BORING AUGER FOR HORIZONTAL EARTH BORING MACHINE

Inventor: Albert R. Richmond, West Salem, Ohio
Assignee: The Richmond Manufacturing Company, Ashland, Ohio
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ABSTRACT

A portable earth boring machine adapted for horizontal boring of shafts for the insertion of pipelines in installations where excavation from the surface is undesirable. The machine is characterized by a novel earth boring auger for effectively drilling pipeline holes under difficult earth conditions such as are encountered in boring earth of hard rock content. The novel auger comprises a base plate, spaced auger side plates forming rigid gussets, with such plates providing bit mounting surfaces for a unique and efficient array of a plurality of bits mounted on the auger.

12 Claims, 5 Drawing Figures
BORING AUGER FOR HORIZONTAL EARTH BORING MACHINE

This invention relates to portable earth boring machines and more particularly to a machine adapted for horizontal boring of shafts for the insertion of pipelines at installations where excavation from the surface is undesirable.

In general, the machine of the present invention comprises a base means that includes spaced track members which are disposed in a trench adjacent the hill to be bored, for example, an embankment adjacent a highway where drainage is required. The machine further includes a carriage means mounted for movement along the track means and such carriage supports a power train for rotating successively connected sections of auger shafts that drive at their front end an earth boring auger.

The carriage further supports a pusher ring for successively driving sections of casing into the bored hole.

The present earth boring machine is of the same general type disclosed in my co-pending application Ser. No. 867,815 filed Oct. 20, 1969, now U.S. Pat. No. 3,610,345 issued Oct. 5, 1971 and in accordance with the present invention includes an improved auger construction for boring holes in the earth under highways and the like into which section of casing are subsequently installed by the same machine.

With machines of this general type, a problem has been encountered where the ground conditions make horizontal boring difficult. For example, in the New England states where the earth contains a high content of hard rock, conventional rock-incrusted earth in that they either make little or no headway, or upon sustained axial thrusts are subject to uneconomical failure of the bit members on the augers.

In accordance with the present invention, the above mentioned problem has been solved by providing a novel auger construction which effectively and efficiently bores pipeline holes under difficult earth conditions where high rock content is present, with an economically acceptable amount of auger wear.

More specifically, the horizontal earth boring auger of the present invention comprises an auger means of composite construction wherein an auger shaft is provided with a base plate and such plate is rigidly braced to an auger shaft by a plurality of circumferentially spaced auger side plates of generally triangular configuration which form rigid gussets between the auger base plate and the auger shaft.

More over, such auger side plates serve the additional function of providing outer bit mounting surfaces, which converge forwardly and inwardly, and thereby provide base means for the mounting of a plurality of side bits.

As another aspect of the present invention, the above mentioned auger means includes a unique mounting arrangement of the side bits thereon wherein the side bits are inclined forwardly and outwardly with respect to the path of rotation of the outer surfaces on the auger side plates.

As still another aspect of the present invention, the above mentioned side bits are inclined slightly forwardly, toward the tip section of the auger, such that each of them can progressively bite into the difficult physical characteristics of the rocky earth being bored.

As still another aspect of the present invention, the novel auger means includes, at the base portion thereof, a plurality of pivoted arm means or brackets mounted on the base plate thereof, which serve as mounts for base bits which extend radially from the extreme periphery of the auger means and which are inclined forwardly therefrom with respect to its direction of rotation. This arrangement permits pivoting and inward yielding of the base bits, and release thereof from the earth, when the auger means is rotated in a reverse direction for the withdrawal thereof from the hole being bored.

As still another aspect of the present invention, the improved auger means includes a novel tip portion wherein a tip plate is mounted on the forward end of an auger shafts so as to provide mounting means for a plurality of tip bits which are inclined forwardly and outwardly with respect to the direction of rotation of the tip section.

It is therefore an object of the present invention to provide an earth boring machine which includes an improved auger means of novel construction which is uniquely adapted to bore horizontal holes in earth of high rock content without untimely wear or failure of the plurality of bit members which comprise the most expensive portion of the auger structure.

It is another object of the present invention to provide an improved auger means of the type described which provides long life for an earth boring machine, thereby avoiding excessive auger replacement and the other expenses incident to the shutdown time of an earth boring machine.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

IN THE DRAWINGS

FIG. 1 is a side elevational view of an earth boring machine constructed in accordance with the present invention which includes an improved auger means mounted thereon;

FIG. 2 is a partial front elevational view of an improved auger means comprising a portion of the earth boring machine of the present invention;

FIG. 3 is a side elevational view of the improved auger means of FIG. 2;

FIG. 4 is a partial sectional view of a side bit construction comprising a portion of the auger means of FIGS. 2 and 3, the section being taken along the line 4—4 of FIG. 3 and

FIG. 5 is another partial view of some of the side bits means of the auger construction of FIGS. 2 and 3 which view shows the forward angular disposition thereof.

Referring in detail to the drawings, FIGS. 1 and 2 illustrate the horizontal earth boring machine of the present invention which includes a base means indicated generally at 20. Such base means includes spaced longitudinally extending track means 22 which support, for longitudinal movement, a carriage means indicated generally at 24.

The machine further includes an upper carriage frame portion 26 which is removably mounted on a lower carriage frame portion 28, and lower carriage
frame portion 28 is provided with wheels 30 which roll on the tracks 22 and the upper carriage frame portion 26 can be removed from lower carriage frame portion 28 by opening clamp and guide key assemblies 32.


The carriage means 24 is advanced and retracted along track 22 by a hydraulic power cylinder a portion of which is seen at 34 with such power cylinder being operatively connected between a power cylinder base 36 and the carriage means 24.

Details of power cylinder 34 and power cylinder base 36 are disclosed and described in detail in may co-pending application Ser. No. 867,816 filed Oct. 20, 1969.

It will further be seen that pressurized fluid for actuating power cylinder 34 is provided by a fluid power system including a pump 38 driven by an engine 40. The fluid power circuit further includes a control valve mechanism 42 and conduits 44 and 46 such that when control valve mechanism 42 is actuated the power cylinder 34 is extended and retracted so as to move carriage means 24 forwards or rearwards along the tracks 22.

Referring again to FIG. 1, the boring machine further includes a pusher ring 50 including a front annular surface 52 for engaging the sections of pipe casing for pushing such sections into the bored hole. Such pusher ring 50 includes the transverse pusher ring plate 60 and 92 which are backed up by a thrust plate 51 mounted on the carriage means with such thrust plate 51 serving as a mount for a thrust bearing assembly indicated at 72. The mechanism comprising the thrust plate 51, the thrust bearing assembly 72 mounted thereon, and the back up plates 90 which transmit the thrust from the auger means 94 to the carriage means 24 and thereby isolate a speed varying or gear reduction unit 54 from the thrust. This thrust absorbing mechanism is described in detail in my co-pending application Ser. No. 85,600 filed Oct. 30, 1970.

It should further be mentioned with reference to FIG. 1, that a slip clutch assembly 62 is provided between gear reduction unit 54 and the auger connecting shaft 64 such that in the event an overloaded condition occurs, then slip clutch 62 will permit the power train to function with the auger means 94 in a stalled condition without overloading and damaging the elements of the power train.

Reference is next made to the improved auger means which is indicated generally at 94 in FIGS. 1–3. Such auger means 94 includes a base portion in the form of an auger base plate 96 mounted on an auger shaft 122 and such base plate 96 is rigidly reinforced by a plurality of auger side plates 114 which are generally of triangular cross-section and which include base edges welded to auger base plate 96 at 113, and forward extending edges 115 welded to auger shaft 122 at welds 115.

In the preferred embodiment of the auger means, seen in FIGS. 2 and 3, four such side plates 114 are shown. It will be understood that the number of auger side plates could be varied without departing from the spirit of the present invention.

Referring again to FIGS. 2–5, auger side plates 114 form forwardly and inwardly inclined surfaces 116 each of which mount a plurality of auger side bits 121 which are preferably of the projectile style, known to the art, and including a block portion 120 welded to side plate surface 116, a sleeve portion 123, FIG. 4, removably and replaceably mounted in block 120 and a rotary bit portion 140 which is mounted in sleeve portion 123 and replaced therewith when excessive wear occurs.

It should further be mentioned that side bits 121 include a hardened tip 138 formed of carboloy or the like.

With continued reference to FIG. 2–5, the side bit members 121 are inclined forwardly and radially outwardly at an angle 136 with respect to the direction of rotation of the auger means indicated diagrammatically by the arrow 144 in FIGS. 2 and 4. The forwardly and radially outward inclination of side bits 121 is shown at 136 in FIG. 4.

It has been determined that in difficult rock boring earth conditions that the angle 136 mentioned above should be approximately 40° with the limits of the acceptable angular disposition of the side bit axes 138 being determined at between 30° and 50°.

With reference to FIG. 5, it has further been determined that the longitudinal axis 132 of the side bit 121 should be inclined forwardly, with respect to a plane 150 perpendicular to the longitudinal axis 168 of the side plates at an angle of approximately 2°. This gives the tips 138 of the side bit 121 an effective bite into the difficult rock boring situations mentioned previously.

The forward inclination of the longitudinal axis 132 of side bits 121 is shown in detail at the angle 154 in FIG. 5, with the view of FIG. 5 being taken along the inclined plane 5–5 in FIG. 3.

Referring again to FIGS. 2 and 3, the auger means 94 further includes a pivoted arm mechanism 98 which functions to accomplish the extreme peripheral boring of the hole and such arm mechanism 98 includes the rear and front arm sections 100 and 102 which are pivoted to the base plate 96 at a pivot pin 106. The pivoted arm mechanism 98 mounts the most peripherally extending bits 108 as seen in FIG. 2 and 3 and when the auger means 94 is rotated in a normal counter-clockwise boring direction, as indicated by arrow 144 in FIG. 2, then the base bits 108 are rigidly maintained outwardly beyond the auger base plate 96 by the radially outward extension of arm mechanism 98.

After the auger means has been advanced into the hole to a position wherein additional auger shaft sections are to be added and the auger is to be retracted, then the boring machine is reversed such that the auger means is rotated in a clockwise direction, FIG. 2, opposite to the normal boring direction 144, and in such instance the base arm mechanism 98 can yield about pivot 106 thereby releasing base bits 108 from possible locked engagement with the rocky terrain.

It should further be mentioned that auger base plate 96 may be provided with additional peripheral fixed base bits which are rigidly mounted, without use of the pivoted arm mechanism 98, and such fixed base bits are shown at 110 in FIGS. 2 and 3.
Referring again to FIGS. 2 and 3, the auger means 94 includes a tip portion provided by a forwardly disposed tip plate 124 on which are mounted a plurality of tip bits 126 with such tip bits being inclined radially outwardly and forwardly with respect to the longitudinal axis of auger shaft 122.

It should further be mentioned that auger means 94 includes, on its tip portion, a forwardmost cutter or drill element 128 which is mounted in a longitudinal hole, not shown, in the front end of auger shaft 122 and keyed therein so as to be removable and replaced when excessive wear occurs.

In operation, the machine is operated by installing the base means 20 on flat terrain adjacent the earth hill to be bored, for example, a highway embankment where it is desired to install a drainpipe thereunder.

With the engine 40 being energized, the auger means 94 is driven an carriage 24 is advanced along the track means 22 such that the auger means 94 engages the embankment and starts the drilling of a hole therethrough. As the auger means 94 progresses, the tip bits 126, side bits 121 and base bits 108 and 110 chip away at the earth and rock and the cuttings are augered rearwardly to the openings formed by the open area segments 129 provided at, for example, 90° intervals in the base plate 96 as seen in FIG. 2.

As the cutting progresses and the boring machine advances to the limit of its track extent, then additional auger sections are added by retracting the carriage 24 and disconnecting auger means 94 from the auger driving shaft 64.

Such auger sections can, for example, be 10 feet long or any desired length depending on the length of the track means and as the boring operation progresses the addition of auger sections can be added when required.

1. A portable earth boring machine comprising, in combination, base means including spaced track members; a carriage means mounted for movement along said track means; a fluid motor for driving said carriage means along said track members; an engine mounted on said carriage means including an engine drive shaft; a speed varying unit mounted on said carriage means and including an input shaft driven by said engine drive shaft and an output shaft; auger connecting shaft means including a rear end driven by said output shaft and a front end; and a thrust plate mounted on said carriage means and including a plurality of circumferentially spaced generally triangular auger side plates including radial edges mounted on said auger base plate, longitudinal edges mounted on said auger shaft portion, and forwardly and inwardly inclined bit mounting side surfaces, a plurality of side bit members mounted along the longitudinal extent of said bit mounting surfaces in side by side relationship, an auger tip portion including a tip bit member; and an auger base portion including a base bit member extending radially of said base portion.

2. The apparatus defined in claim 1 wherein said base bit member is inclined forwardly and outwardly with respect to the path of rotation of said auger base portion.

3. The apparatus defined in claim 1 wherein said auger base portion includes a pivotally mounted bit mounting arm, said base bit member being mounted on said arm whereby said base bit member can yield inwardly upon reverse rotation of said auger means.

4. The apparatus defined in claim 1 wherein said auger tip portion includes a radially extending tip surface and wherein said tip bit member is inclined forwardly and outwardly with respect to said auger tip portion.

5. The apparatus defined in claim 1 wherein said auger tip portion includes a radially extending tip surface and wherein said tip bit member is inclined forwardly and outwardly with respect to said auger tip portion.

6. A portable earth boring machine comprising, in combination, base means including spaced track members; a carriage means mounted for movement along said track members; a fluid motor for driving said carriage means along said track members; an engine mounted on said carriage means and including an engine drive shaft; a speed varying unit mounted on said carriage means and including an input shaft driven by said engine drive shaft and an output shaft; auger connecting shaft means including a rear end driven by said output shaft and a front end; and a thrust plate mounted on said carriage means and including a plurality of circumferentially spaced generally triangular auger side plates including radial edges mounted on said auger base plate, longitudinal edges mounted on said auger shaft portion, and forwardly and inwardly inclined bit mounting side surfaces, a plurality of side bit members mounted along the longitudinal extent of said bit mounting surfaces in side by side relationship, an auger tip portion including a tip bit member; and an auger base portion including a base bit member extending radially of said base portion.

7. The apparatus defined in claim 6 wherein said base bit members are inclined forwardly and outwardly with respect to the path of rotation of said side surface.

8. The apparatus defined in claim 6 wherein said side bit members are angled toward said tip portion with respect to a reference plane normal to the longitudinal axis of said side surface.

9. The apparatus defined in claim 6 wherein said auger base portion includes a pivotally mounted bit mounting arm, said base bit member being mounted on said arm whereby said base bit member can yield inwardly upon reverse rotation of said auger means.

10. The apparatus defined in claim 6 wherein said base bit member is inclined forwardly and outwardly with respect to the path of rotation of said auger base portion.

11. The apparatus defined in claim 6 wherein said auger tip portion includes a radially extending tip surface and wherein said tip bit member is inclined forwardly and outwardly with respect to said auger tip portion.

12. A portable earth boring machine comprising, in combination, base means including spaced track members; a carriage means mounted for movement along said track members; a fluid motor for driving said carriage means along said track members; an engine mounted on said carriage means and including an engine drive shaft; a speed varying unit mounted on said carriage means and including an input shaft driven by said engine drive shaft and an output shaft; a thrust plate mounted on said carriage means forwardly of said
speed varying unit; thrust bearing means mounted on said thrust plate; auger connecting shaft means including a rear end driven by said output shaft and a front end; auger means driven by said front end of said auger connecting shaft means and including forwardly and inwardly inclined bit mounting side surface, a plurality of rotatable side bit members mounted along the longitudinal extent of said bit mounting surface in side by side relationship, an auger tip portion including a tip bit member inclined forwardly with respect to the path of rotation of said side surface; and an auger base portion including a base bit member extending radially of said base portion.