high pressure jet streams adjacent the leading edge of the blade to facilitate movement of the blade through earthen formations. Also, the blade is provided with a plurality of spaced inclined elevator devices for urging the soil adjacent the blade upwardly as the blade moves therethrough to relieve the soil adjacent the extruder cone and thereby facilitate formation of the tunnel passage therethrough. The method of the present invention includes treating the interior of the tunnel with a weighted low friction coefficient fluid or aqua gel to lubricate the passage to facilitate insertion of the pipe into the tunnel without damaging the coating on the pipe.

5 Claims, 6 Drawing Figures

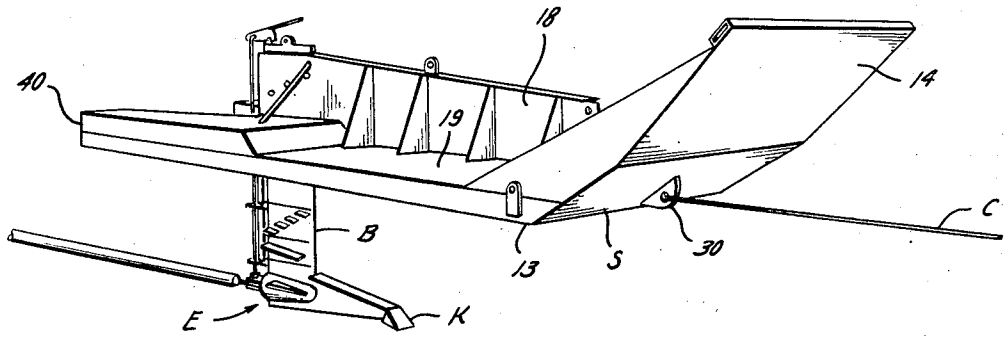


Fig. 1

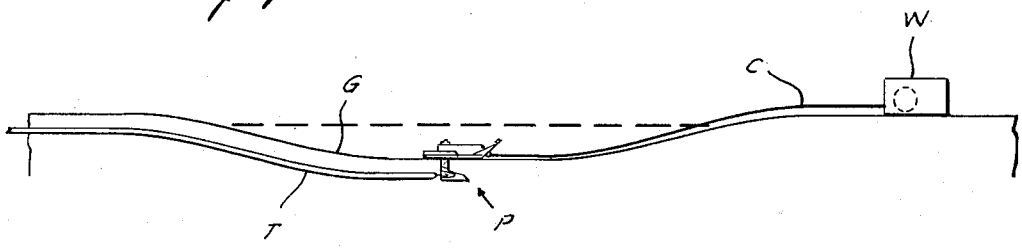


Fig. 2

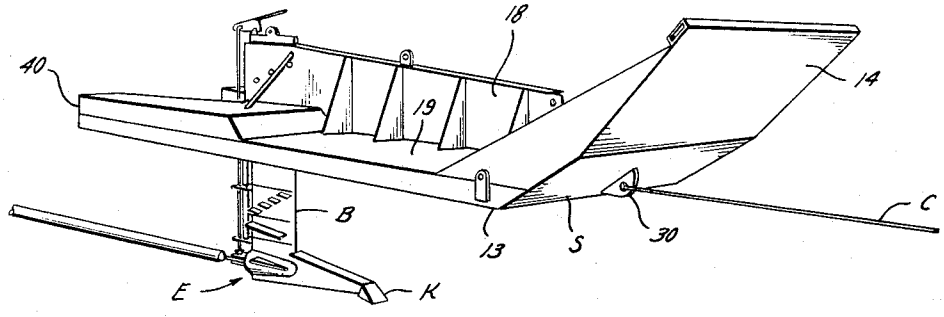
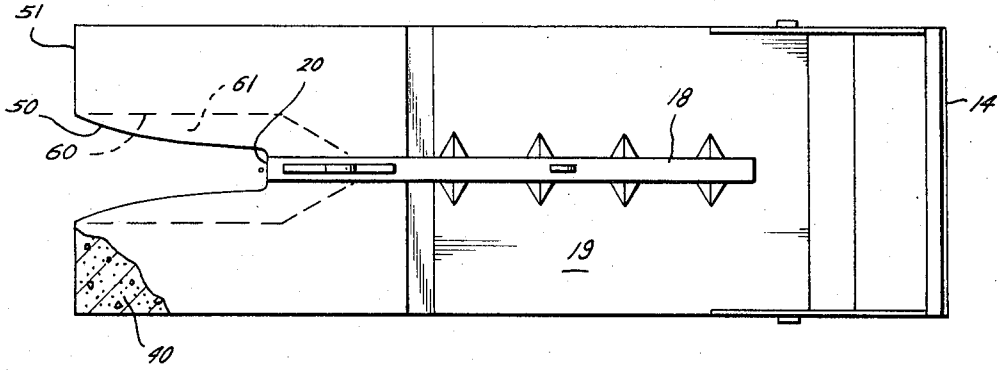


Fig. 3



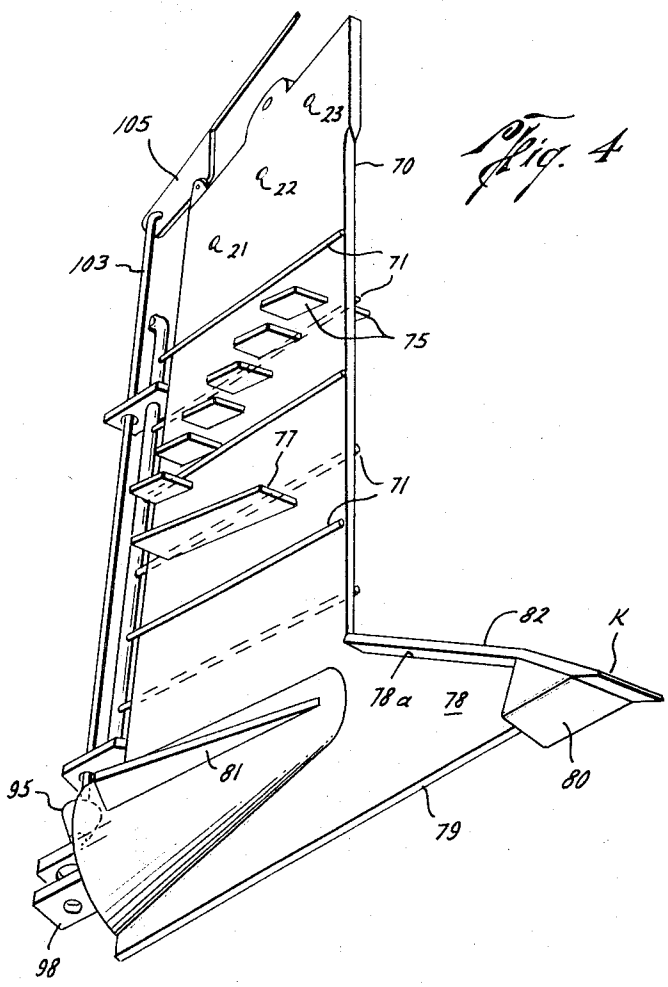


Fig. 4

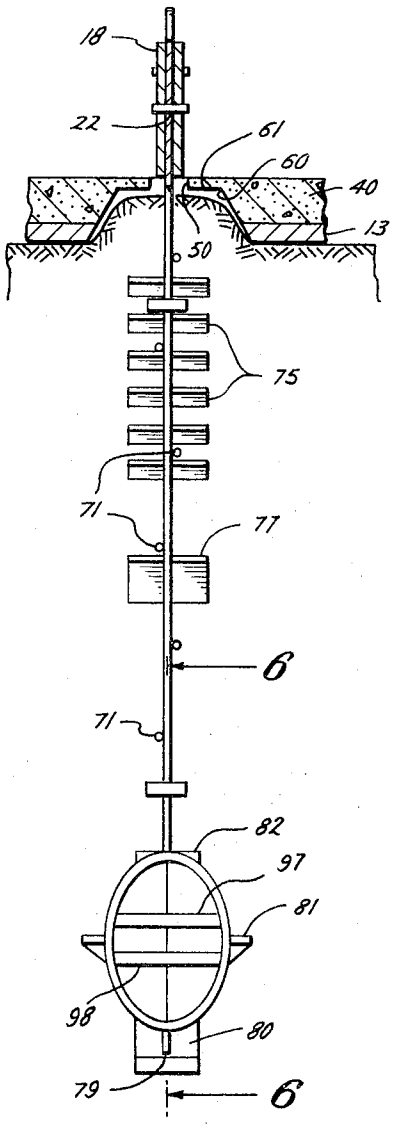


Fig. 5

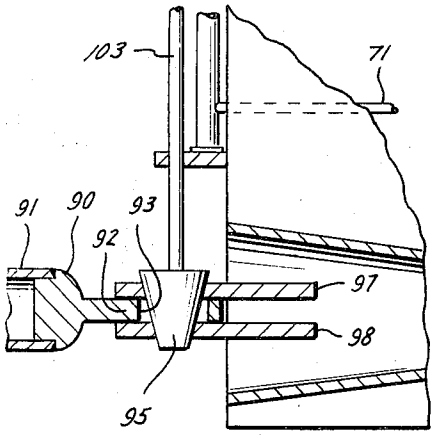


Fig. 6

METHOD AND APPARATUS FOR LAYING A PIPE LINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and apparatus for forming a subterranean tunnel for receiving a buried pipe line and a method for inserting the pipe into such tunnel.

2. Summary of the Prior Art

The prior art is believed to be exemplified by the following U.S. Pat. Nos. 178,231 to Campbell; 354,429 to McMullin; 369,783 to Fisk; 815,163 to Hatfield; 1,160,549 to Sweeney; 1,817,792 to Yares; 2,144,063 to Irvin; 2,992,537 to Callahan; 3,201,944 to Christensen; 3,423,946 to Maclay.

As will be noticed from examination of the above references, various devices have been suggested in the past for forming a tunnel or ditch for receiving pipe or other conduits and cables. However, none of such devices provides an apparatus such as that of the present invention for extruding a subterranean tunnel for receiving a buried pipe or conduit.

SUMMARY OF THE INVENTION

The present invention comprises a new and improved method and apparatus for forming a subterranean tunnel in remote places, such as beneath the bed of a river or other body of water, for receiving a pipe or other conduits so as to lay a pipe line therein. With this invention, laterally extending inclined surfaces are provided adjacent the sides of the vertically extending blade for moving soil and earthen formations adjacent thereto to facilitate the extrusion of soil around the plow foot which forms the tunnel or passage for receiving the pipe or conduit. Further, a plurality of vertically spaced jets are provided at the leading edge of the vertical blade for jetting and cutting the soil immediately ahead of the blade to facilitate passage of the blade therethrough when forming the pipeline tunnel. Such vertical blade is supported by a weighted sled having an upturned nose or leading surface for riding over obstacles on the surface of the river bed or other soil formation on which the plow is used and also to engage the surface of the earth to support the tunnel extruding device at a predetermined elevation therebelow.

With the apparatus of this invention, a subterranean tunnel may be formed in the earth for receiving a pipe or other conduit with a minimum disturbance of the over burdening soil and the surface and which enables a pipeline to be laid beneath the surface of a river or other water body.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view partly in section showing the pipeline plow apparatus being pulled through the earth to form a subterranean tunnel and placing a pipe therein;

FIG. 2 is an isometric view of the plow sled with the blade depending therefrom;

FIG. 3 is a plan view of the pipeline plow sled;

FIG. 4 is an isometric view of the plow blades showing the side elevators and also the extrusion cone at the foot;

FIG. 5 is a rear view of the blade shown in FIG. 4; and

FIG. 6 is a sectional view taken on line 6—6 of FIG. 5 showing details of construction of a remotely actuated disconnect for disconnecting a string of pipe from the plow blade.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Briefly, the pipeline plow apparatus of the present invention, which is designated generally P in FIGS. 1 and 2 of the drawings, comprises a sled S having a substantially vertically extending blade B depending therebelow for supporting an extruding cone E at a predetermined elevation beneath the ground line G for forming a subterranean tunnel T for receiving a pipe or other conduit. The sled S is moved along the ground line G, which may be the bed of a water body or the surface of dry ground, by means of a cable C wound on a winch W. A bull plug B secured to the aft end of the extruder shoe E is provided for pulling a string of pipe L into the tunnel formed by the extruder E.

Considering now the apparatus of the present invention in more detail, the plow sled S preferably comprises a longitudinally extending platform having a substantially flat bottom **13** with an upwardly inclined leading bow section **14** for enabling the bow to roll or slide over obstructions which may lie in its path. The sled includes a vertically disposed pull beam member **18** which extends axially of the sled S and projects upwardly from the deck **19**. The beam **18** is preferably welded to the deck **19** and extends rearwardly from the bow section **14** and includes blade pocket **20** that comprises a vertical opening or passage that extends through the body of the sled S for receiving the blade B. With the blade positioned in the pocket, it is affixed to the beam **18** by means of a plurality of removable pins **30** which extend through suitable openings **21, 22** and **23** in the upper end of the blade B and which are received in corresponding openings **21***a*, **22***a* and **23***a* in the beam **18.** As shown, the pull eye **30** to which the cable C is affixed is positioned at the forward end of the beam **18** and in line therewith for applying the pull forces axially of the beam.

The body of the sled is preferably provided with a compartment **40** for receiving high density concrete to reinforce and stabilize the sled adjacent the pocket through which the blade extends to minimize or substantially eliminate oscillations or vibrations which may be set up in the plow and to provide a substantial counterweight aft of the blade B to assist in holding the blade in the ground at the desired elevation and to aid in forming the extruded tunnel T as will be described in detail hereinafter. The counterweight can vary in size according to soil conditions, however a substantial weight such as approximately 15,000 pounds has been found to be beneficial in preventing the sled from riding up so as to elevate the extruder above the desired depth, which is usually from 4 to 8 feet below the ground line G. The compacting action of the weighted sled also tends to fix the soil above the tunnel and thereby reduce or eliminate the need for a weight coat on the buried pipe.

As best seen in FIG. 3 of the drawings, the aft end of the sled S is provided with a central or axially disposed channel or opening **50** which extends from the aft end **51** of the sled to adjacent the aft end of the pocket **20** so that the counterweight formed in the compartment **40** is not disposed directly above the tunnel formed by the extruder E. Further, a cathedral trough or inverted V-shaped opening **60** formed by upwardly and inwardly

inclined sides or walls **61** which extend from the bottom **13** upwardly toward the top of the compartment **40** to provide space for any soil which is moved upwardly by the plow blade B and extruder E to be displaced slightly above the surface of the ground level G as will be explained in detail hereinafter.

The blade B comprises a steel plate having a tapered or relieved leading edge **70** with a plurality of cutting jets **71** positioned adjacent thereto so as to provide a series of jets for cutting the soil adjacent the leading edge of the blade B to facilitate its movement therethrough. Such jets are connected to a supply manifold **74** by means of suitable conduits **73** disposed on opposite sides of the blade B and affixed thereto. The supply manifold **74** is positioned on the trailing or aft edge of the blade B and connected to a remote pressure source (not shown) for supplying water or other fluid under pressure at approximately 10,000 psi to each of the jets **71.**

Also, as shown in FIGS. **4** and **5** of the drawings, a plurality of short elevators **75** are provided on opposite sides of the blade B for disturbing or elevating the soil on either side of the blade as it moves therethrough. Such elevators preferably comprise relatively short vanes which project laterally from the sides of the blade B and which are inclined at an angle of approximately from 17° to 22°. The elevators **75** are preferably arranged so that each elevator is positioned slightly rearwardly of the elevator immediately thereabove so as to provide a series of vanes, each set at substantially the same angle and arranged in a substantially diagonal line across the faces or sides of the blade B so as to provide a means for cutting or disturbing the soil beneath the sled and adjacent the sides of the blade over substantially its full submerged depth in the soil.

A diving vane **77** is positioned beneath the elevators E to facilitate holding the extrusion shoe E at a desired depth beneath the ground line G and for also relieving or disturbing the soil immediately thereabove to facilitate extrusion of the soil around the periphery of the extrusion cone E as will be described. It has been found that such diving vane should be substantially within the range of 17° to 22° from horizontal in order to best function as a means for holding the extrusion head E in its proper submerged position and to facilitate the movement of the extrusion head through the adjacent soil.

As shown the extrusion cone E is positioned at the foot of the blade B and rearwardly of the cutting tooth K. Such cutting tooth K preferably comprises a triangular or wedge-shaped point **78** formed integrally with the blade B and projecting forwardly of the leading edge **70.** The foot or bottom of the cutting tooth K is preferably relieved slightly so as to avoid frictional engagement of the bottom surface **79** with the soil adjacent thereto. The top of the tooth K includes a wedge-shaped point **80** affixed to the forward end of the wedge-shaped portion **78.** A cap or plate **82** is welded or otherwise affixed to the upper inclined surface **78a** of the wedge-shaped portion **78** and is wider than the plate forming the blade B so as to project laterally on either side thereof. The extrusion cone E is positioned rearwardly of the wedge-shaped portion **78** of the tooth K at the foot of the blade B. As shown in FIG. **6,** such extrusion head E is shaped so as to form an eliptical cross section with its longer axis in a vertical plane and its shorter axis in a horizontal plane. The conical eliptical-shaped extrusion member is welded to the blade B and is provided with a pair of laterally projecting longitudinally extending vanes **81** which are inclined at substantially the same angle as that of the diving vane **77.** Further, the eliptical extrusion cone is positioned on the blade B so the bottom edge **79** projects below the cone to form a vertically projecting longitudinally extending bottom vane beneath such extrusion member E.

As shown in FIG. **6** of the drawings, the apparatus for releasably attaching the leading end of the string of pipe to the extrusion foot comprises a cap or bull plug **90** which is normally welded onto the end of the pipe **91.** Such plug includes an axially extending eye pin **92** having a loop or opening **93** therein for receiving the locking member **95.** Such eye member **92** is inserted between parallel plates **97** and **98** which are welded or otherwise attached to the conical extruder E. As shown, the locking member **95** comprises a conical or tapered pin which is inserted through the opening **93** in the eye member **92** for locking and securing the eye thereto. A remote actuating device designated generally **100** is also provided for releasing or withdrawing the lock member or pin **95** from the opening **93** so as to enable the pipe **91** to be disconnected from the extruder E when the pipe is several feet beneath the ground line G which in some instances may also be many feet below the surface of the overlying water body. Thus, it can be appreciated that in the event the plow should encounter some obstruction or if the pipe should for some reason become stuck at some point along the course short of the final destination, the pipe can be disconnected from the eliptical extrusion member E. An operation rod **103** is connected to the tapered pin **95** and extends upwardly along the aft edge of the blade B through a plurality of spaced guides **104** to an actuating cam **105** pivotally mounted at the upper end of the blade B. An operating arm **106** is also connected to the cam **105** for rotating the cam to raise the rod **103** and disconnect the pipe from the plow.

In using the plow of the present invention for forming a subterranean tunnel for receiving a submerged pipeline, particularly in remote locations such as beneath the bed of rivers or other water bodies, a suitable bell hole is prepared sufficiently far back on the bank to prevent surface water from flowing into the bell hole and a slide or launching approach of approximately 12° grade from the bottom of the river up to the bell hole is also prepared and the sled with the plow blade set at the required depth for the extrusion head is placed in position for entering the river bed. A suitable length of pipeline for making the crossing is welded together, coated, tested and placed on pipe dollies or skids and thereafter the pipe is connected to the pull plug on the bottom of the plow. The sled is then pulled across the river with the necessary cables operated by the winch. With the sled following the grade of the river bed, the extrusion head prepares the extruded tunnel at the preset depth below the river bed. The extrusion head E is normally 4 inches larger in side diameter than the pipe which is to be pulled through the tunnel behind it. Of course, it will be appreciated that the number of lines and sheaves required to make each pull may vary according to the pipe size and the soil conditions to be encountered. However, by pulling on the cable or line from the draw works or winch, the sled is drawn along the surface of the ground with the extrusion head bur-

ied at the desired depth. It will also be appreciated that the laterally projecting elevators as well as the larger diving vane will displace soil adjacent the plow blade and on opposite sides thereof vertically upwardly as the blade is drawn through the earth so as to relieve the overburden and thereby facilitate extrusion of the tunnel by movement of the extruder head through the soil beneath the area which is disturbed by the blade and the vanes projecting laterally therefrom. Further, it will be appreciated that by providing the inverted V-shaped opening in the bottom of the sled aft of the blade that space will be provided for receiving soil which may be extruded upwardly on opposite sides of the blade and further, that the weighted sled will not bear directly upon the soil adjacent the blade which is being displaced or extruded upwardly. The weighted sled is arranged so that the opening **51** spaces the weighted portions on opposite sides of the trench thereby providing a counterweight or compacting force on the soil adjacent the path of the tunnel.

Further, it will be appreciated that a suitable portable high pressure fluid system may be carried on a suitable flotation member during river crossing so as to provide a source of high pressure fluid to the jets which jet the earthen formations immediately in front of the leading edge of the blade. Also, in some instances it is desirable to plow the tunnel without having the pipe which is to be inserted therein attached to the plow on the first pass so as to prepare the path for the pipe and thereby reduce the hazards of sticking the pipe in a partially completed tunnel. After the first pass has been made with the plow to prepare the extruded tunnel, then on a second pass the plow is guided through substantially the same course with the pipe attached to the foot of the plow.

It has also been found that to facilitate the insertion of a coated pipe into the extruded tunnel without unnecessarily damaging or breaking a wrap or protective coating formed on the pipe that an aqueous, viscous fluid or gel coat may be injected into the tunnel to form a lubricating means for sliding the pipe through the tunnel with a minimum of frictional drag. In some instances where the extruded tunnel is plowed without the pipe being attached to the plow the lubricating gel is pumped into the tunnel and such lubricating gel has a specific gravity greater than one so as to displace any water that may be in the tunnel and thereby remain in place until the pipe is placed in the tunnel and displaces some of the weighted viscous fluid.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

What is claimed is:

1. An underwater plow for forming a subterranean tunnel beneath a water body for receiving a conduit comprising:

a. a sled having a substantially flat bottom adapted to engage a submerged bottom surface and having an upturned bow to facilitate movement along such submerged bottom surface and to support an extruder head a substantially predetermined distance below said bottom surface;

b. a vertically disposed plow blade having a leading edge and a trailing edge extending beneath the bottom of said sled and rigidly affixed thereto;

c. a plurality of lateral productions on the sides of said blade for displacing the earthen formations adjacent to said blade as it passes therethrough;

d. extruder head means at the foot of said blade for forming a subterranean bunnel in the earth a substantially predetermined distance below such ground surface; and

e. longitudinally extending inclined diving vanes projecting laterally from the opposite sides of the plow blade and extending substantially from the leading edge to the trailing edge thereof for urging said blade downwardly as it is moved through the earth so as to secure said sled to a river bed.

2. The invention of claim **1** wherein said means at the foot of said blade for forming a subterranean tunnel comprises a wedge-shaped blade member projecting forwardly of the leading edge of said blade with an eliptical cone member positioned aft of said wedge member and disposed with the longer axis of said elipse substantially parallel to the plane of said blade.

3. The invention of claim **2** including longitudinally extending laterally projecting vanes positioned in a substantially horizontal plane on opposite sides of said eliptical cone.

4. The invention of claim **3** wherein said diving vane is inclined at an angle of 17° to 22° with respect to the base of said sled.

5. The invention of claim **1** including means for releasably connecting a string of pipe to the foot of said blade includes an eye member adapted to receive a tapered pin with rod means connecting said pin to an actuating cam at the top of said blade to permit withdrawing said pin from said eye from a remote location above the earth's surface.

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