

Aug. 14, 1962

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3,049,185

METHOD FOR OSCILLATING DRILLING

Filed Dec. 26, 1956

4 Sheets-Sheet 1

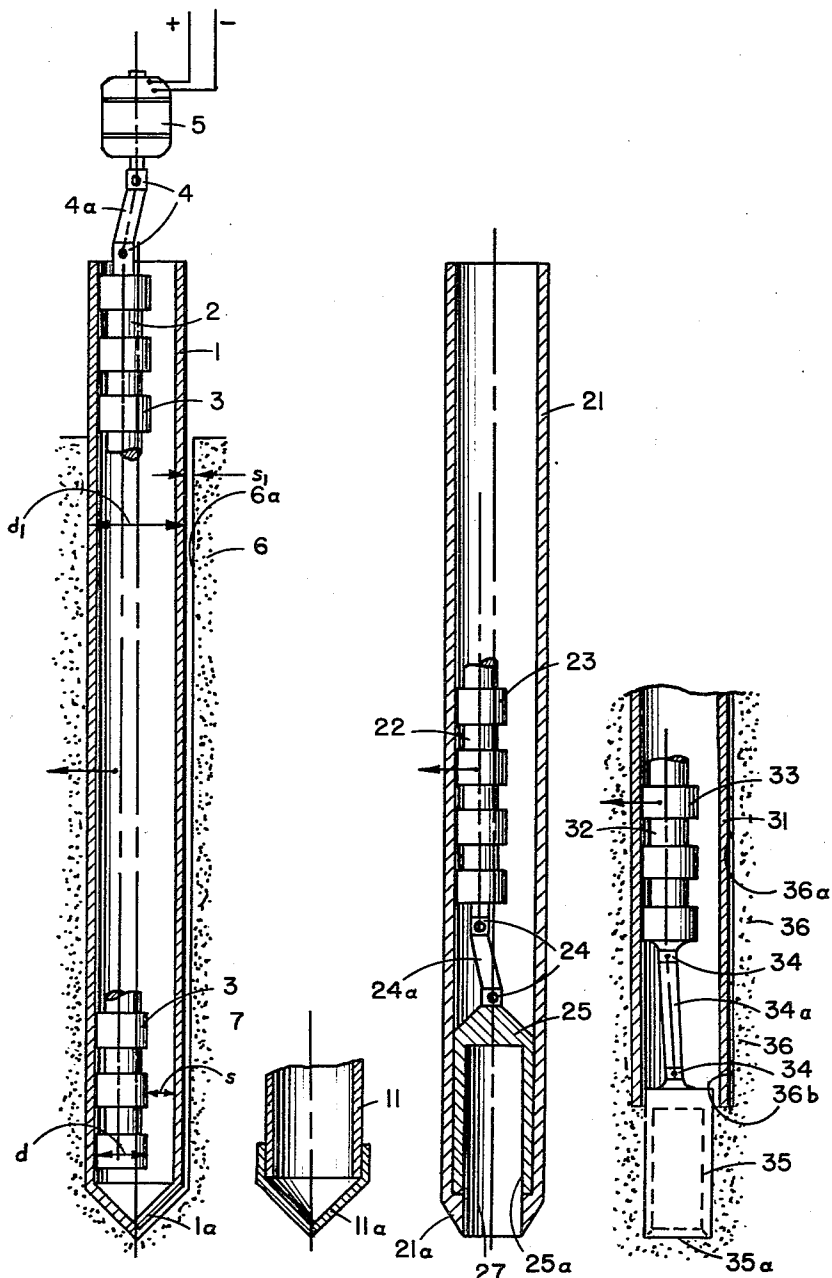


FIG. 1

FIG. 2

FIG. 3

FIG. 4

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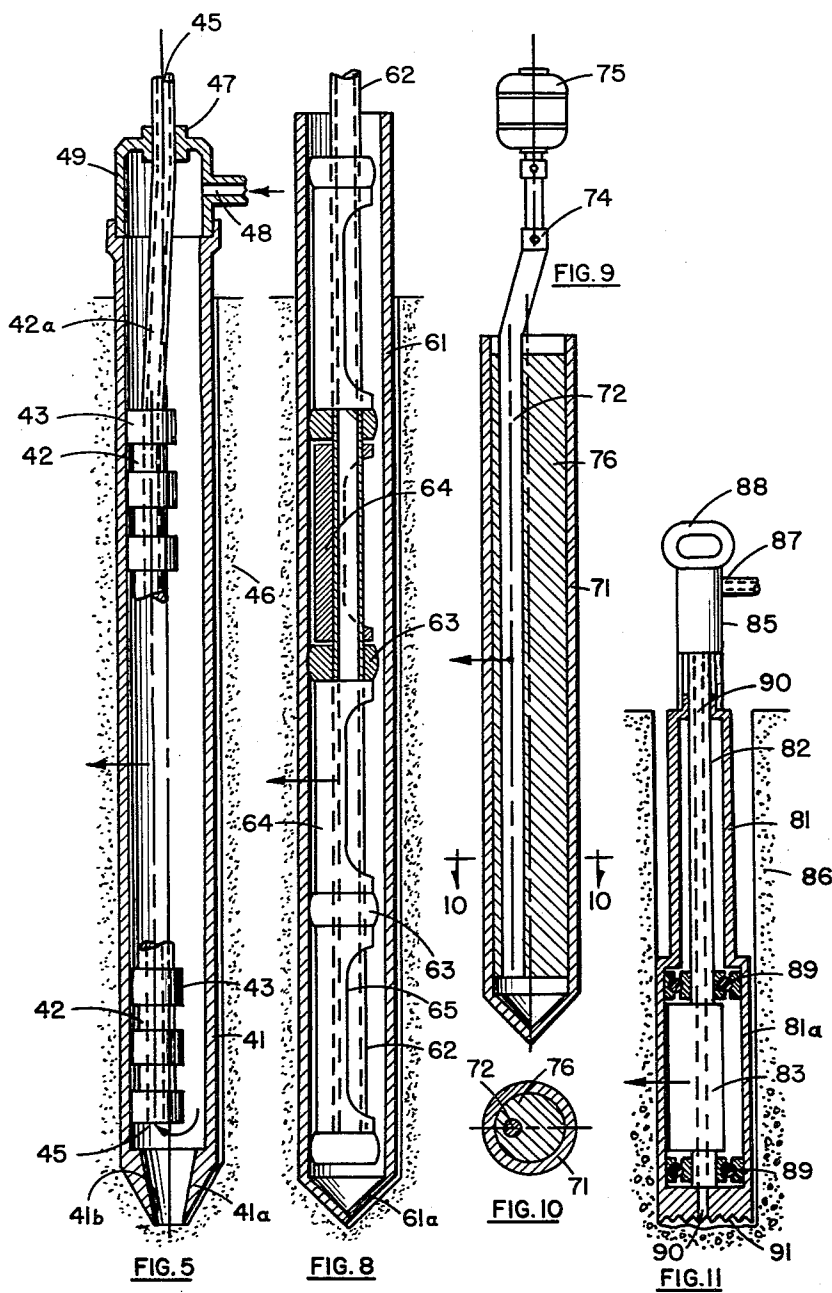
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4 Sheets-Sheet 3

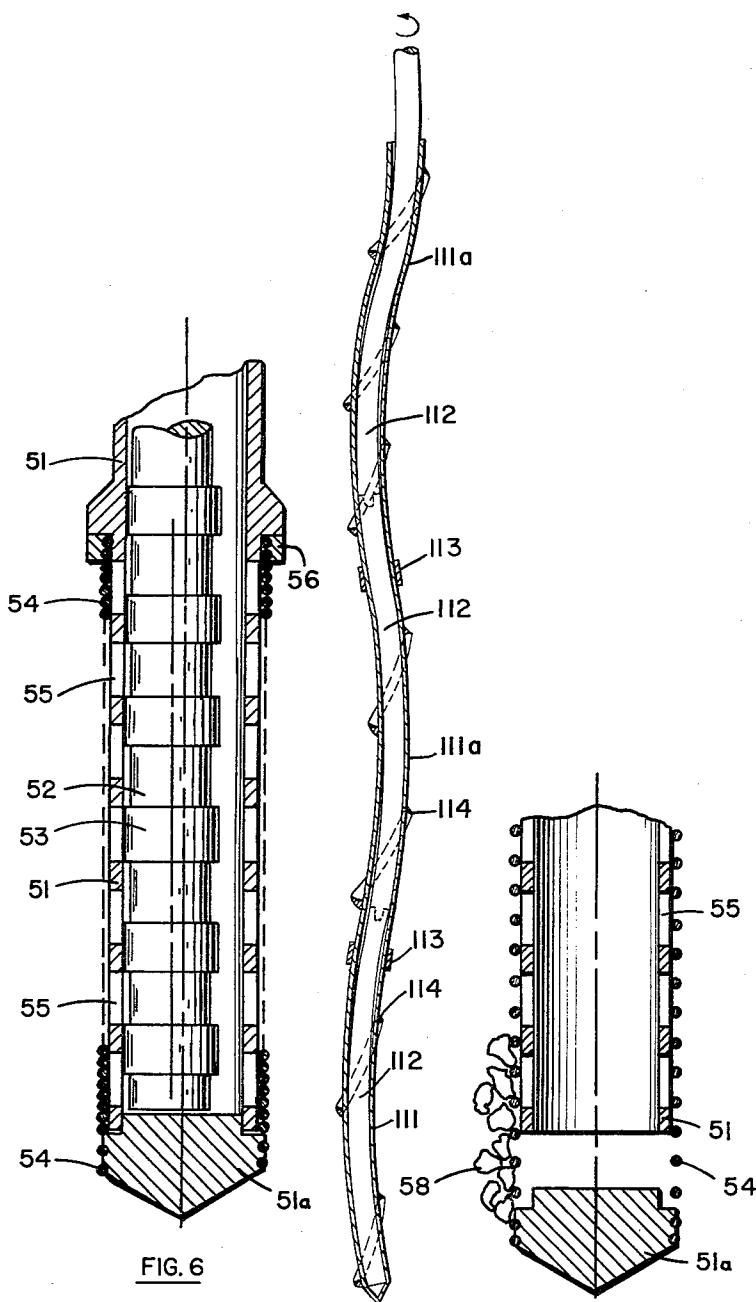


FIG. 6

FIG. 16

FIG. 7

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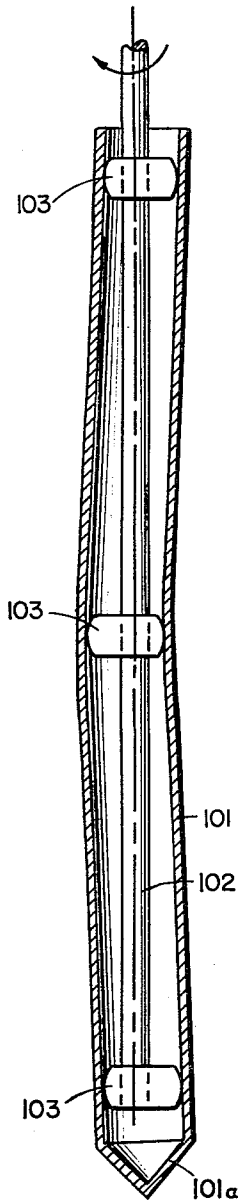


FIG. 12

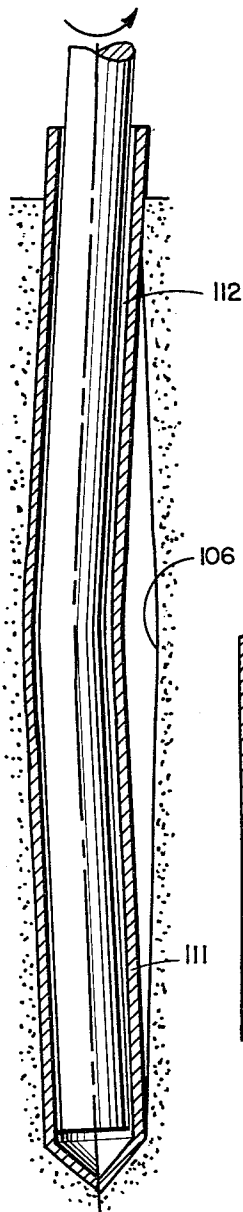


FIG. 13

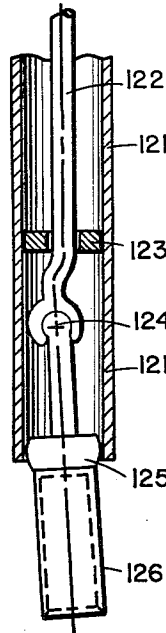


FIG. 14

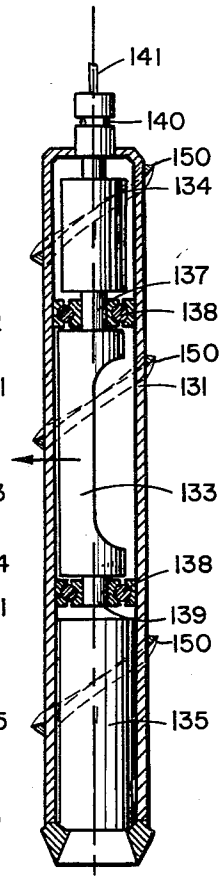


FIG. 15

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METHOD FOR OSCILLATING DRILLING

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9 Claims. (Cl. 175—19)

When holes are drilled into the ground, whether accomplished by hammer blows or through rotary drilling, the boring always produces a hole having a diameter which is considerably larger than the poles or drill rods which operate the boring tool. If the hole is not self supporting, a protective tubing must be inserted to prevent cave-ins. This protective tubing usually is not utilized as a part of the drilling equipment and its sole purpose is protection against the collapse of the material immediately surrounding the drill hole.

For horizontal drilling in light or sandy soil, methods are known in which the drill tubing is embedded in the soil, making contact therewith with its whole outer surface in such a manner that, through a shuttle motion by means of hydraulic drives which are capable of producing considerable force, the tubing is advanced in the direction of the drilling to overcome the very great friction between the soil and the tubing. However, the operational range of these methods is limited by the excessive resistance of the friction.

The present invention provides means and method for drilling, utilizing a drill operating mechanism in which the drill rod and casing are combined as a unit so that the rod drives the casing within the bored hole. The means to accomplish the work performable by the present invention are, in part, disclosed in my United States Patent No. 2,730,176, which relates to a method for the recovery of imbedded tubing by rolling oscillation. In accordance with that patent, the imbedded tubes are subjected to oscillating forces, acting across the tube axes, and to rotary motions. According to the present invention, a drill rod and roller disks secured on said rod are caused to rotate in contact with the internal surface of the drill tubing to produce centrifugal forces perpendicular to the main longitudinal axis of said drill tubing, which also serves as the protective tubing in the hole.

During the rotating and rolling process of the drill rod, it is held in an eccentric position relative to the axis of the drill tubing. The drill tubing rotates on enlarged diameter rollers on the drill rod and which in turn roll along the inner wall of the drill tube. The latter rotates on its own axis in the direction opposite to that of the circulating centrifugal force because the drill tubing itself rolls about the wall of the bore hole effected by the circulating centrifugal force. Thus, the drill tubing is driven immediately within the hole to be drilled and gets its rotating drive at the inner wall of the bore hole and not from a rotary table above the ground, and advances by its own weight as it would in conventional rotary drilling.

In the present method the resistance of friction between the exterior surface of the drill tubing and the soil is practically wholly eliminated in the direction of the advance of the drilling so that the weight of the equipment for vertical drilling, or the force required for the advance in horizontal drilling, is exerted to its full extent to the bottom or advanced drill point of the soil and, therefore, in favor of the advance of the drill. It is known from the theory of friction, that the latter is always opposed to the direction of the advancing force. That is, to move a mass along a support offering friction, the force required to move the mass must be at

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least equal to the coefficient of friction multiplied by the mass or no motion will result. If the force is of that required magnitude, that is, the mass is in motion, an insignificantly small force in the direction vertical to the main force will cause a component of motion in the direction across the direction of the main force. For this motion across the direction of the main force, no minimum force is required; however, each force across the direction of the main force, no matter how small, creates a motion, the coefficient of friction along the cross direction being practically zero.

In conventional rotating drilling employing a tube mechanism for entering the soil, the identical teachings apply; however, the resistance of friction to be overcome through the rotation of the tool soon becomes prohibitive at worthwhile depths. In accordance with the present invention, however, only the dynamic friction, which is considerably smaller, needs to be overcome. In addition according to the present invention, the soil is continuously removed by means of the rotation and caked so that the transmission remains loose within the soil.

The method of drilling provided by the present invention is superior over known methods in the art in that only a single, relatively narrow tube train or drill rod transmission within a drill tubing is required to attain a drilled hole equipped with a protective tubing down to the final depth of the hole. These tubings never seat inside the soil and can be loosened, even after long periods, either for the purpose of continued boring or for the removal of the tubing. By employing the present invention it is now possible to drill effectively a small diameter hole into light soil in a horizontal direction for long distances because the resistances of friction are eliminated in the direction of the drilling so as to prevent the seating of the drill and transmission tubing.

It is an object of the present invention to provide a new and improved method and means of drilling.

It is a principal object of the present invention to provide a method and means for vertical and horizontal drilling in which a protective drill tubing, forming the drilled hole, is caused to roll along said hole surface by means of rotating centrifugal forces directed across the longitudinal axis of the tubing.

It is a further object of the present invention to provide a method of drilling in which the resistance between the outside of the drive tubing and the soil is practically wholly eliminated in the direction of the advance of the drilling so that the weight of the equipment is exerted to its full extent in favor of the advance of the drill.

Other objects of invention will become apparent from the following description taken in connection with the accompanying drawings, in which

FIG. 1 is a partially cross sectional view of a motor driven drill rod transmission magnetically attracted to the interior surface of the drill tubing which has a closed advancing end;

FIG. 2 is a view of the present invention in which the advancing end of the drill tubing is detachable;

FIGS. 3 and 4 show embodiments of the present invention by which periodic core samples may be extracted;

FIG. 5 is a view of the present invention by which the soil loosened by the drill tip may be forced from the hole through the drill rod;

FIGS. 6 and 7 illustrate an embodiment of the present invention by which a permanent filter may be inserted with the drill tubing;

FIG. 8 is an embodiment of the present invention employing a non-magnetic drill rod transmission linkage;

FIG. 9 shows another embodiment for the creation of rotating cross forces according to the present invention;

FIG. 10 is a cross sectional view taken along the line 10—10 of FIG. 9;

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FIG. 11 illustrates an embodiment of the present invention in which a nonmagnetic eccentric weight is used to create centrifugal force across the longitudinal axis of a hard surface drill;

FIG. 12 shows an embodiment of the invention in which eccentric cams are caused to produce a circulating elastic bend;

FIG. 13 is an embodiment of the present invention in which a curved core rod is used within the hollow drill tubing also causing a circulating elastic bend;

FIG. 14 is an embodiment of the invention which develops a rotating kinking process to cause a rotary motion of the drill tubing;

FIG. 15 is an embodiment of the invention in which a high speed motor within a case, having a core tube, drives an eccentric weight to develop centrifugal force to cause the rotation of the drill tubing; and

FIG. 16 shows a train of transmission rods assembled from a number of the elements of the embodiments shown in FIG. 13.

Referring to FIG. 1, cylindrical hollow tubing or drill tubing 1, having a closed tapered point 1a at its low or advancing end, is extending into a bored hole 6a in soil 6. In the interior of tubing 1 is an inner transmission linkage comprising a drill rod 2 having enlarged diameter rollers 3 spaced and fixed thereon to rotate therewith. Rollers or disks 3 are attracted magnetically to the inside wall of tubing 1 but are free to roll along said wall. In this embodiment of the invention tubing 1 is magnetically attractable and disks 3 are permanent magnets. Disks 3 would also function in the same manner having a conventional electromagnet built therein for which direct current for energizing the magnet could be supplied through a pair of lead-in wires wound around rod 2 or supplied by having a positive lead-in wire wound around the rod with the negative wire of the magnet grounded to pipe 1 in a conventional manner. The lead-in wires could also be inserted inside rod 2.

Through rotation of rod 2 by means of universal joints 4 and connecting link 4a, as driven by motor 5, the disk magnets 3 roll along the inside surface of tubing 1, eccentric with respect to the latter's longitudinal axis. The drill rod 2 and the magnetized disks 3 rotate on their own coincident axes with the same speed as motor 5, in the same direction, but their mass axis (the same as the latter in symmetrical rods and disks, as shown), circulates or rolls with the speed according to the ratio of d/s with respect to the motor speed around the axis of drill tubing 1, where d is the diameter of rollers 3 and s is the play of the rollers 3 inside of tube 1. That is, d plus s are equal to the inside diameter of tube 1. The roll of the drill rod and of the disks is in the opposite direction of their rotation and this thereby effects the centrifugal force in the direction indicated by the arrow, located in the approximate center of FIG. 1, extending to the left from tubing 1. This may be explained in that the circumference of the inner wall of the drill tubing is $\pi(d+s)$, and that the circumference of disks 3 is πd . Thus, after one complete rotation of the disks on their axes while in contact with the inner wall of the drill tube, for example, to the left in FIG. 1, the drill rod and disks have been rolled around their own axes to the right the following distance:

$$\frac{\pi(d+s) - \pi d}{d}$$

which equals

$$\frac{s}{d}$$

Therefore, one rotation of the drill rod around its own axis to the right corresponds with d/s rotations of the motor, rod, and disks to the left.

As the drill tubing is forced by the aforesaid centrifugal force against the wall of the bore hole, it rotates slowly on its own axis in the same direction as the rod

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but in the opposite direction of the rotation of the points of contact of the centrifugal force made by the drill tube on the bore hole so that the ratio of the distance traveled by the drill tubing to that of the points of contact of the centrifugal force is

$$\frac{s_1}{d_1}$$

where d_1 is the outside diameter of the drill tube and s_1 is the distance from the exterior of the tube 1 to the surface of the bored hole, d_1+s_1 being equal to the diameter of bored hole 6a. Thus, the drill tubing rotates about its own axis in the same direction as motor 5 at a ratio of $d/s \times s_1/d_1$ with respect to the speed of the motor. However, the speed of the drill tubing depends in part upon the compressibility of the soil. The expression "circulating or rotating centrifugal force" refers to the rotation of the points of contact where the rollers exert the centrifugal force against the drill tubing. Thus, as the disks roll on the drill tubing, the points of contact where the centrifugal force is effected, also rotate.

Motor 5 and tubing 1 thereby rotate in the same direction and the tapered point 1a propels itself into the soil, advancing therein by its own weight or through an additional weight applied thereto. Concurrently, the transmission linkage, drill rod 2 and disk 3, and the motor are also advanced in the direction of the drilling. In this operation, the soil is, as in a ramming process, repelled and due to the vibration created, its natural density increases, thus yielding additional space externally of tube 1. Thus, according to the present invention, the forces required to repel the soil are considerably less than in a ramming process, and in addition, the increase of the surrounding soil density provides considerable advantage in making foundations.

Motor 5 may be suspended from a cable or a typical drilling rod, not shown, as may be secured to a conventional drilling tower. The length of tubing 1, of course, is dependent upon the depth of the hole and motor 5 may be lowered in the same linear relationship, as shown in FIG. 1, into the hole, as it is made so that the actual drilling forces are developed within the hole and not in a conventional way in a drilling tower. Motor 5 may typically be driven by electricity, water or air. As indicated, the motor should have a diameter smaller than that of the inside diameter of the tubing if it is to be lowered therein as the drilling progresses.

This embodiment of the invention is of particular merit in the installation of pile foundation. As shown in FIG. 2, the tapered point 11a at the bottom of drill tubing 11 is detachable. That is, after tip 11a has reached its final depth, the drill rod may be withdrawn and a preformed concrete pile may be inserted into the drill tubing, or mixed liquid concrete may be poured therein to surround the usual steel reinforcements. Thereafter, tubing 11 may be withdrawn and the detached tip 11a remains in the soil.

In FIG. 3, an embodiment of the invention is shown by which periodic extraction of cores is possible. For this purpose generally cylindrical drill tubing 21, similar to tubing 1 in FIG. 1, has an open lower, tapered end 21a and has a shoulder 27 within the tubing adjacent the open end 25a. In the same manner, as described in reference to FIG. 1, the transmission linkage composed of a drill rod 22 and spaced magnetic disks 23, being magnetically attracted to tubing 21, develop a centrifugal force in the direction of the arrow to cause the rotation of tubing 21. At the lower end of drill rod 2 are, typically, universal joints 24 connected by a link 24a and the core receiving member 25 having its lower end 25a open in the direction of drilling. The core receiving member is filled as the drill tubing 21 advances into the hole and may be withdrawn at any time during the drilling process by removing the drill rod 22. If it is desired, a flexible shaft may be used instead of the universal joints and the connecting links.

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In FIG. 4, another type of core receiving member 35 having an open end 35a is shown. In this embodiment, the drill tubing 31 is open ended and is shown in soil 36 having formed a hole 36a therein. Core receiving member 35 will penetrate farther, as shown, forming drilled hole 36b. This arrangement is not intended for continuous core drilling, but only for the occasional taking of a test core. Drill rod 32, forming the transmission linkage with magnet disks 33, being magnetically attracted to tubing 31 and being driven by a motor not shown, has caused the advancement of drill tubing 31 into soil 36 and the advancement of core receiver 35 by means of connecting link 34a, which joins the drill rod and the core receiver by universal joints 34.

In FIG. 5 is shown another embodiment of the present invention in which drill tubing 41 has a tapered tip 41a, said tip having an open end 41b. The transmission linkage, which may be driven by a motor as shown in FIG. 1, is comprised of drill rod 42 and magnetic disks 43 spaced thereon and being magnetically attracted to drill tubing 41. Drill rod 45 is hollow and has a passage 45 therein, which extends through a flexible portion 42a of the rod. Flexible rod portion 42a extends through gland 47 in head 49 on tubing 41, said tubing 41 being shown to have entered soil 46. This modification of the present invention permits the removal of the loosened soil through passage 45 in drill tubing 42 as the drilling progresses. Compressed air or other fluid pressure may be supplied through fitting 48 so as to flow into tubing 41 around disks 43 and rod 42 return above or out of the ground through bore 45, carrying with it the soil that has loosened by drill tip 41a and forced into the opening 41b therein. If water is used for this process, it may be drawn from the water table in the ground. For the drilling process proper, however, no water is required and this is of utmost importance in areas suffering from water shortage.

When drilling for water and using compressed air to lift the loosened soil through a bore, as 45 in rod 42, the presence of water is indicated generally by its flowing upward through the tubing. By the insertion of a slotted filter tube over the drill tubing and slidably engaged therewith, it is possible to combine test boring for water with the actual drilling process by means of the present invention. The filter tube may be slotted so as to have the effect of the spring in FIG. 7. In this case, however, the drill tubing would not be slotted as it would be intended to withdraw it leaving the filter in place. The formation of a bed of natural gravel packing around the filter will be aided effectively through the vibratory motions from the transmission linkage. If water is found in sufficient quantity and of adequate quality and, if the ejected soil indicates that adequately large grain is present to form a natural gravel packing, the drill tubing together with the inner transmission linkage may be withdrawn, while under vibration from the rotating motions and while still carrying the water from within the filter which may be left in the drilled hole, as held there by the packing gravel. Afterwards, a sump pump may be installed if necessary. If no satisfactory conditions result, the filter tubing may then be pulled along with the drill tubing likewise under vibration, and recovered. The aforementioned use of the filter tubing may be employed for horizontal boring as well as the vertical, thus allowing, in accordance with the invention, for example, for drainage of sandy slopes and rises created in above surface mining for lignite by horizontal drilling and its accompanying subsequent solidification of the surrounding soil.

In place of a filter tubing, a closely wound coil spring may be employed around the drill tubing. This is illustrated in FIGS. 6 and 7, where the cylindrical tubing 51 has holes or slots 55 through its cylindrical surface. Tubing 51 has a detachable pointed tip 51a and is shown with a portion of transmission linkage of the present in-

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vention having magnetic disks 53 on drill rod 52, said disks being magnetically attracted to the internal cylindrical surface of tube 51. Around the cylindrical surface of tip 51a and slotted portion of tube 51 is tightly wound a coil spring 54, as shown in FIG. 6. Flange 56 on tubing 51 serves to hold spring 54 in tight compression, the other end of said spring being secured to tip 51a. During the drilling process, the spring is pushed forward by flange 56 and remains tightly closed. As soon as the intended length of the bore has been reached, the rod 52 is lowered a short distance while drill 51 is not lowered. This pushes tip 51a downward and the coils of spring 54; open evenly to form a helical filter or screen over slots 55 as shown in FIG. 7. Gravel 58 enters between the coils of the spring, as shown, and precludes its contraction or further compression.

Referring to FIG. 8, an embodiment of the invention in partial cross-section is shown in which a nonmagnetic inner transmission linkage for the generation of rotating cross-forces is illustrated. In the drill tubing 61, similar to that in FIG. 1, having a tapered tip 61a is provided an inner linkage composed of a hollow drill rod 62 on which are spaced, rotatable transmission rollers or cams 63 which transfer the circulating centrifugal forces caused by the eccentric weights 64 fixed on drill rod 62. The eccentric weights 64, between rollers 63, have their eccentricity positioned in the same direction and are formed of sleeveings having the front or side thereof removed, leaving a cutaway portion 65. Drill tubing 62 is caused to rotate by a motor, not shown, as illustrated in FIG. 1, and rollers 63 transmit centrifugal forces to drill tubing 61 while rolling on the inner surface thereof. The rollers 63 are, in effect, the transmission bearings for the mass eccentric drill rod 62. In other words, although rollers 63 rotate on and are concentric to drill rod 62, they are forced against the inner surface of tubing 61 by the rotation of the eccentric weights 64 and are in continuous contact with said surface at the point where the resulting force from the eccentric weights is directed. In this embodiment there is no up-gearing or speeding up, as occurs with the magnetically attracted rollers, of the inner linkage, and the directions of rotation and of the cross-forces motion are the same. It should be noted that an essential difference exists when the rotating centrifugal force is produced, as in FIGS. 1-6, by rolling magnets or as in FIGS. 8-15, by eccentric nonmagnetic weights and a rotating flexible, bending tube. In the first case, the centrifugal force runs contrary to the direction of rotation of the motor and a gearing in relation to d/s occurs. That is, when s is small in comparison with d the rotation is up-gear. In the second case, the direction of rotation of the motor and rotating centrifugal force or elastic bending tube, as in FIGS. 8, 9, 11-15, is the same and no gearing occurs. Further, the slow rotation of the drill tube and of the rotating centrifugal force are always in opposite directions and drill tube 61 rotates in the opposite direction to drill rod 62, in FIG. 8, for example.

Referring to FIGS. 9 and 10, there is illustrated another modification for the creation of rotating cross-forces according to the present invention. Within the cylindrical drill tubing 71, having a closed tapered point, an eccentric rod or tube 72 is provided, embedded, for a considerable length within a core 76 which may be made of a non-metallic or of some plastic material. The transmission assembly formed with rod 72 and core 76 is rotatable within tubing 71 and is under a slip fit therein. Rod 72 is shown connected by means of universal joint 74 to shaft of motor 75 which may be suspended from a crane or a conventional drilling tower. As core 76 is rotated within tubing 71 it serves as a journal for the entire transmission of said cross-forces.

In the drilling of solid rock, it is not necessary to subject the whole drill tubing to the rotating cross-forces because the soil around the drill hole does not need to

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be repelled. That is, it suffices to prepare the lower or near end of the drill hole properly. FIG. 11 illustrates an embodiment of the invention for use in drilling rock or other hard materials. Drill tubing 81 is shown in cross section in bored hole 86 and has an enlarged diameter cylindrical portion 81a. At the forward or lower end of portion 81a is a plane surface having cutting edges to form a cutting bit 91. Within the enlarged diameter portion 81a, a more or less oblong eccentric weight 83 is mounted on drill shaft or rod 82 for rotation within ball bearing 89 to subject tube portion 81a to the rotating cross-forces. Weight 83 is driven rotatably by a high speed motor 85, shown to be enclosed, said motor may be driven by compressed air or electricity. The cutting bit may be of tool steel or cutting diamonds and has a passage 90 therein which extends through rod 82 into the motor portion. If the motor is air driven, for example, the exhaust air may be fed into passage 90 to supply a rinse means to the cutting surface of the bit. If the motor should be driven by electricity, other passage means may be made available through tube 81a to supply water or air to the aforesaid cutting surface. The entire drilling apparatus may be suspended by a cable through loop 88 and if the motor is driven by air, the air may be supplied through a supply connection 87. Likewise, if the drive is electric, wires may be connected to the motor through a fitting similar to 87.

The advantage resulting from this embodiment are, first, that high speed lightweight motors or drives may be used because the down gearing of reduction in rotation speed of the drill tubing is effected through the rolling process within the soil and, second, that all points on the plane face of bit 91 move at the same speed, resulting in equal wear to all the cutting points. In conventional drilling, the rotational speed at the center of the drill is zero and is considerable along the periphery, resulting in fast wear of the cutting edges located along the outer zones.

The embodiment shown in FIG. 11 may also be used for metals, wood or the like, to countersink or plane. The rolling motion of the hollow tubing 81 and 81a within a drill hole may also be accomplished if the transmission link is flexed elastically or slightly kinked as may be made possible by application of a universal joint, the flexed or kinked portion being rotated rapidly.

Another embodiment of the invention is shown in FIG. 12 in which three eccentric cams 103 are fixed and spaced upon an essentially rigid rotatably driven rod 102 within hollow tubing 101, having a tapered tip 101a. The rotation of the cams cause a bending effect upon the hollow tubing which rolls as it enters the soil and forms the bore hole. In this operation, rod 102 flexes too; this, however, has no importance in the operation and the flexing movement of the aforesaid rod is not shown in the drawing. By means of the rotating deflection, the hollow tubing 101 rolls about the lateral surface of the drill hole and thus, turns slowly also about its own axis. The effect is identical to that caused by the centrifugal force drive through the built-in masses. The forces in this embodiment, however, do not depend on the rotational speed of the drive as the deflection merely depends on the physical dimensions and not on the rotational speed. This device, therefore, permits the use of comparatively low driving speeds.

The principle shown in the device in FIG. 12 may be more directly applied in the embodiment illustrated in FIG. 13 by the insertion of a curved inner rod 112 in the rolling hollow tubing 111, as shown in soil 106, the motor to drive rod 112 not being shown. The curved inner rod 112 flexes the surrounding hollow tubing 111 elastically. The flexing, as shown in FIGS. 12 and 13, is somewhat exaggerated, the true extent of the flexing being that as found possible in typical steel tubing in wells. In this device the hollow tubing may be also curved and if the two curvatures register, the maximum total deflection results; if the rotatably driven inner rod or linkage has

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a curvature opposed to that of the hollow tubing, a straight combination will result and the rolling hollow tubing will then, in rapid succession, become curved and straight, respectively. The elastic deflection likewise rotates but it is, however, larger in the direction of the curvature of the rolling rod than in the direction perpendicular to it. Depending upon a selection of the curvatures of the inner and outer elements and their moduli of inertia, the various effects can be accomplished. It is also possible to use a hollow inner linkage, having flutes on its outer surface, if flushing is desired during the drilling process as is described relative to FIG. 5.

A long train of transmission rods 112, shown in FIG. 16, assembled from a number of such curved elements shown in FIG. 13, will provide a rotating and winding motion and will roll slowly rotating itself about the surrounding soil. The long train of links, formed by drill tubing 11 and 11a and held together by coupling 113, may be provided with helical flutes 114 on the exterior thereof so as to cause its own advance in the direction of the drilling. In horizontal boring, the drilling and rolling links work themselves farther into the to-be-drilled hole thus minimizing or even precluding the application of back pressure. This embodiment excels through its simplicity and the lubrication of the inner transmission within the outer tubing can be readily accomplished by simply periodically forcing the greases or oil through a long aperture in one of the bearing surfaces.

In FIG. 14 there is a modification of the present invention in which the core cutter tubing 126 receives its drive from the ball and socket joint 124 at the cranked lower end of motor driven drill rod 122, said rod being held in a central position in drill tubing 121 by spacer 123. The ball and socket joint 124 does not transmit a torque from drill rod 122 through the shaft of core cutter 126, but it does transmit a conical movement to the axis of the core cutter with respect to the axis of the drill tubing. By this movement, the path of a cone is generated, said cone having its apex in the center of the ball in the joint 124, having its base formed on the roller element 125 at the top of the core cutter tube, and in the same movement, roller 125 effects a circulating movement in the lower part of drill tubing 121. As a result of this, core cutting tube 126, as well as roller block 125, rolls about the walls of the drilled hole and both carry out a slow rotary motion about the longitudinal axis of the drill tubing.

The present invention further permits the placing of the drive means immediately at the point of action and permits the transmission of the energy required for drilling by electrical, compressed air or other fluids by means of cables or hoses, all this also being applicable to horizontal drilling. FIG. 15 illustrates such a modification of the present invention. Within the tubular envelope or drill tubing 131 is a high speed motor 134 arranged to drive an eccentric weight 133, said motor being electrical or fluid driven. Drill tube 131 may be suspended by a hose, tube or cable 141 which is secured to swivel joint 140 so as to permit the rotation of tube 131 with respect to the holding means 141. Eccentric weight 133 is connected to motor 134 by shaft 137 which rotates in ball bearings 138 as does shaft 139 at the other end of said weight. Core tubing 135 is secured to tubing 131 and rotates therewith. The core tubing here is shown for example only and would not be attached for general use. Ordinarily, a pointed drilling tip would be employed, as shown in FIG. 13. By means of the centrifugal force developed through the high speed rotation of eccentric weight 133, the tubular envelope 131 rolls on the surface of the drill hole and rotates slowly about the longitudinal axis. By means of helical flutes 150 provided along the outer surface of the tubular envelope, this automatic boring tool will advance on its own in the direction of the drilling without requiring a backup force and is capable of pulling the hose or cable with it, depending upon whether the

motor is fluid or electrically driven. The cable or hose connection is made through the swiveled head to preclude any undesirable twisting.

The present invention provides a number of advantages in its various embodiments. These include high speed drives with which a great speed reduction can be made and the generation of large torques within the drill hole without the need of rugged transmissions. It further provides drilling means in which it is impossible to jam the drilling tool because of the absence of friction and at the same time obtain a fully protected drill hole. Further, the drilling is possible in a minimum diameter hole from start to finish in sandy soils where the density thereof is increased by means of the continuous vibration which simultaneously causes the repulsion of the surrounding soil. It further provides a method by which dry and damp soil and water may be flushed from the hole equally effectively by air and provides a device in which the employment of a filter is possible along with the actual drilling operation.

Although the various embodiments of this invention differ in some respects, they are all based on the same basic principle, and that is, that the drill linkage in whole or in part, a self-advancing drilling tool, is forced against the surface of the drilled hole as the drill tubing rotates and rolls along said surface.

Although the invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of this invention being limited only by the terms of the appended claims.

I claim:

1. A method for drilling comprising introducing combined protective and drill tubing into the material being drilled, inserting means within said tubing adapted to rotate on the interior surface of said tubing to provide rotating centrifugal forces across the longitudinal axis of said tubing, rotating said means to create said forces, and rotating said tubing in said hole being drilled against the surface thereof.

2. A method for drilling a bore hole comprising introducing combined protective and drill tubing into the material to be drilled, inserting into said drill tubing rotatable eccentric means adapted to roll on the interior surface of said drill tubing, rotating said eccentric means on said interior surface, and rotating said tubing in said hole being drilled against the surface thereof.

3. A method for drilling a bore hole comprising introducing combined protective and drill tubing into the material being drilled, inserting a drill rod longitudinally into said drill tubing positioned adjacent the advance drilling end of said tubing, said rod having enlarged diameter portions spaced longitudinally thereon within said tubing, forcing said enlarged diameter portions into a physical contact with the internal surface of said tubing, rotating said enlarged diameter portions on the said internal surface of said tubing, and rotating said tubing in said hole being drilled against the surface thereof.

4. A method for drilling a bore hole comprising introducing into the material being drilled combined protec-

tive and drill tubing of a paramagnetic material, inserting into said drill tubing a drill rod longitudinally positioned adjacent the advance end of said drill tubing, said drill rod having enlarged diameter disks spaced longitudinally on said drill rod within said tubing, forcing said disks into contact with the internal surface of said drill tubing with magnetic means, rotating said disks on the internal surface of said drill tubing around the axis of said drill tubing, and rotating said drill tubing in the hole being drilled against the surface thereof.

5. A method according to claim 4 in which said drill tubing has slotted portions extending through its lower end and in which the slotted portions are covered by a compressed helical spring surrounding said drill tubing, including the step of releasing said spring from its compressed position so that it will form a filter externally of said slots.

6. A method for drilling a bore hole comprising introducing into the material to be drilled combined protective and drill tubing, inserting a drill rod into said drill tubing, said rod having disks longitudinally spaced thereon within said tubing, eccentric weights secured on said rod between said disks, rotating said rod and weights so as to force said disks to rotate on the internal surface of said drill tubing, and rotating said drill tubing against the surface of the hole being drilled.

7. A method for drilling a bore hole comprising introducing into the material to be drilled combined protective and drill tubing, inserting into said drill tubing a cylindrical core, inserting a drill rod into said core, said rod being eccentric within said core, rotating said rod and said core so as to force said core to rotate on the internal surface of said drill tubing, and rotating said drill tubing against the surface of the whole being drilled.

8. A method for drilling a bore hole comprising introducing protective and drill tubing into the material in which the whole is to be drilled, inserting a drill rod into said drill tubing in a position adjacent the drilling end of said drill tubing, said rod having eccentric cams secured and spaced thereon, rotating said rod and said cams so as to cause a bending effect in said drill tubing, and rotating said drill tubing against the surface of the hole being drilled.

9. A method for drilling a bore hole comprising introducing protective and drill tubing into the material to be drilled, rotating a curved substantially cylindrical rod against the internal surface of said tubing, said rod being in slip fit within said tubing, and rotating said drill tubing against the surface of the hole being drilled.

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