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(54) **IMPROVEMENTS IN OR RELATING TO METHODS AND APPARATUS FOR USE IN FORMING PILES**

VERBESSERUNGEN AN ODER IM ZUSAMMENHANG MIT VERFAHREN UND VORRICHTUNGEN ZUR HERSTELLUNG VON PFÄHLEN

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Description

[0001] The present invention relates to methods and apparatus for use in forming piles (see for example document US-A-5219246).

[0002] Various techniques have been proposed for forming piles in the ground for use in supporting buildings or other structures. Preformed piles may be driven into the ground by hammering or vibration. Alternatively, piles may be formed in situ by introducing a settable material into a cavity formed in the ground. These techniques may present various drawbacks when used in particular ground conditions, or when piles are closely spaced, or for various other reasons. For example, excessive disturbance of the surrounding ground may lead to problems such as heave.

[0003] Examples of the present invention provide pile forming apparatus comprising:

an auger;
a hollow member which is open-ended and which has one or more external projections which form at least one helical flight;
wherein, in use, the auger is positioned within the hollow member to extend through the mouth of the hollow member,
the auger and the hollow member each being rotatable, during use, to cause the auger to draw spoil into the hollow member and to cause the hollow member to advance into the ground by engagement of the helical flight with the surrounding ground.

[0004] The hollow member may be cylindrical. The hollow member may comprise a hollow tube, the or each external projection being formed at the outer surface of the tube. The or each helical flight may be coaxial with the tube. The or each helical flight may be continuous. The or each helical flight may be discontinuous.

[0005] The auger and the hollow member may be rotatable, in use, about a common axis. The auger may have a flight of either hand relative to the helical flight of the hollow member. The auger may be axially movable relative to the hollow member to vary the length of projection of the auger beyond the mouth of the hollow member.

[0006] The auger may have a hollow stem for introduction of settable material into the ground as the auger withdraws.

[0007] The apparatus may further comprise independent rotary drive arrangements for the hollow member and for the auger. The drive arrangements may be operable to change the relative speeds of rotation of the auger and the hollow member. The auger may be removable from hollow member.

[0008] Examples of the present invention also provide a method of forming a pile, in which:

pile forming apparatus as defined above is used to penetrate the ground by:

rotating the hollow member to draw the hollow member into the ground by engagement of the helical flight or flights and the surrounding ground, and
rotating the auger to remove spoil from ahead of the hollow member.

[0009] The rotation speed of the auger relative to the hollow member may be sufficient to prevent heave or overcompaction of soil arising from compaction of the ground by the advancing hollow member. The auger may be retracted into the hollow member, the rotation of the hollow member then being reversed to withdraw the hollow member. Settable material may be introduced into the void left by the withdrawing hollow member. The auger may have a hollow stem for introduction of settable material into the ground as the auger withdraws.

[0010] Examples of the present invention further provide a pile formed by the method set out above.

[0011] Examples of the present invention will now be described in more detail, by way of example only, and with reference to the accompanying drawings, in which:

Fig 1 is a perspective view illustrating pile forming apparatus according to one example of the present invention; and

Figs 2 to 7 are highly diagrammatic illustrations of the apparatus of Fig 1 being used for forming a ground pile.

Overview of the apparatus

[0012] Fig 1 shows pile forming apparatus 10 comprising an auger 12 and a two-part hollow member indicated generally at 14. The hollow member 14 is open-ended at 16 and has an external projection 18 which forms a helical flight around the hollow member 14. In use, as shown, the auger 12 is positioned within the hollow member 14, to extend through the mouth 16 of the hollow member 14. The auger 12 and the hollow member 14, are each rotatable. The auger 12 and the hollow member 14, are also rotatable relative to each other, during use. In use, the auger 12 draws spoil into the hollow member 14, and the hollow member 14 advances into the ground by engagement of the helical flight 18 with the surrounding ground, as will be described.

Auger

[0013] In more detail, the auger 12 has a central shaft 20, which is hollow in this example. The auger 12 has a rotation axis 22, indicated by broken lines in Fig 1. The central shaft 20 carries a helical flight 24, which terminates at a leading edge 26. The hollow central shaft 20 is open at the end illustrated. Fluent material such as

concrete, screed or other cementitious material can be introduced into the central shaft 20 at (or above) ground level, to flow down the shaft 20 and out through the mouth 27. The open mouth 27 can be capped.

[0014] In use, rotation of the auger 12 can be used to break up the ground. The leading edge 26 breaks up the ground material, which can then be drawn into the hollow member by engagement with the helical flight 24.

Hollow member

[0015] The hollow member 14 includes a hollow tube 28 forming a terminal part of the hollow member 14, and carrying the helical flight 18. In this example, the hollow tube 28 is a circular cylinder of slightly greater size than hollow member 14 to reduce friction on hollow member 14. The hollow tube 28 may be formed, for example, from a length of pipe of suitable dimensions. The tube 28 finishes at the mouth 16. During use, the tube 28 will be oriented with a generally vertical axis, with the mouth 16 at the lowermost end of the tube 28.

[0016] The hollow member 14 also includes a hollow tube 30. The tube 30 is much longer than the tube 28 and carries no external flight in this example. The tube 30 is a circular cylinder of similar diameter to the tube 28. The tube 30 may be formed, for example, from a length of pipe of suitable dimensions.

[0017] The tube 28 is secured to the tube 30 to align the tubes 28, 30 coaxially.

[0018] In the example illustrated, the external helical flight 18 is provided by a helical projection around the outer surface of the tube 28. The helical flight 18 is coaxial with the cylindrical tube 28. The helical flight 18 is continuous in this example, but may alternatively be discontinuous. A single helical flight 18 is illustrated in this example, but there may be more than one helical flight formed around the outer surface of the tube 28. The illustrated helical flight 18 extends around slightly more than one turn of the helix, but could extend around further turns.

[0019] The tube 28 is illustrated as being quite short (only a few pitch lengths of the helical flight 24 of the auger 12). The tube 30 is likely to be much longer than the tube 28, so that the hollow member 14 is also much longer than the tube 28. Desirably, the auger 12 and the hollow member 14 are both sufficiently long to penetrate the ground to the depth required for the pile which is being constructed, leaving sufficient length above ground for the auger 12 and the tube 14 to be engaged by driving apparatus, as will be described.

Auger and hollow member in combination

[0020] When the auger 12 and the hollow member 14 are being used, the auger 12 is positioned within the hollow member 14, as illustrated in Fig 1. The tubes 28, 30 fit around the auger 12 like a sleeve. That is, the outer diameter of the helical flight 24 is no greater than the internal diameter of the tubes 28, 30. This allows the auger 12 to turn within the tubes 28, 30. The auger 12 and the tubes 28, 30 are coaxial at the axis 22. In Fig 1, the auger 12 is shown extending through the mouth 16 of the tube 28. It can be seen from Fig 1 that in this example, the helical flight 24 of the auger 12 is opposite-handed relative to the helical flight 18 of the hollow member 14. That is, one of the flights 18, 24 will be a left-handed helix; the other of the flights 18, 24 will be a right-handed helix. The flights 18, 24 could be of the same hand.

[0021] When the apparatus is in use, as will be described, the auger 12 and the hollow member 14 are separately driven for rotation. For example, a double rotary head pile driving rig may be used, providing one rotary head for driving the auger 12, and another rotary head for driving the hollow member 14. The auger 12 is free to turn within the tubes 28, 30, as noted above. Providing independent rotary drive to the auger 12 and to the hollow member 14 allows each of the auger 12 and the hollow member 14, to be rotated and also allows relative rotation between the auger 12 and the hollow member 14, by providing different rotation speeds or directions.

[0022] The drive arrangements for the auger 12 and the hollow member 14, preferably also allow for relative axial movement of the auger 12 within the tubes 28, 30, so that the length of the auger 12 projecting through the mouth 16 can be controlled, or the tip of the auger 12 can be retracted into the tube 28.

Method of use

[0023] The apparatus described above and illustrated in Fig 1 can be used in the formation of ground piles in the manner illustrated in the remaining drawings. These remaining drawings are highly diagrammatic in the interests of clarity.

[0024] Fig 2 illustrates the initial condition. The tubular member 14 has been positioned above the ground 31 at the required position for the pile to be formed, and with the axis 22 substantially vertical. The auger 12 is positioned within the tubes 28, 30 and thus also has a substantially vertical rotation axis 22. The auger 12 is coupled to a suitable rotary drive head 32. The hollow member 14 is coupled to a suitable rotary drive head 34. The mouth 27 of the auger 12 is capped at 35.

[0025] The head 32 now begins to turn the auger 12, and to advance it down into engagement with the ground 31. The auger 12 begins to penetrate down into the ground 31.

[0026] Once the auger 12 has advanced by a suitable distance through the mouth 16, which may be up to 2m, for example, the head 34 begins to turn the hollow member 14, and to advance it down into engagement with the ground 31. As the hollow member 14 turns, the helical flight 18 engages the ground 31 and pulls the hollow member 14, down into the ground 31 in an action reminiscent of a screw thread engaging a workpiece. This is in contrast with the action of the auger 12, which is an

auger action causing material of the ground 31 to be disturbed, broken up and then pulled by the auger action up into the hollow member 14. Thus, the hollow member 14 draws itself into the ground by engagement of the helical flight 18 with the surrounding ground, whereas the auger 12 draws spoil from ahead of the hollow member 14 up into the hollow member 14, by virtue of the rotation of the auger 12 and the projection of the auger 12 through the mouth 16. Fig. 3 illustrates the position after some spoil has been drawn up into the hollow member 14, above ground level. This spoil is indicated by shading within the hollow member 14.

[0027] The operation continues with the auger 12 drawing spoil 36 into the hollow member 14, and the hollow member 14 advancing down into the ground 31 by the screw action just described, until the position is reached in which the hollow member 14 has reached the required depth for the pile being formed. This is illustrated in Fig 4. At this point, the helical flight 18 will have cut into the surrounding ground 31, which may cause some compression of the ground 31. However, spoil will have been drawn into the tubes 28, 30 by operation of the auger 12, which relieves the pressure created in the ground by the hollow member 14. Thus, compaction which may occur around the hollow member 14 is reduced and controlled by the auger operation, as will be described below.

[0028] When the stage of Fig. 4 has been reached, the auger 12 is retracted into the hollow member 14. The rotation of the hollow member 14 is then reversed to withdraw the hollow member (similar to the manner in which a screw is unscrewed from a workpiece). As the hollow member 14, and the auger 12 are simultaneously withdrawn, a settable material such as concrete, screed or other cementitious material is pumped down through the hollow shaft 20 of the auger. Initially, this creates a body of concrete under pressure below the auger 12, having flowed out through the mouth 27. The cap 35 is forced off the mouth 27 and left in the ground. Concrete 40 can flow out through the mouth 27 into the void below the withdrawing members 12, 14 including the helical void left by the flight 18. Any spoil within the hollow member 14, is held by the auger 12 and thus withdrawn with it. Eventually, the position of Fig 5 is reached, in which the hollow member 14 and the auger 12 have been withdrawn to the surface, and settable material to form a pile 42 has been left in the ground, having a central portion which corresponds in size with the tube 28, and a helical flight 44 around the pile 42, providing additional grip with the ground 31.

[0029] A reinforcing cage 45 can then be introduced into the concrete 40 before it sets (Fig. 6).

[0030] Finally, any spoil 36 carried away as the hollow member 14 withdraws can be discharged from the hollow member 14 at ground level by back screwing the auger 12 within the hollow member 14 (Fig. 7) leaving a pile of spoil 36 at the surface for spreading over the surface, or for removal.

Additional comments and explanation

[0031] The penetration of the hollow member 14, including the helical flight 18, into the ground 31 can create compaction of the ground around the hollow member, as noted above. In the absence of the action of the auger 12, significant compaction would arise from the need to displace ground material which originally occupied the volume of the helical flight 18 and tubes 28, 30. The volume occupied by the tubes 28, 30 is significantly greater than the volume of the helical flight 18, as can readily be understood from Fig 1. This compaction could be considerable, particularly to accommodate the tubes 28, 30, creating the potential risk of heave at the ground surface, indicated in Fig 6 by broken arrows 46. In particular, heave 46 could be created if two or more piles 42 were formed close together, in the absence of the expected benefits arising from the use of the auger 12. Alternatively, or in addition, the ground may be compacted or densified by the penetration of the hollow member 14, to such an extent as to prevent further penetration by the hollow member 14.

[0032] In the examples described, the amount of compaction which occurs in the ground 31 can be controlled by the operation of the auger 12. If the auger 12 is used in the manner described, some ground material can be withdrawn into the hollow member 14, using the auger action of the auger 12, thus reducing the degree of compaction required in the surrounding ground 31. For example, the whole of the material corresponding with the volume of the tubes 28, 30 could be drawn into the hollow member 14, by the auger 12, so that the only ground compaction required is to accommodate the helical flight 18. Alternatively, if the auger 12 is not used at all, the whole of the volume of the tubes 28, 30 must be accommodated by compaction of the surrounding ground 31. In many practical situations, it may be desirable to withdraw some ground material by using the auger 12, but it may not be necessary to withdraw all of the ground material corresponding with the volume of the tubes 28, 30. This will depend on the nature of the ground. The amount of ground material withdrawn by the auger will depend on the rotation speeds and relative rotation speeds of the auger 12 and the hollow member 14, as they advance into the ground.

[0033] Consequently, the degree of compaction created within the ground 31 can be controlled by controlling the amount of material withdrawn by the auger 12. It is desirable not to create unnecessary spoil at the surface (which may need to be transported away for disposal), but it is also desirable not to create so much compaction that the hollow member 14 cannot penetrate the ground, or there is a risk of creating heave 46. Accordingly, a compromise is likely to be required, in which the minimum amount of spoil is withdrawn in order to achieve a required pile performance without creating heave or too much compaction.

[0034] Withdrawing spoil by means of the auger 12

may also assist in ground conditions which are initially very hard (incompressible), loosening the ground to allow penetration of the helical flight 18 and hollow member 14. If dense, incompressible material (such as sand) is encountered by the flight 18 and hollow member 14, further penetration may be prevented due to being unable to sufficiently compress the ground to accommodate the volume of the flight 18 and hollow member 14.

[0035] However, the auger 12 can be used to break up and/or remove some of the hard ground material, thus reducing the amount of compaction required for the helical flight 18 and hollow member 14 to advance further. The auger 12 can be provided with a cutting edge or other arrangement to allow the auger 12 to break and remove rock, debris or other obstacles.

Concluding comments

[0036] Many variations and modifications can be made to the apparatus described above, without departing from the scope of the present invention.

[0037] In particular, many different shapes, sizes, relative shapes and relative sizes of components could be used. Alternative arrangements for turning and advancing the auger 12 and the hollow member 14 could be envisaged. The auger 12 has been described as having a hollow stem to allow for concrete material to be introduced. Alternatively, a solid stem could be used, if an alternative arrangement is provided for concrete to flow, such as a passage through the body of the hollow member 14.

[0038] Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

Claims

1. Pile forming apparatus (10) comprising:

an auger (12);
a hollow member (14) which is open-ended (16) and which has one or more external projections (18) which form at least one helical flight;
wherein, in use, the auger (12) is positioned within the hollow member (14) to extend through the mouth of the hollow member,
the auger (12) and the hollow member (14) each being rotatable, during use, to cause the auger to draw spoil into the hollow member and to cause the hollow member to advance into the ground by engagement of the helical flight (18) with the surrounding ground (31).

2. Apparatus according to claim 1, wherein the hollow member is cylindrical.

3. Apparatus according to claim 1 or 2, wherein the hollow member comprises a hollow tube, the or each external projection being formed at the outer surface of the tube.

4. Apparatus according to claim 3, wherein the or each helical flight is coaxial with the tube.

5. Apparatus according to any preceding claim, wherein the or each helical flight is continuous.

6. Apparatus according to any of claims 1 to 4, wherein the or each helical flight is discontinuous.

7. Apparatus according to any preceding claim, wherein the auger and the hollow member are rotatable, in use, about a common axis.

8. Apparatus according to any preceding claim, wherein the auger has a flight of the same hand as the helical flight of the hollow member.

9. Apparatus according to any of claims 1 to 7, wherein the auger has a flight of the opposite hand to the helical flight of the hollow member.

10. Apparatus according to any preceding claim, wherein the auger is axially movable relative to the hollow member to vary the length of projection of the auger beyond the mouth of the hollow member.

11. Apparatus according to any preceding claim, wherein the auger has a hollow stem for introduction of settable material into the ground as the auger withdraws.

12. Apparatus according to any preceding claim, further comprising independent rotary drive arrangements for the hollow member and for the auger.

13. Apparatus according to claim 12, wherein the drive arrangements are operable to change the relative speeds of rotation of the auger and the hollow member.

14. Apparatus according to any preceding claim, wherein the auger is removable from hollow member.

15. A method of forming a pile, in which:

pile forming apparatus as defined in any of claims 1 to 14 is used to penetrate the ground by:

rotating the hollow member to draw the hollow member into the ground by engagement

of the helical flight or flights and the surrounding ground, and
rotating the auger to remove spoil from ahead of the hollow member.

16. A method according to claim 15, wherein the rotation speed of the auger relative to the hollow member is sufficient to prevent heave or overcompaction of soil arising from compaction of the ground by the advancing hollow member.

17. A method according to claim 15 or 16, wherein the auger is retracted into the hollow member, the rotation of the hollow member then being reversed to withdraw the hollow member.

18. A method according to claim 17, wherein settable material is introduced into the void left by the withdrawing hollow member.

19. A method according to claim 18, wherein the auger has a hollow stem for introduction of settable material into the ground as the auger withdraws.

20. A pile formed by the method of any of claims 15 to 19.

Patentansprüche

1. Pfahl-bildendes Gerät (10) umfassend:

einen Bohrer (12);
ein hohles Glied (14), das ein offenes Ende (16) aufweist und das einen oder mehrere externe Vorsprünge (18) aufweist, die wenigstens einen spiralförmigen Schraubengang bilden;
wobei der Bohrer (12) in Verwendung in dem hohlen Glied (14) positioniert ist, um sich durch den Mund des hohlen Glieds zu erstrecken,
wobei der Bohrer (12) und das hohle Glied (14) während der Verwendung jeweils rotierbar sind, um zu bewirken, dass der Bohrer Aushub in das hohle Glied zieht und um zu bewirken, dass das hohle Glied in den Boden vorrückt, durch Eingriff des spiralförmigen Schraubengangs (18) mit dem umliegenden Boden (31).

2. Gerät nach Anspruch 1, wobei das hohle Glied zylindrisch ist.

3. Gerät nach Anspruch 1 oder 2, wobei das hohle Glied ein hohles Rohr umfasst, wobei der oder jeder externe Vorsprung an der äußeren Oberfläche des Rohrs gebildet ist.

4. Gerät nach Anspruch 3, wobei der oder jeder spiralförmige Schraubengang koaxial mit dem Rohr ist.

5. Gerät nach einem voranstehenden Anspruch, wobei der oder jeder spiralförmige Schraubengang kontinuierlich ist.

6. Gerät nach einem der Ansprüche 1 bis 4, wobei der oder jeder spiralförmige Schraubengang diskontinuierlich ist.

7. Gerät nach einem voranstehenden Anspruch, wobei der Bohrer und das hohle Glied in Verwendung um eine gemeinsame Achse rotierbar sind.

8. Gerät nach einem voranstehenden Anspruch, wobei der Bohrer einen Schraubengang mit derselben Drehrichtung wie der spiralförmige Schraubengang des hohlen Glieds aufweist.

9. Gerät nach einem der Ansprüche 1 bis 7, wobei der Bohrer einen Schraubengang mit entgegengesetzter Drehrichtung zu dem spiralförmigen Schraubengang des hohlen Glieds aufweist.

10. Gerät nach einem voranstehenden Anspruch, wobei der Bohrer relativ zu dem hohlen Glied axial bewegbar ist, um die Vorsprungslänge des Bohrers jenseits des Munds des Hohlglieds zu variieren.

11. Gerät nach einem voranstehenden Anspruch, wobei der Bohrer einen hohlen Schaft aufweist, um verfestigbares Material in den Boden einzuführen, wenn der Bohrer zurückgezogen wird.

12. Gerät nach einem voranstehenden Anspruch, ferner umfassend unabhängige Drehantriebsanordnungen für das hohle Glied und den Bohrer.

13. Gerät nach Anspruch 12, wobei die Antriebsanordnungen betreibbar sind, die relativen Drehzahlen des Bohrers und des hohlen Glieds zu ändern.

14. Gerät nach einem voranstehenden Anspruch, wobei der Bohrer von dem hohlen Glied abnehmbar ist.

15. Verfahren zum Bilden eines Pfahls, wobei:

ein Pfahl-bildendes Gerät gemäß einem der Ansprüche 1 bis 14 verwendet wird, um den Boden zu penetrieren, durch:

Rotieren des hohlen Glieds, um das hohle Glied durch Eingriff des spiralförmigen Schraubengangs oder Schraubengänge mit dem umliegenden Boden in den Boden zu ziehen, und
Rotieren des Bohrers, um Aushub vor dem hohlen Glied zu entfernen.

16. Verfahren gemäß Anspruch 15, wobei die Drehzahl

des Bohrers relativ zu dem hohlen Glied ausreichend ist, um eine Hebung oder ein Überverdichten von Aushub zu verhindern, verursacht durch eine Verdichtung des Bodens durch das vorrückende hohle Glied.

17. Verfahren nach Anspruch 15 oder 16, wobei der Bohrer in das hohle Glied eingezogen wird, wobei die Rotation des hohlen Glieds dann umgekehrt wird, um das hohle Glied zurückzuziehen.

18. Verfahren nach Anspruch 17, wobei verfestigbares Material in den Hohlraum eingeführt wird, der durch das Zurückziehen des hohlen Glieds zurückgelassen wird.

19. Verfahren nach Anspruch 18, wobei der Bohrer einen hohlen Schaft aufweist, um verfestigbares Material in den Boden einzuführen, wenn der Bohrer zurückgezogen wird.

20. Pfahl gebildet durch das Verfahren nach einem der Ansprüche 15 bis 19.

Revendications

1. Appareil de formation de pieux (10), comprenant :

une tarière (12) ;
un élément creux (14) qui est ouvert à une extrémité (16) et qui présente une ou plusieurs saillies externes (18) qui forment au moins un pas hélicoïdal ;
dans lequel, en cours d'utilisation, la tarière (12) est positionnée à l'intérieur de l'élément creux (14) pour s'étendre au travers de l'embouchure de l'élément creux,
la tarière (12) et l'élément creux (14), pouvant chacun être mis en rotation, en cours d'utilisation, pour permettre à la tarière d'extraire du déblai dans l'élément creux et pour permettre à l'élément creux d'avancer dans le sol par une mise en prise du pas hélicoïdal (18) avec le sol environnant (31).

2. Appareil selon la revendication 1, dans lequel l'élément creux est cylindrique.

3. Appareil selon la revendication 1 ou 2, dans lequel l'élément creux comprend un tube creux, la saillie ou chaque saillie extérieure étant formée au niveau de la surface externe du tube.

4. Dispositif selon la revendication 3, dans lequel le pas ou chaque pas hélicoïdal est coaxial avec le tube.

5. Appareil selon l'une quelconque des revendications précédentes, dans lequel le pas ou chaque pas hélicoïdal est continu.

6. Appareil selon l'une quelconque des revendications 1 à 4, dans lequel le pas ou chaque pas hélicoïdal est discontinu.

7. Appareil selon l'une quelconque des revendications précédentes, dans lequel la tarière et l'élément creux peuvent être mis en rotation, en cours d'utilisation, autour d'un axe commun.

8. Appareil selon l'une quelconque des revendications précédentes, dans lequel la tarière présente un pas de même sens que le pas hélicoïdal de l'élément creux.

9. Appareil selon l'une quelconque des revendications 1 à 7, dans lequel la tarière présente un pas du sens opposé à celui du pas hélicoïdal de l'élément creux.

10. Appareil selon l'une quelconque des revendications précédentes, dans lequel la tarière est mobile axialement par rapport à l'élément creux pour faire varier la longueur de la saillie de la tarière au-delà de l'embouchure de l'élément creux.

11. Appareil selon l'une quelconque des revendications précédentes, dans lequel la tarière présente une tige creuse pour l'introduction de matériau durcissable dans le sol lorsque la tarière se retire.

12. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre des dispositifs d'entraînement en rotation indépendants pour l'élément creux et pour la tarière.

13. Appareil selon la revendication 12, dans lequel les dispositifs d'entraînement peuvent être actionnés afin de modifier les vitesses relatives de rotation de la tarière et de l'élément creux.

14. Appareil selon l'une quelconque des revendications précédentes, dans lequel la tarière peut être retirée du corps creux.

15. Procédé de formation d'un pieu, dans lequel :

un appareil de formation de pieu selon l'une quelconque des revendications 1 à 14 est utilisé pour pénétrer dans le sol au moyen des étapes consistant à :

mettre en rotation l'élément creux pour tirer l'élément creux dans le sol par la mise en prise du pas ou des pas hélicoïdaux avec le sol environnant, et
mettre en rotation la tarière pour extraire les

déblais de l'avant de l'élément creux.

16. Procédé selon la revendication 15, dans lequel la vitesse de rotation de la tarière par rapport à l'élément creux est suffisante pour empêcher le soulèvement ou le surcompactage du sol résultant du compactage du sol par l'avancée de l'organe creux.

17. Procédé selon la revendication 15 ou 16, dans lequel la tarière est rétractée dans le corps creux, la rotation de l'élément creux étant alors inversée pour retirer l'élément creux.

18. Procédé selon la revendication 17, dans lequel du matériau durcissable est introduit dans le vide laissé par le retrait de l'élément creux.

19. Procédé selon la revendication 18, dans lequel la tarière présente une tige creuse pour l'introduction de matériau durcissable dans le sol lorsque la tarière se retire.

20. Pieu formée par le procédé selon l'une quelconque des revendications 15 à 19.

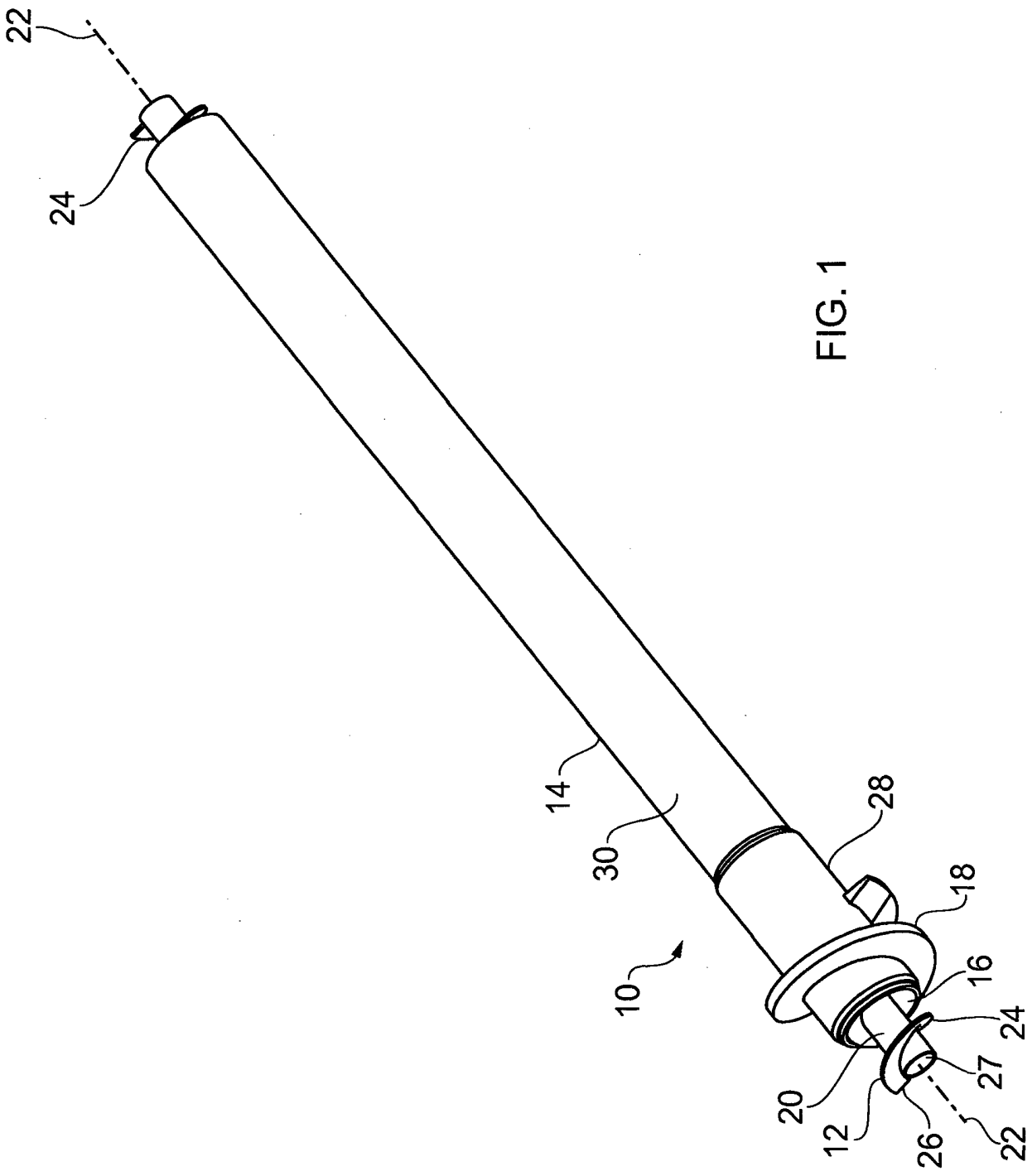


FIG. 1

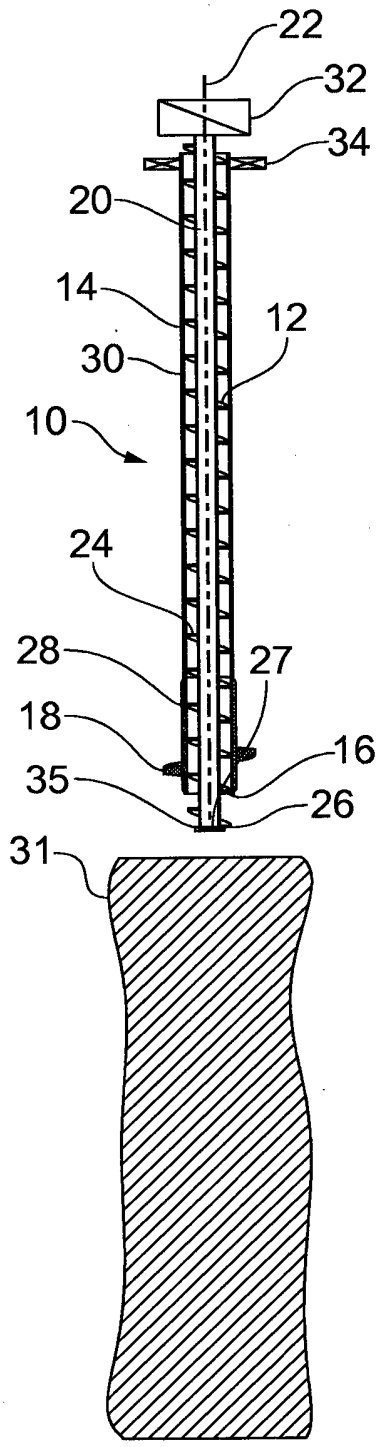


FIG. 2

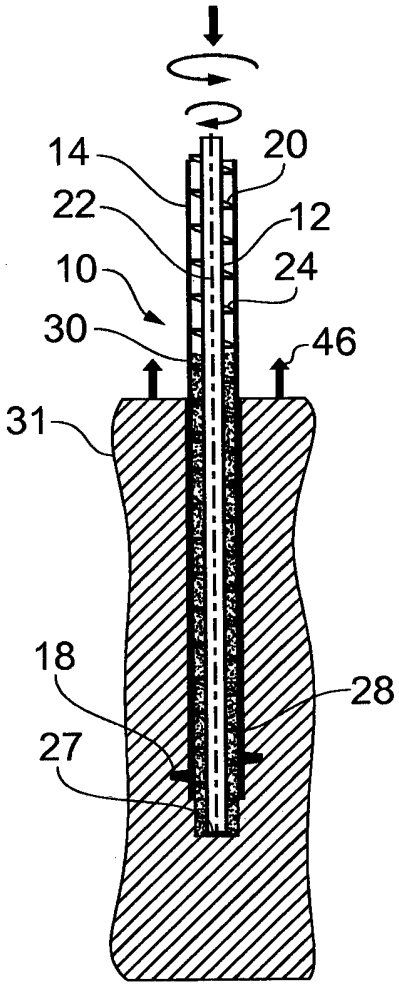


FIG. 3

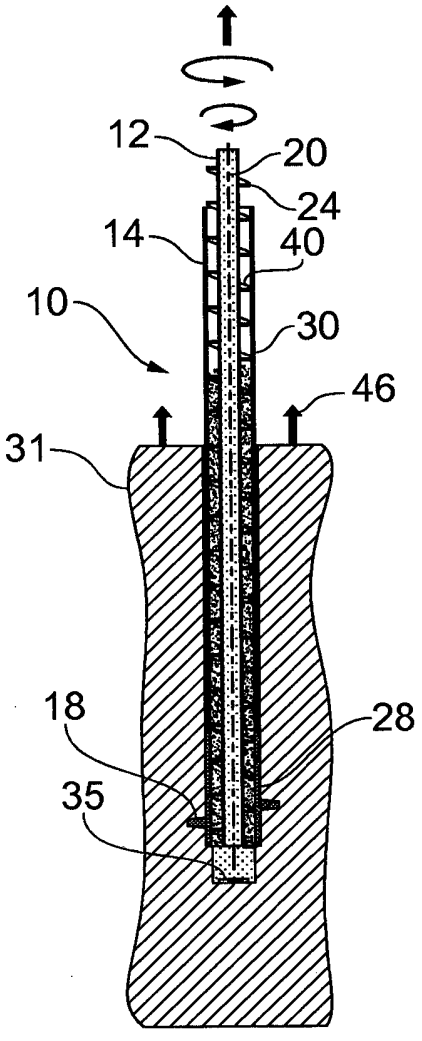


FIG. 4

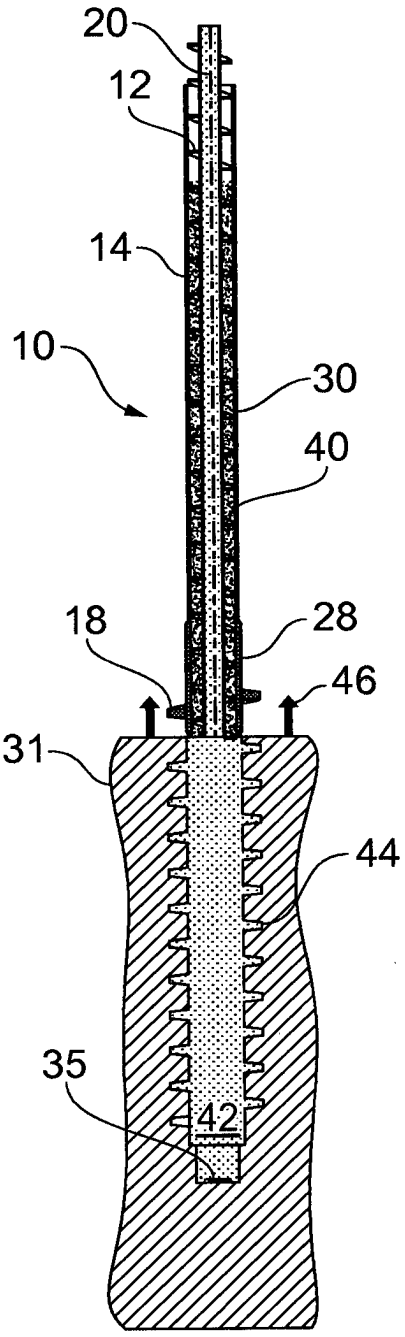


FIG. 5

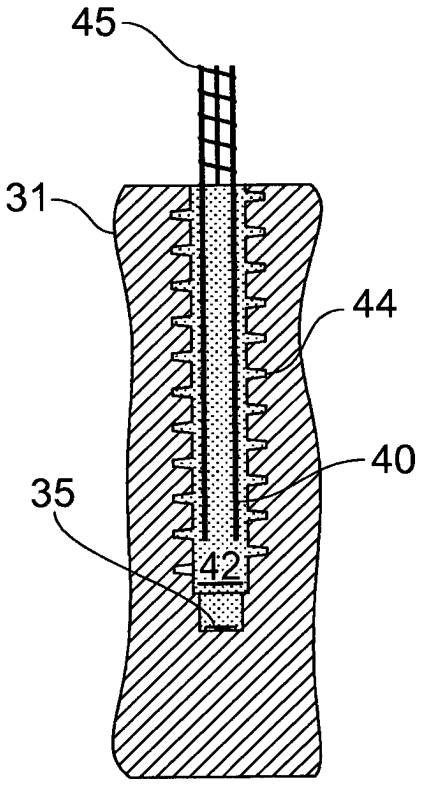


FIG. 6

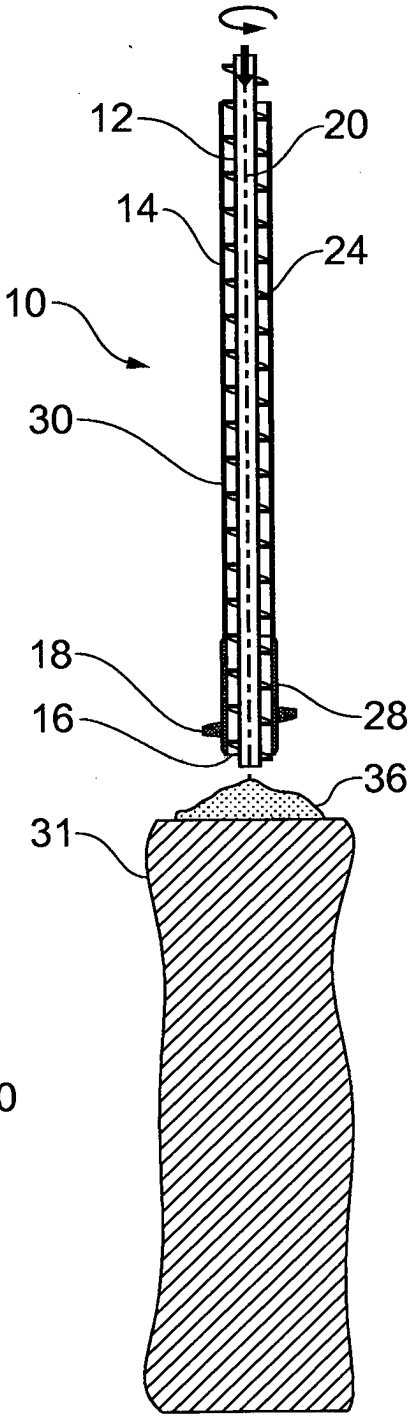


FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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