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(54) **Percussion tool for drilling holes in the soil.**

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US-A- 4 396 073

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Description

This invention relates generally to percussion tools for drilling holes in the soil.

Utility companies often find it necessary to install or replace piping beneath different types of surfaces such as streets, driveways, railroad tracks, etc. To reduce costs and public inconvenience by eliminating unnecessary excavation and restoration, utilities sometimes use underground boring tools to install the new or replacement pipes. Existing boring tools are suitable for boring short distances (up to 60 ft or 18 m).

Conventional pneumatic and hydraulic percussion moles are designed to pierce and compact compressible soils for the installation of underground utilities without the necessity of digging large launching and retrieval pits, open cutting of pavement or reclamation of large areas of land. An internal striker or hammer reciprocates under the action of compressed air or hydraulic fluid to deliver high energy blows to the inner face of the body. These blows propel the tool through the soil to form an earthen casing within the soil that remains open to allow laying of cable or conduit.

Several percussion mole steering systems are revealed in the prior art. Coyne et al, Us Patent 3, 525, 405 discloses a steering system which uses a beveled planar anvil that can be continuously rotated or rigidly locked into a given steering orientation through a clutch assembly. It is to be used particularly for burrowing out relatively shallow ground depths. The planar beveled front face of the mole, provides free axial rotation with respect to the mole body. Spiral flutes are mounted on the nose of the mole causing the nose to rotate. The mole is steered by locking, or unlocking the rotating part of the tool, with respect to the beveled face part of the tool, using a remotely controlled clutch which is located within the tool. This device achieves an improved steering tool by reducing the size of the forces needed to steer a mole; by reducing turning radius of the mole; by simplifying the process of mole planting; and preventing the mole edging upwards towards the soil surface during use.

Chepurnoi et al, U.S. Patent 3, 952, 813 discloses an off-axis or eccentric hammer steering system in which the striking position of the hammer is controlled by a transmission and motor assembly.

Gagen et al, U.S. Patent 3, 794, 128 discloses a steering system employing one fixed and one rotatable tail fin, each fin being diametrically opposite to the other. The two fins are sited at the rear of the mole and the rear portion of the mole is tapered. The rotable fin is controlled by a mechanism located inside the mole. The steering system can have either curvilinear motion or move in a forward direction, the direction of movement being dependent on the relative positions of the fins. The device achieves an improved steering system by using a mole which is smaller and shorter than those already known, whilst providing an equivalent turning radius. The further advantages of the system are the provision of extra internal space, the rearportion being tapered allows for smaller fins and/or a smaller turning radius for a given length of mole.

However, in spite of these and other prior art systems, the practical realization of a technically and cost-effective steering system has been elusive because the prior systems require complex parts and extensive modifications to existing boring tools, or their steering response has been far too slow to avoid obstacles or significantly change the direction of the boring path within the borehole lengths typically used.

Several steering systems have been developed in an attempt to alleviate this problem by providing control of the boring direction. However, experience indicates that the tool substantially resists sideward movement which seriously limits the steering response. A method is needed by which the tool can travel in a curved path without displacing a significant amount of soil inside the curve. Reducing this resistive side force would provide higher steering rates for the tools. The prior art does not disclose a steerable percussion boring tool having means for reducing friction during boring and turning.

The tools of the prior art have been unsatisfactory to the extent that their traverse has not been accurate or controllable. All too frequently other underground utilities have been pierced or the objective target has been missed by a substantial margin. It has also been difficult to steer around obstacles and get back on course.

It is therefore one object of this invention to provide a cost-effective guided horizontal boring tool which can be used to produce small diameter boreholes into which utilities, e.g., electric or telephone lines, TV cables, gas distribution piping, or the like, can be installed.

It is another object of the present invention to provide a steering system that offers a repeatable and useful steering response in boreholes which is compatible with existing boring equipment and methods and requires only minimal modification of existing boring tools.

Another object of this invention is to provide a boring tool immune to adverse environmental conditions and which allows the boring operation to be conducted by typical field service crews.

A still further object of this invention is to provide a guided horizontal boring tool which requires a minimal amount of excavation for launching and retrieval and thereby reducing the disturbance of trees, shrubs or environmentally sensitive ecosystems.

Another object of this invention is to provide a horizontal tool having reduced friction during turning and arcuate movement.

Another object of this invention is to provide a boring tool which is constructed to permit transmittal of the impact force of the tool to the soil while permitting free rotation of the tool.

Another object of this invention is to provide a boring tool with overgage body sections permitting a 2-point contact (front and rear) of the outer housing of the tool with the soil wall as opposed to the line contact which occurs without the undercut.

Another object of the invention is to provide a percussion boring tool having a body surface configuration permitting the tool to bore in an arc without distorting the round cross-sectional profile of the pierced hole.

A further object of this invention is to provide a percussion boring tool having a construction in which a higher rate of turning is possible for a given steering force at the front and/or back of the tool since a smaller volume of soil needs to be displaced.

Other objects of the invention will become apparent from time to time throughout the specification and claims as hereinafter related.

A guided horizontal boring tool constructed in accordance with the present invention will benefit utilities and rate payers by significantly reducing installation and maintenance costs of underground utilities by reducing the use of expensive, open-cut trenching methods.

The above noted objects and other objects of the invention are accomplished by percussion boring tool for boring in the earth at an angle or in a generally horizontal direction.

Accordingly, the present invention provides a percussion tool for drilling holes in the soil comprising

a cylindrical housing with a front end shaped for boring,

a first means on said front end for applying a boring force to the soil,

a second means in said housing for applying a percussive force to said boring force applying means, characterised in that

said housing having front and rear portions of an outside continuous constant diameter larger than that of the intermediate portion of the housing, thereby providing two spaced continuous circumferential zones of frictional contact with the soil during boring,

and thereby to reduce friction with the wall of the bore formed by the tool and to permit the tool to turn in its path along a shorter radius.

The percussion boring tool has a cylindrical body with overgage sleeves located over a portion of the outer body affixed so that they can rotate but cannot slide axially. The overgage areas at the front and back of the tool, or alternately, an undergage section in the centre of the tool body permits a 2-point contact (front and rear) of the outer housing with the soil wall as opposed to the line contact which occurs without the undercut. The 2-point contact allows the tool to deviate in an arc without distorting the round cross-sectional profile of the pierced hole. Thus, for a given steering force at the front and/or back of the tool, a higher rate of turning is possible since a smaller volume of soil needs to be displaced.

Fig. 1 is a schematic view and partial vertical section through the earth showing a guided horizontal boring tool illustrating an alternate embodiment of the percussion boring tool with overgage sections on the tool housing and illustrating the tool as used with a magnetic attitude sensing system.

Fig. 2 is a view, in elevation, of a percussion boring tool having overgage collars, shown in section, secured in fixed positions at the front and rear of the tool housing.

Fig. 3 is a view, in elevation, of a percussion boring tool having overgage collars, shown in section, one in a fixed position at the front and the other supported on bearings for rotation at the rear of the tool housing.

Fig. 4 is a view, in elevation, of a percussion boring tool having overgage collars, shown in section, secured in fixed positions at the front and rear of the tool housing and further showing a slant nosed boring member at the front and spin controlling fins at the rear.

Fig. 5 is a view, in elevation, of a percussion boring tool having overgage collars, shown in section, one in a fixed position at the front and the other supported on bearings for rotation at the rear of the tool housing and further showing a slant nosed boring member at the front and spin controlling fins at the rear.

Figs. 6A, 6B, and 6C are segments in longitudinal cross section of a boring tool as shown in Fig 5 having a slanted nose member and fixed/locable fin arrangement in the unlocked position.

The invention will now be described, by way of example only, with reference to the drawings that follow.

In the applicant's European Patent Application No EP0202013, an invention is described which provides for control of a percussion boring tool to effect either straight boring or boring along a deviate or arcuate path. The invention may include a slanted nose member or an eccentric hammer to deliver an off-axis impact which produces a turning force to the tool. Either an eccentric hammer or nose member will produce the desired result, since the only requirement is that the axis of the impact does not pass through the frontal centre of pressure. In order to allow the tool to travel in a straight path tail fins are incorporated into the trailing end of the tool which can be selectively moved so that they impart a spinning motion to the tool, which will negate the steering action of the slanted nose member or eccentric hammer.

This embodiment of the present invention consists of an overgage sleeve or sleeves located over a portion of the tool outer surface which are affixed such that they can rotate but cannot slide axially. This permits transmittal of the tool's axial impact force from the tool to the soil while allowing free rotation of the tool during spinning operations. The overgage areas are at the front and back of the tool, or alternately, an undergage section in the centre of the tool body. This undercut in the centre of the tool permits a 2-point contact (front and rear) of the tool's outer housing with the soil wall as opposed to the line contact which occurs without the undercut. The 2-point contact allows the tool to deviate in an arc without distorting the round cross-sectional profile of the pierced hole. Thus, for a given steering force at the front and/or back of the tool, a higher rate of turning is possible since a smaller volume of soil is displaced.

In Fig. 1 , there is shown a preferred guided horizontal boring tool 1010, having overgage body sections, used with a magnetic field attitude sensing system. The boring tool 1010 may be used with various sensing systems, and a magnetic attitude sensing system is depicted generally as one example.

As shown in Fig. 1 , the boring tool 1010 includes a steering system comprising a slanted-face nose member 1018 attached to the anvil 1033 of the tool to produce a turning force on the tool and tail fins 1017 on a rotary housing 1019a on the trailing end of the tool which are adapted to be selectively positioned relative to the body of the tool to negate the turning force. Turning force may also be imparted to the tool by an internal eccentric hammer, as shown in Fig. 41 of the EP-A-0202013 application referred to above, delivering an off-axis impact to the tool anvil.

For turning the tool, the tail fins 1017 are moved into a position where they may spin about the longitudinal axis of the tool 1010 and the slanted nose member 1018 or eccentric hammer will deflect the tool in a given direction. When the fins 1017 are moved to a position causing the tool 1010 to rotate about its longitudinal axis, the rotation will negate the turning effect of the nose member 1018 or eccentric hammer as well as provide a means for orienting the nose piece into any given plane for subsequent turning or direction change.

The body of the tool 1010 has front 1021 and rear 1022 overgage body sections which give improved performance of the tool in angular or arcuate boring. These overgage sections are fixed longitudinally on the tool body and may be fixed against rotation or may be mounted on bearings which permit them to rotate.

The steering system of the present invention will allow the operator to avoid damaging other underground services (such as power cables) or to avoid placing underground utilities where they may be damaged. The body construction of the tool including the overgage sections cooperates with the steering mechanism to give overall improved performance.

Figs. 2 through 5 illustrate various embodiments of the boring tool with overgage sections on the tool body. In Fig. 2 , there is shown a boring tool 1010 having a body 1020 enclosing the percussion mechanism driving the tool. The front end of body 1020 is tapered as at 1029 and has the external portion 1035 of the anvil protruding therefrom for percussion boring.

Front sleeve 1021 and rear sleeve 1022 are mounted on tool body or housing 1020 by a shrink or interference fit. In this embodiment, overgage sleeves 1021 and 1022 are both fixed against longitudinal or rotational slippage. The sleeves may be pinned in place as indicated at 1024. The rear body portion is connected to a hydraulic or air line for supply of a pressurized operating fluid to the tool.

In Fig. 3, there is shown another embodiment of the boring tool in which one of the overgage sleeves is free to rotate. In this embodiment, boring tool 1010 has a body 1020 enclosing the percussion mechanism driving the tool. The front end of body 1020 is tapered as at 1029 and has the external portion 1035 of the anvil protruding therefrom for percussion boring.

Front sleeve 1021 is mounted on tool body or housing 1020 by a shrink or interference fit. The overgage sleeve 1021 is fixed against longitudinal or rotational slippage. The sleeve 1021 may be pinned in place as indicated at 1024. The rear sleeve 1022 is mounted on body 1020 on bearings 1025 for rotary motion thereon. The rear body portion is connected to a hydraulic or air line for supply of a pressurized operating fluid to the tool.

In the embodiments of Figs. 2 and 3 , the protruding anvil portion 1035 was not provided with any special boring surface. In the embodiments of Figs. 4 and 5 , the tool has a slanted nose member which causes the tool to deviate from a straight boring path at an angle or along an arcuate path. The rear of the tool has controllable fins which allow the tool to move without rotation or to rotate about its longitudinal axis. This arrangement is as in EP-A-0 202 013 referred to above and is described at least partially below.

In Fig. 4 , there is shown a boring tool 1010 having a body 1020 enclosing the percussion mechanism driving the tool. The front end of body 1020 is tapered as at 1029 and has the external portion 1035 of the anvil protruding therefrom for percussion boring. The protruding portion 1035 of the anvil has a slanted nose member 1018 secured thereon for angular or arcuate boring.

Front sleeve 1021 and rear sleeve 1022 are mounted on tool body or housing 1020 by a shrink or interference fit. In this embodiment, the overgage sleeves 1021 and 1022 are both fixed against longitudinal or rotational slippage. The sleeves may be pinned in place as indicated at 1024.

At the rear of body 1020, there is a rotatable housing 1019a on which there are fins 1017. The housing and fin assembly is actuatable between an inactive position in which the tool does not rotate about its axis and an actuated position where the fins cause the tool to rotate. The rear body portion is connected to a hydraulic or air line for supply of a pressurized operating fluid to the tool.

In Fig. 5 , there is shown another embodiment of the boring tool in which one of the overgage sleeves is free to rotate. In this embodiment, boring tool 1010 has a body 1020 enclosing the percussion mechanism driving the tool. The front end of body 1020 is tapered as at 1029 and has the external portion 1035 of the anvil protruding therefrom for percussion boring. The protruding portion 1035 of the anvil has a slanted nose member 1018 secured thereon for angular or arcuate boring.

Front sleeve 1021 is mounted on tool body or housing 1020 by a shrink or interference fit. The overgage sleeve 1021 is fixed against longitudinal or rotational slippage. The sleeve 1021 may be pinned in place as indicated at 1024. The rear sleeve 1022 is mounted on the body 1020 on bearings 1025 for rotary motion thereon.

At the rear of body 1020, there is a rotatable housing 1019a on which there are fins 1017. The housing and fin assembly is actuatable between an inactive position in which the tool does not rotate about its axis and an actuated position where the fins cause the tool to rotate. The rear body portion is connected to a hydraulic or air line for supply of a pressurized operating fluid to the tool.

Figs. 6 A, 6 B, and 6 C illustrate a boring tool 1027 having a slanted nose member and fixed/lockable fin arrangement as described generally in reference to Figs. 1 and 2 in EP-A-0 202 013.

OPERATION

The tool described above is capable of horizontal guidance, has overgage body sections, and is preferably used with a magnetic field attitude sensing system. The boring tool may be used with various sensing systems, and a magnetic attitude sensing system is depicted generally as one example. The overgage sleeves may be fixed or rotatable on bearings as described above. Likewise, the overgage sleeves may be used with any percussion boring tool of this general type and is not limited to the particular guidance arrangement, i.e., the slanted nose member and controllable tail fins, described above. It is especially noted that any of the arrangements described in EP-A-0 202 013 patent application referred to above can be used with overgage sleeves to obtain the desired advantages.

The procedure for using this percussion tool is to first locate and prepare the launching and retrieval pits. As described above, the launching pit P is dug slightly deeper than the planned boring depth and large enough to provide sufficient movement for the operator. The boring tool 1010 is connected to a pneumatic or hydraulic source 11, is then started in the soil, stopped and properly aligned, preferably with a sighting frame and level. The tool is then restarted and boring continued until the tool exits into the retrieval pit (not shown).

The tool can move in a straight direction when used with an eccentric boring force, e.g., the slanted nose member or the eccentric hammer or anvil, provided that the fins 1017 are positioned to cause the tool the rotate about its longitudinal axis. When the fins are set to allow the tool to move without rotation about the longitudinal axis, the eccentric boring forces cause it to move either at an angle or along an arcuate path.

As previously described, the overgage sleeves, which are located over a portion of the tool outer surface, are affixed such that they can rotate but cannot slide axially. This permits transmittal of the axial impact force from the tool to the soil while allowing free rotation of the tool during spinning operations. The overgage areas are at the front and back of the tool, or alternately, an undergage section in the center of the tool body. This undercut in the center of the tool permits a 2-point contact (front and rear) of the tool's outer housing with the soil wall as opposed to the line contact which occurs without the undercut. The 2-point contact allows the tool to deviate in an arc without distorting the round cross-sectional profile of the pierced hole. Thus, for a given steering force at the front and/or back of the tool, a higher rate of turning is possible since a smaller volume of soil needs to be displaced.

In the embodiment shown, for turning the tool, the tail fins 1017 are moved into a position where they may spin about the longitudinal axis of the tool 1010 and the slanted nose member 1018 or eccentric hammer will deflect the tool in a given direction. When the fins 1017 are moved to a position causing the tool 1010 to rotate about its longitudinal axis, the rotation will negate the turning effect of the nose member 1018 or eccentric hammer as well as provide the means for orienting the nose piece into any given plane for subsequent turning or direction change.

The front 1021 and rear 1022 overgage body sections give improved performance of the tool both in straight boring and in angular or arcuate boring. These overgage sections are fixed longitudinally on the tool body and may be fixed against rotation or may be mounted on bearings which permit them to rotate.

While the overgage sleeves can be used with any percussion boring tool, they have been shown in combination with one of the embodiments of EP-A-0 202 013 application referred to above. The operation of this percussion boring tool 1027 is as follows. Under action of compressed air or hydraulic fluid in the central cavity 1041, the hammer 1037 moves toward the front of the body 1028. At the foremost position, the hammer imparts an impact on the flat surface 1036 of the anvil 1033.

In this position, compressed air is admitted through the passages 1044 from central cavity 1041 into the annular cavity 1039. Since the effective area of the hammer including the larger diameter rear portion 1040 is greater than the effective area of the central cavity 1041, the hammer starts moving in the opposite direction. During this movement, the bushing 1042 closes the passages 1044, thereby interrupting the admission of compressed air into annular cavity 1041.

The hammer 1037 continues its movement by the expansion of the air in the annular cavity 1039 until the passages 1044 are displaced beyond the ends of the bushing 1042, and the annular cavity exhausts to atmosphere through the holes 1050 in the stop member 1049. Then the cycle is repeated.

The operation of the tail fin assembly 1062 is best seen with reference to Fig. 6 C. The compressed air or fluid in the annular cavity 1114 moves the piston 1077 against the spring 1090 and toward the front of the sub 1063. In the foremost position, the front end of the piston 1077 contacts the shoulder 1071 and the drive teeth 1086 and 10101 become disengaged. In this position, compressed air or fluid is admitted through the passage 1119 from the source into the annular chamber 1114. The fin sleeve 1091 is then free to rotate relative to the tool body. Pressure which may otherwise become trapped in the first cavity 1080 and hinder reciprocation is exhausted through the pressure relief passage 1120 to atmosphere.

When the air or fluid pressure within the chamber 1114 is relieved, the force of the spring 1090 moves the piston 1077 in the opposite direction. During this movement, the drive teeth 1086 and 1101 become engaged once again and the fin sleeve 1091 becomes locked against rotational movement relative to the tool body. The cycle may be selectively repeated as necessary for proper alignment the slanted nose member 1018 and attitude adjustment of the tool. It should be understood that the passage 1120 may also be connected to a fluid source, i.e. liquid or air, for moving the piston to the rearward position.

The reciprocal action of the hammer on the anvil and nose member as previously described produces an eccentric or asymmetric boring force which causes the tool to move forward through the earth along a path which deviates at an angle or along an arcuate path when the tool is not rotating. When the tool is rotated by operation of the fins, it moves along a substantially straight path (actually a very tight spiral). The overgage sleeves support the tool housing at two separated points. This 2-point contact (front and rear) of the tool housing with the soil wall allows the tool to deviate in an arc without distorting the round cross-sectional profile of the pierced hole. Thus, for a given steering force at the front and/or back of the tool, a higher rate of turning is possible since a smaller volume of soil needs to be displaced and the helix length is reduced.

Other types of boring or drilling systems can be used in conjunction with the present invention, such as hydraulic percussion tools, turbo-drill motors (pneumatic or hydraulic) or rotary-drill type tools.

It should be noted that the present invention may also be used in conjunction with the guidance system described in European patent application No 90 122 530.0 (EP-A-0 428 180).

Claims

1. A percussion tool for drilling holes in the soil comprising:
   a cylindrical housing (1019) with a front end (1018) shaped for boring, a first means (1033) on said front end for applying a boring force to the soil, a second means (1024) in said housing for applying a percussive force to said boring force applying means, characterised by said housing having front (1021) and rear (1022) portions of an outside continuous constant diameter larger than that of the intermediate portion of the housing, thereby providing two spaced continuous circumferential zones

of frictional contact with the soil during boring, said front and rear portions being adapted to reduce friction with the wall of the bore formed by the tool and to permit the tool to turn in its path along a shorter radius.

2. A percussion tool for drilling holes in the soil according to Claim 1 characterised by said first and second means being co-operable to apply an asymmetric boring force, and means on said housing having one position preventing rotary motion of said housing about its longitudinal axis and allowing said housing to have a pre-determined curved path through the soil and another position causing said housing to rotate about its longitudinal axis to cause the same to have a straight path through the soil.

3. A percussion tool for drilling holes in the soil according to Claim 2 characterised in that said means on said housing having one position preventing rotary motion comprise a plurality of guide fins positioned in the exterior of said housing at the rear end thereof, and the tool further comprises means (1077) for moving said fins between said first and second positions.

4. A controllable percussion tool according to Claim 3 characterised in that said first means comprises an anvil (1033) having a striking surface (1036) inside said housing (1019) and a boring surface outside said housing comprising a cylindrical nose portion (1018) having a side face (1060) extending longitudinally from the tip at an acute angle thereto, and said second means comprises a reciprocally movable hammer (1024) positioned in said housing to apply a percussive force to said anvil striking surface.

5. A percussion tool according to any preceding Claim characterised in that said housing is cylindrical, said front and rear portions of selected outside diameter comprise sleeve members secured to the outside of said housing at the front and rear ends thereof.

6. A percussion tool according to Claim 5 characterised in that said sleeve members are secured on said housing against longitudinal movement thereon.

7. A controllable percussion tool according to Claim 6 characterised in that at least one of said sleeve members is secured on said housing for rotary movement thereon.

8. A controllable percussion tool according to Claim 7 characterised in that said housing includes a friction bearing member (1025) on the outer surface thereof in bearing relation with said at least one sleeve member to permit rotary movement thereof.

Patentansprüche

1. Ein Schlagbohrwerkzeug zum Bohren von Löchern in den Boden, mit:
einem zylindrischen Gehäuse (1019) mit einer Vorderseite (1018), die zum Bohren geformt ist, einem ersten Mittel (1033) an der genannten Vorderseite zum Angriff einer Bohrkraft auf den Boden, einem zweiten Mittel (1024) im genannten Gehäuse zum Angriff einer Schlagkraft auf die genannten Bohrkraftangriffsmittel, gekennzeichnet dadurch, daß das genannte Gehäuse vordere (1021) und hintere (1022) Abschnitte von einem gleichbleibend konstanten Außendurchmesser hat, der größer als jener des Zwischenabschnitts des Gehäuses ist, wodurch zwei räumlich aufgeteilte, gleichbleibende Reibkontaktumfangszonen mit dem Boden während des Bohrens geschaffen werden, wobei die genannten vorderen und hinteren Abschnitte angepaßt sind, um die Reibung mit der Wand der durch das Werkzeug geformten Bohrung zu verringern, und dem Werkzeug zu gestatten, sich auf seinem Weg entlang eines kürzeren Radius zu drehen.

2. Ein Schlagbohrwerkzeug zum Bohren von Löchern in den Boden, gemäß Anspruch 1, gekennzeichnet dadurch, daß die genannten ersten und zweiten Mittel zum Angriff einer asymmetrischen Bohrkraft zusammenwirkend sind, wobei Mittel am genannten Gehäuse eine Position haben, welche die Drehbewegung des genannten Gehäuses um seine Längsachse verhindert und erlaubt, daß das genannte Gehäuse einen vorbestimmten gekrümmten Weg durch den Boden nimmt, und eine weitere Position, welche bewirkt, daß sich das Gehäuse um seine Längsachse dreht, um dasselbe dazu zu bringen, einen geraden Weg durch den Boden zu nehmen.

3. Ein Schlagbohrwerkzeug zum Bohren von Löchern in den Boden, gemäß Anspruch 2, gekennzeichnet dadurch, daß genannte Mittel am genannten Gehäuse mit einer Position, welche Drehbewegung verhindert, eine Vielzahl von Lenkflossen enthalten, die in der Außenseite des genannten Gehäuses am hinteren Ende davon positioniert sind, und daß das Werkzeug ferner Mittel (1077) zur Bewegung der genannten Flossen zwischen den genannten ersten und zweiten Positionen enthält.

4. Ein steuerbares Schlagbohrwerkzeug, gemäß Anspruch 3, gekennzeichnet dadurch, daß das genannte erste Mittel einen Amboß (1033) enthält, der eine Auftreffläche (1036) innerhalb des genannten Gehäuses (1019) und eine Bohrfläche außerhalb des genannten Gehäuses hat, mit einem zylindrischen Nasenabschnitt (1018), der eine Seitenfläche (1060) hat, welche sich längs von der Spitze in einem spitzen Winkel dazu erstreckt, und daß das genannte zweite Mittel einen hin- und herbewegbaren Hammer (1024) enthält, der zum Angriff einer Schlagkraft auf die genannte Amboßauftrefffläche im genannten Gehäuse positioniert ist.

5. Ein Schlagbohrwerkzeug, gemäß irgendeinem vorhergehenden Anspruch, gekennzeichnet dadurch, daß das genannte Gehäuse zylindrisch ist, die genannten vorderen und hinteren Abschnitte des ausgewählten Außendurchmessers Bohrhülsenbauteile enthalten, die an der Außenseite des genannten Gehäuses an den vorderen und hinteren Seiten davon gesichert sind.

6. Ein Schlagbohrwerkzeug, gemäß Anspruch 5, gekennzeichnet dadurch, daß die genannten Bohrhülsenbauteile am genannten Gehäuse gegen Längsbewegung darauf gesichert sind.

7. Ein steuerbares Schlagbohrwerkzeug, gemäß Anspruch 6, gekennzeichnet dadurch, daß mindestens eines der genannten Bohrhülsenbauteile am genannten Gehäuse zur Drehbewegung darauf gesichert ist.

8. Ein steuerbares Schlagbohrwerkzeug gemäß Anspruch 7, gekennzeichnet dadurch, daß das genannte Gehäuse an seiner Außenfläche ein Friktionslagerbauteil (1025) in Lagerbeziehung mit mindestens einem genannten Bohrhülsenbauteil einschließt, um die Drehbewegung desselben zu ermöglichen.

Revendications

1. Outil à percussion pour le forage de trous dans le sol, comprenant un carter cylindrique (1019) ayant une extrémité avant (1018) conformée en vue du forage, un premier moyen (1033) sur ladite extrémité avant pour appliquer une force de forage au sol, un second moyen (1024) dans ledit carter pour appliquer une force de percussion audit moyen d'application de la force de forage, caractérisé par le fait que ledit carter a des parties avant (1021) et arrière (1022) d'un diamètre extérieur, continu, constant, supérieur à celui de la partie intermédiaire du carter, ménageant ainsi deux zones périphériques, continues, espacées, de contact de frottement avec le sol pendant le forage, lesdites parties avant et arrière étant adaptées pour réduire le frottement avec la paroi du trou formé par l'outil et pour permettre à l'outil de tourner dans sa trajectoire le long d'un rayon plus court.

2. Outil à percussion pour le forage de trous dans le sol selon la revendication 1, caractérisé par le fait que lesdits premier et second moyens sont susceptibles de coopérer pour appliquer une force de forage asymétrique, et par le fait que des moyens sur ledit carter ont une position empêchant un mouvement de rotation dudit carter autour de son axe longitudinal et permettant audit carter d'avoir une trajectoire courbe prédéterminée à travers le sol, et une autre position amenant ledit carter à tourner autour de son axe longitudinal pour amener celui-ci à avoir une trajectoire rectiligne à travers le sol.

3. Outil à percussion pour le forage de trous dans le sol selon la revendication 2, caractérisé par le fait que lesdits moyens sur ledit carter ayant une position empêchant un mouvement de rotation comprennent plusieurs ailettes de guidage, positionnées à l'extérieur dudit carter à l'extrémité arrière de celui-ci, et l'outil comprend en outre des moyens (1077) pour déplacer lesdites ailettes entre lesdites première et seconde positions.

4. Outil à percussion contrôlable selon la revendication 3, caractérisé par le fait que ledit premier moyen comprend une enclume (1033) ayant une surface d'impact (1036) à l'intérieur dudit carter (1019) et une surface de forage à l'extérieur dudit carter, comprenant une partie de nez cylindrique (1018) ayant une face latérale (1060) s'étendant longitudinalement à partir de la pointe suivant un angle aigu par rapport à celle-ci, et ledit second moyen comprend un marteau (1024) se déplaçant en va-et-vient, positionné dans ledit carter, pour appliquer une force de percussion à ladite surface d'impact de l'enclume.

5. Outil à percussion selon l'une des revendications précédentes, caractérisé par le fait que ledit carter est cylindrique, et que lesdites parties avant et arrière de diamètre extérieur choi-

si comprennent des éléments de manchon fixés sur l'extérieur dudit carter aux extrémités avant et arrière de celui-ci.

6. Outil à percussion selon la revendication 5, caractérisé par le fait que lesdits éléments de manchon sont fixés sur ledit carter à l'encontre d'un déplacement longitudinal sur celui-ci.

7. Outil à percussion contrôlable selon la revendication 6, caractérisé par le fait qu'au moins l'un desdits éléments de manchon est fixé sur ledit carter en vue d'un déplacement en rotation sur celui-ci.

8. Outil à percussion contrôlable selon la revendication 7, caractérisé par le fait que ledit carter comprend un élément de palier à glissement (1025) sur la surface externe de celui-ci en relation d'appui avec ledit ou lesdits éléments de manchon pour permettre un mouvement de rotation de celui-ci ou de ceux-ci.

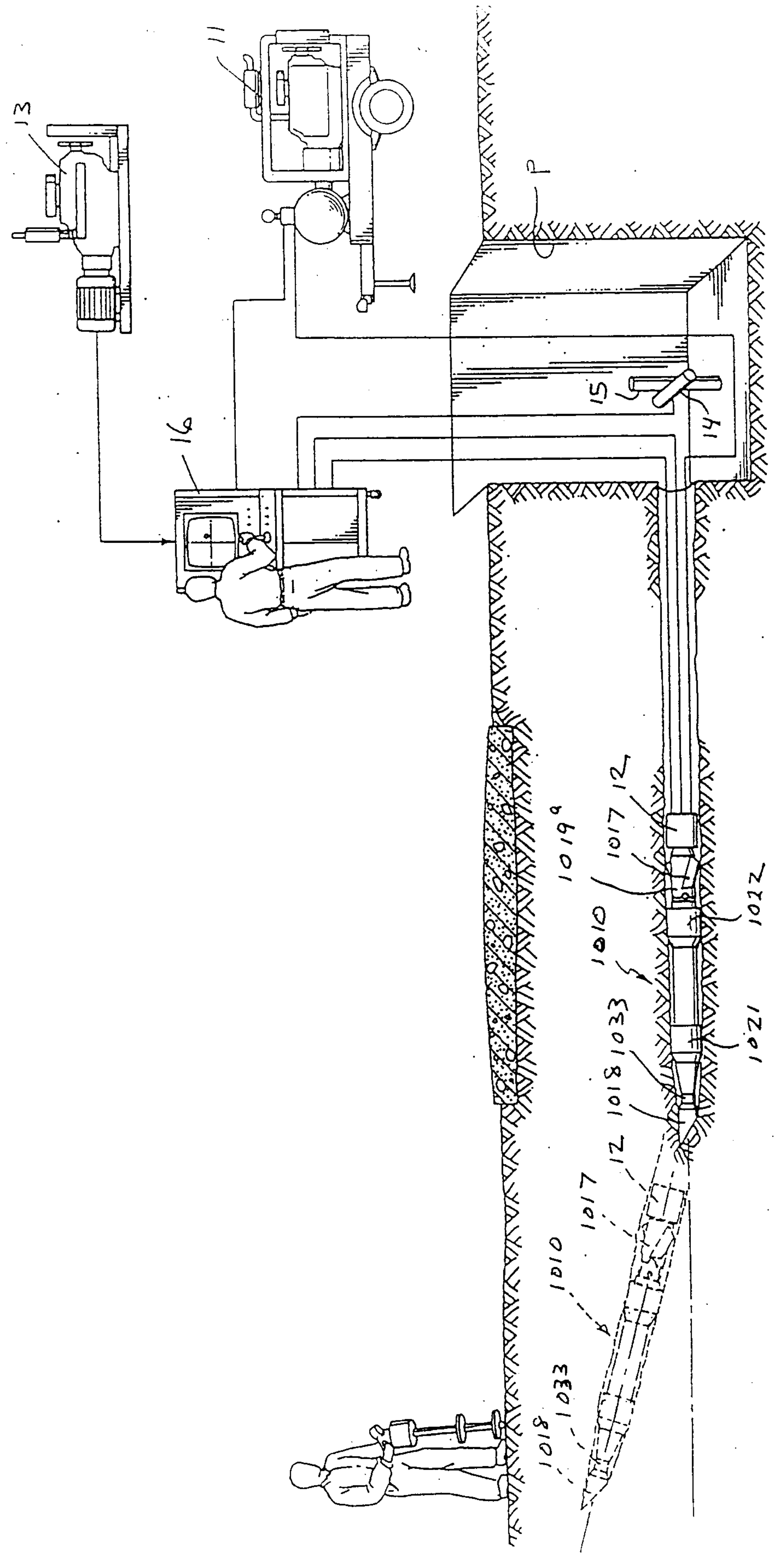
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Fig. 1

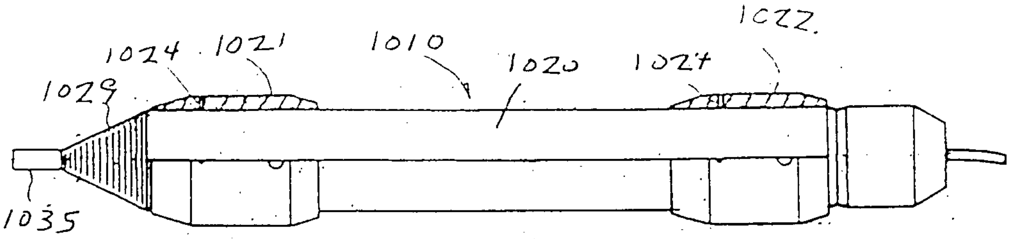

Fig. 2

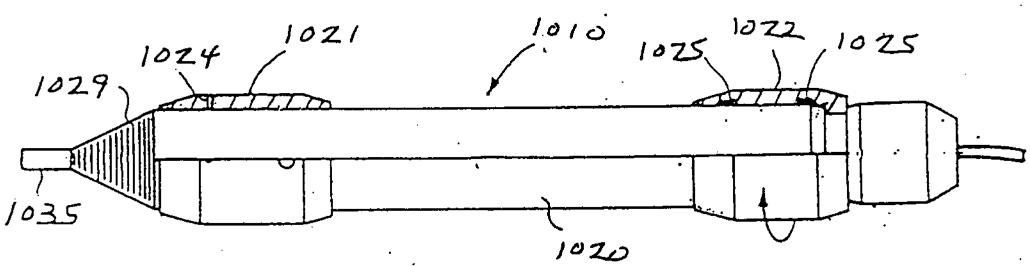

Fig. 3

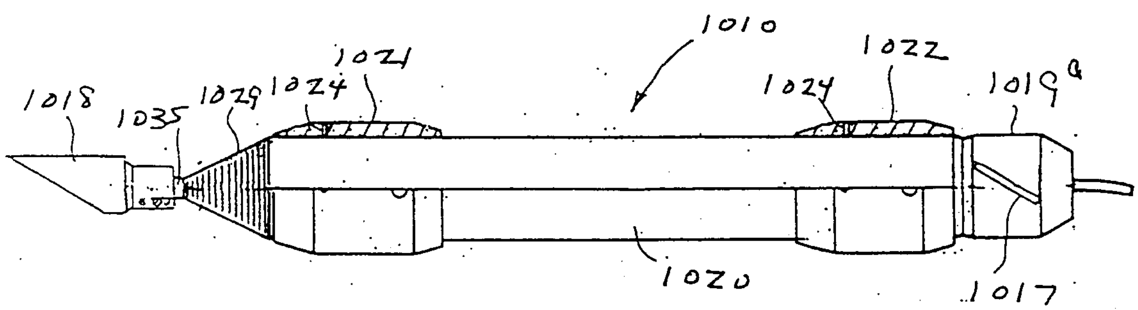

Fig. 4

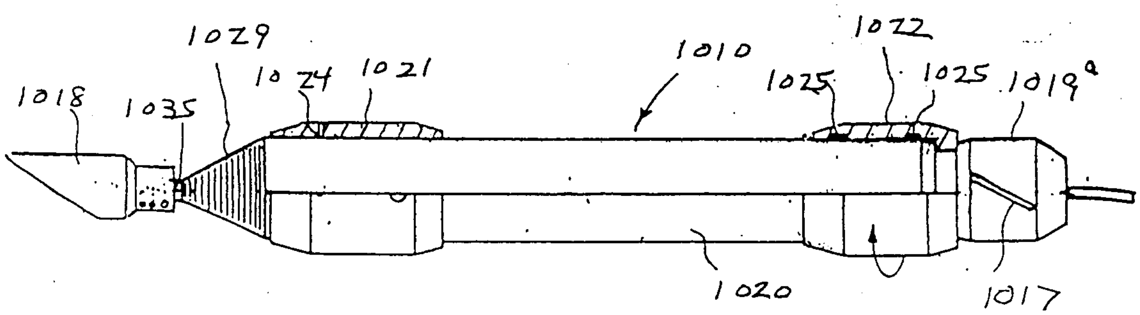

Fig. 5

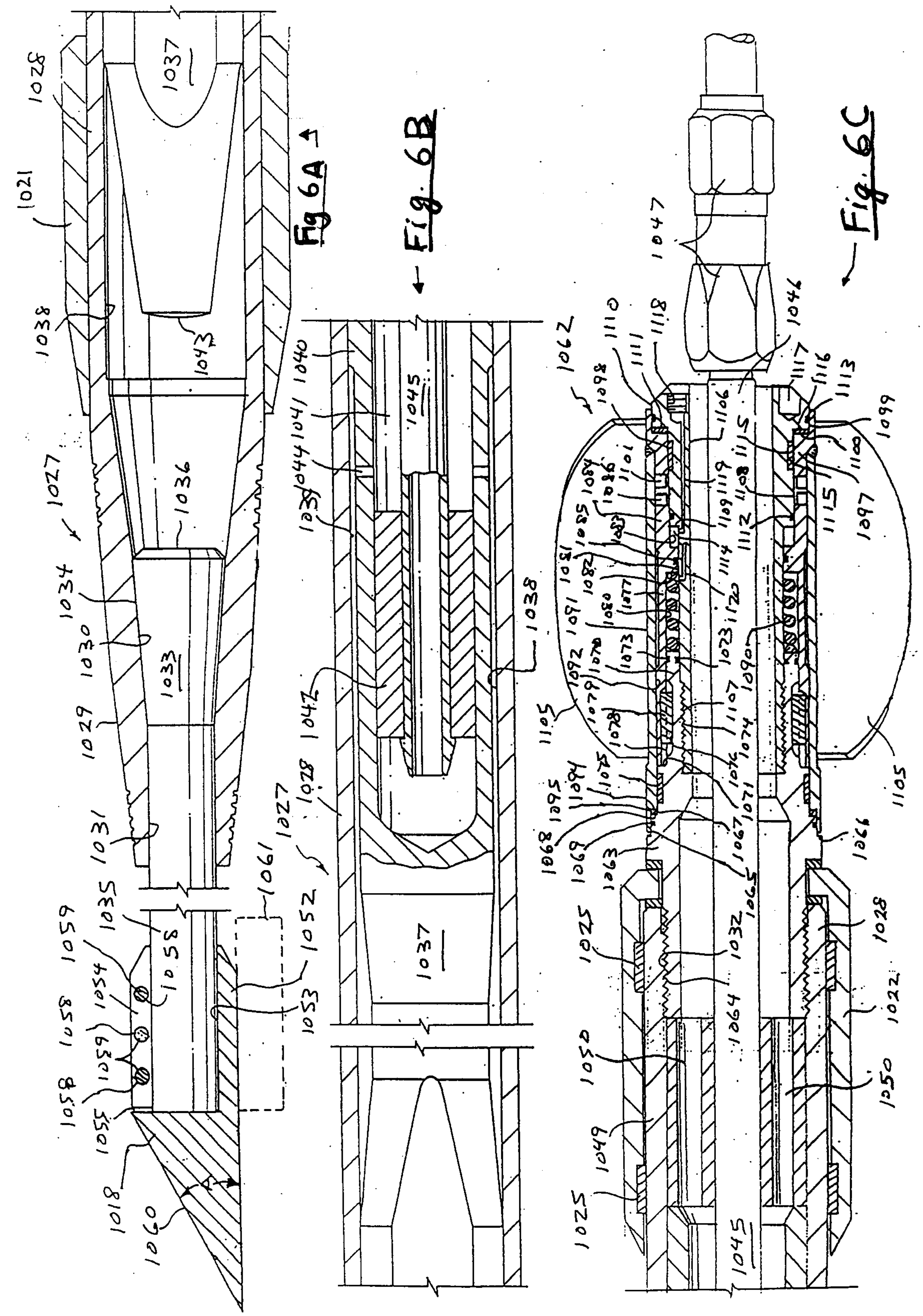
Fig 6A
Fig. 6B
Fig. 6C