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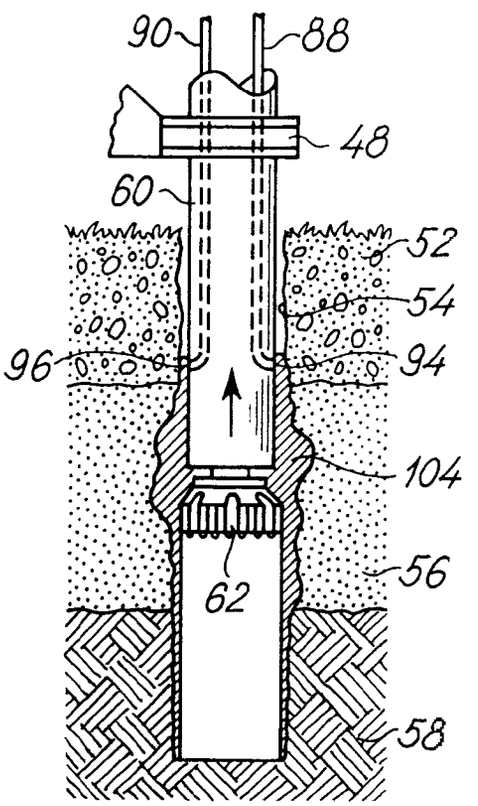
(54) A method of producing a concrete encasing in the ground, an apparatus for producing a concrete encasing within a hole in the ground, and a concrete encasing provided within a hole in the ground

(57) A method of producing a concrete encasing in the ground, comprising: providing a hole in the ground which defines a proximal end and a distal end, and providing a casing (60) having an outer casing wall of a configuration allowing the casing to be moved within the hole in the longitudinal direction thereof from the distal end to the proximal end, and including a set of nozzles (94,96) positioned at one end of the outer casing wall for the expelling of liquid or pasty concrete material. The casing includes conductor means (88,90) for the supply of the liquid or pasty concrete material to the set of nozzles (94,96) from a source supplying the liquid or pasty concrete material. Positioning the casing at the distal end of the hole so as to position said one end of the outer casing wall facing towards the proximal end of the hole. Supplying the liquid or pasty concrete material to the set of nozzles and expelling the liquid or pasty substance therefrom for filling out the cavity (104) defined between the outer casing wall of the casing and the inner wall of the hole. Moving the casing from the distal end of the hole towards the proximal end of the hole while expelling the liquid or pasty concrete material from the set of nozzles, thereby in situ casting the concrete encasing constituting a continuous concrete encasing and supporting the concrete encasing by the outer casing wall of the casing until the concrete encasing has solidified to a self-supporting structure.

Fig. 3b



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Description

In numerous instances, a concrete encasing is to be produced within a hole in the ground, e.g. for supporting a structural element, such as a pier. Thus, the concrete encasing may constitute a supporting encasing to which the pier is fixated. Alternatively, the concrete encasing may constitute a circumferential wall within the hole, such as a wall within a tunnel, a sewer, a drain pipe, an underground gas line or an underground oil pipe, etc.

In producing an adequate support for e.g. a road, a bridge, a building, such as a skyscraper, etc., supporting piers have often been used. Also within the railroad building area, pylons have in numerous instances been supported by means of piers. Common to the prior art technique, the concrete encasing to which the pier is fixated for supporting the pier, is constituted by a pre-cast concrete encasing, or alternatively a steel encasing which is introduced into the hole produced in the ground, e.g. by boring or pile-driving. After the introduction of the concrete encasing into the bore, the pier is introduced into the through-going central aperture of the concrete encasing and fixated relative thereto by means of e.g. liquid or pasty concrete which is forced into the interspace defined between the outer wall of the pier and the inner wall of the pre-cast concrete encasing. In producing sewers or similar substantially horizontal pipes, also including tunnels, etc., the hole is initially produced, whereupon pre-cast semi-circular or circular elements are fixated relative to one another for supporting the ground and for producing the inner wall of the pipe or tunnel. The elements are often fixated relative to one another by means of elaborated bolt assemblies which require skill and increase the complexity of the entire structure.

Within the field of renovating sewers, the so-called INSITUFORM® technique has been known for approximately 2 decades and has proven highly advantageous and successful for providing a simple and durable inner covering of the existing brick wall or cast sewer wall. Still, the INSITUFORM® technique, however, has not till now been developed for producing structures, i.e. into a technique rendering it possible to produce a wall within a hole or a bore produced in the ground.

It is an object of the present invention to produce a novel technique rendering it possible to produce a more simple concrete encasing in a hole in the ground.

It is a feature of the present invention that a concrete encasing may be produced in accordance with the techniques of the present invention eliminating any pre-casting procedures and also rendering it possible to produce the concrete encasing in a single casting operation on the actual site or on location.

It is an advantage of the present invention that the technique of producing concrete encasings in holes in the ground may be carried out irrespective of the orientation of the hole, meaning that the concrete encasing may be produced irrespective of whether or not the hole is vertical or horizontal or defines an orientation of any arbitrary sloping direction relative to the vertical or horizontal direction.

The above object, the above feature and the above advantage together with numerous other objects, features and advantages which will be evident from the below detailed description of the present invention are in accordance with a first aspect of the present invention obtained by a method of producing a concrete encasing in the ground, comprising:

i) providing a hole in the ground, said hole defining a longitudinal and a transversal direction, and said hole defining a proximal end and a distal end,

ii) providing a casing having an outer casing wall of a configuration allowing said casing to be moved within said hole in said longitudinal direction thereof from said distal end to said proximal end, said outer casing wall defining a first end and a second end, and said casing including a set of nozzles positioned at said second end of said outer casing wall for the expelling of liquid or pasty concrete material, and said casing including conductor means for the supply of said liquid or pasty concrete material to said set of nozzles from a source supplying said liquid or pasty concrete material,

iii) positioning said casing at said distal end of said hole so as to position said first end of said outer casing wall juxtaposed said distal end and so as to position said second end of said outer casing wall facing towards said proximal end of said hole,

iv) supplying said liquid or pasty concrete material to said set of nozzles through said conductor means for expelling said liquid or pasty substance therefrom for filling out the cavity defined between said outer casing wall of said casing and the inner wall of said hole, and

v) moving said casing from said distal end of said hole towards said proximal end of said hole while expelling said liquid or pasty concrete material from said set of nozzles, thereby in situ casting said concrete encasing constituting a continuous concrete encasing and supporting said concrete encasing by said outer casing wall of said casing until said concrete encasing has solidified to a self-supporting structure.

According to the method according to the first aspect of the present invention, the concrete encasing is in situ cast as the concrete encasing is produced in the hole in the ground by means of the casing which is moved longitudinally through the hole in the ground from the distal end to the proximal end of the hole and at the

same time expelling the liquid or pasty concrete material from the set of nozzles of the casing. Dependent on the actual application, the casing characteristic of the present invention may have any appropriate cross-sectional configuration, such as a quadratic or rectangular, an elliptic, a circular, etc. configuration, or any combination of the above configurations.

Dependent on the implementation of the method of the present invention and the site of producing the concrete encasing, the casing may be moved continuously from the distal end to the proximal end as the liquid or pasty concrete material is expelled continuously or intermittently from the nozzles, or alternatively, the casing may be moved intermittently from the distal end to the proximal end, as the liquid or pasty concrete material is expelled continuously or intermittently from the nozzles.

The orientation of the hole, i.e. the longitudinal direction defined by the hole may as stated above constitute a vertical or substantially vertical direction, a horizontal or substantially horizontal direction, or any sloping direction relative to the vertical or horizontal direction.

The hole within which the concrete encasing is produced in accordance with the in situ casting technique according to the present invention may constitute a pre-produced hole or an existing hole, such as a sewer or a drain pipe, a pre-drilled or pre-produced hole, or alternatively be produced in conjunction with the production of the concrete encasing in accordance with the method of the present invention as the hole may be produced through driving a pipe into the ground, through digging the hole by means of an excavator or the like, or through cracking an existing bore by means of a mandrel or similar hole-producing instrument. Alternatively and advantageously, the hole is produced through drilling by means of a drill tool in conjunction with the casting of the in situ cast concrete encasing in accordance with the method according to the present invention.

According to alternative embodiments of the method according to the present invention, the step of providing the casing and positioning the casing at the distal end of the hole may be performed in connection with or succeeding the step of producing the hole, as the technique of casting the concrete encasing within the hole in accordance with the method of the present invention may be produced in connection with or succeeding the production of the hole.

Provided the hole to be reinforced by means of the concrete encasing produced in accordance with the method of the present invention is produced by means of a drill tool, the drill tool preferably comprises a drill pipe which further advantageously and preferably constitutes the casing. Furthermore, the drill tool may advantageously comprise a drill bit which is positioned at the one end of the drill pipe constituting the first end of the casing.

The technique of producing the hole by means of a drill tool comprising a drill pipe and a drill bit and the technique of producing the concrete encasing by means of the drill pipe constituting the casing characteristic of the technique according to the present invention may further be improved, provided the drill bit protrudes from the first end of the drill pipe and defines a maximum outer diameter exceeding the maximum outer diameter of the drill pipe as the drill pipe may perform, while the drill pipe is moved from the distal end to the proximal end for casting the concrete encasing, a compression action to the self-supporting concrete encasing exposed at the first end of the drill pipe, which compression action may, on the one hand, eliminate any cavities within the self-supporting, yet still plastic concrete encasing, or any cavities produced unintentionally between the concrete encasing and the surrounding earth formations.

The liquid or pasty concrete material may, dependent on the actual application and situation, constitute any appropriate concrete suspension which in accordance with the techniques wellknown within the art per se may have accelerated solidification characteristics as the liquid or pasty concrete material may constitute an aqueous suspension of Portland cement, to which suspension water glass and optionally an acid is added, constituting a solidification accelerating component and a plasticizer or pH-controlling agent, respectively.

The method according to the first aspect of the present invention may, as stated above, advantageously be used for producing a concrete encasing in which supporting piers are fixated. Thus, according to the presently preferred embodiment of the method according to the present invention, the method further comprises:

vi) providing a pier including an elongated fixation shaft and of a configuration allowing said elongated fixation shaft to be received within said concrete encasing,

vii) positioning said elongated fixation shaft within said concrete encasing so as to circumferentially encircle said elongated fixation shaft by said concrete encasing, thereby defining an annular space between the outer surface of said elongated fixation shaft and the inner wall of said concrete encasing, and

viii) fixating said elongated fixation shaft relative to said concrete encasing by applying a liquid or pasty concrete material into said annular space.

The pier may, dependent on the actual application, constitute a cylindrical element such as a circular cylindrical element, as the casing which preferably is constituted by the drill pipe also constitutes a circular cylindrical body.

The method according to the present invention is in a particular application used for producing pylons supporting overhead wires of railroad wirings. For support-

ing the pylons, the piers which are cast into the concrete encasings produced in accordance with the techniques according to the present invention preferably include arresting heads protruding from the one end of the elongated fixation shafts of the individual piers.

The above object, the above feature and the above advantages together with numerous other objects, features and advantages will be evident from the below detailed description of the present invention in accordance with a second aspect of the present invention obtained by an apparatus for producing a concrete encasing within a hole in the ground, said hole defining a longitudinal and a transversal direction, and said hole defining a proximal end and a distal end, said plant comprising:

i) casing means having an outer casing wall of a configuration allowing said casing means to be moved within said hole in said longitudinal direction thereof from said distal end to said proximal end, said outer casing wall defining a first end and a second end, and said casing means including a set of nozzles positioned at said second end of said outer casing wall for the expelling of liquid or pasty concrete material, and said casing means including conductor means for the supply of said liquid or pasty concrete material to said set of nozzles from a source supplying said liquid or pasty concrete material,

ii) means for positioning said casing means at said distal end of said hole so as to position said first end of said outer casing wall juxtaposed said distal end and so as to position said second end of said outer casing wall facing towards said proximal end of said hole,

iii) means for supplying said liquid or pasty concrete material to said set of nozzles through said conductor means for expelling said liquid or pasty substance therefrom for filling out the cavity defined between said outer casing wall of said casing and the inner wall of said hole, and

iv) means for moving said casing means from said distal end of said hole towards said proximal end of said hole while expelling said liquid or pasty concrete material from said set of nozzles, thereby in situ casting said concrete encasing constituting a continuous concrete encasing and supporting said concrete encasing by said outer casing wall of said casing until said concrete encasing has solidified to a self-supporting structure.

The apparatus according to the second aspect of the present invention may in accordance with alternative embodiments fulfil any of the above and any optional requirements relating to the technique of producing in situ cast concrete encasings.

The above object, the above feature and the above advantages together with numerous other objects, features and advantages will be evident from the below detailed description of the present invention in accordance with a third aspect of the present invention obtained by a concrete encasing provided within a hole in the ground, the concrete encasing being produced in accordance with the method according to the first aspect of the present invention and/or by means of the apparatus according to the second aspect of the present invention, as the concrete encasing constitutes an in situ cast continuous concrete encasing.

The present invention will now be further described with reference to the drawings, in which

Fig. 1 is a schematic and sectional view illustrating a first and presently preferred embodiment of a method according to the present invention of founding a pier, such as a pylon supporting an overhead contact wire in a hole formed or drilled in the ground,
Fig. 2 is a schematic, sectional and partly broken-away view of a first and presently preferred embodiment of a tool according to the present invention to be used for carrying out the method according to the present invention,
Fig. 3a is a schematic and sectional view similar to the view of Fig. 2 illustrating a first step of the first and presently preferred embodiment of the method according to the present invention of founding a pier in a hole formed or drilled in the ground by means of the tool illustrated in Fig. 2,
Fig. 3b is a schematic and sectional view similar to the view of Fig. 2 illustrating a second step of the first and presently preferred embodiment of the method according to the present invention of founding the pier in the hole formed or drilled in the ground, which second step constitutes a step of in situ casting a concrete encasing in the hole formed or drilled in the ground,
Fig. 3c is a schematic and sectional view similar to the view of Fig. 2 illustrating a third step of the first and presently preferred embodiment of the method according to the present invention of founding the pier in the hole formed or drilled in the ground, in which third step the pier is positioned in the in situ casted concrete encasing,
Fig. 3d is a schematic and sectional view similar to the view of Fig. 2 illustrating a fourth step of the first and presently preferred embodiment of the method according to the present invention of founding the pier in the ground, in which fourth step a pylon for supporting an overhead contact wire is fixated relative to the pier founded in the hole formed or drilled in the ground,
Fig. 3e is a schematic and sectional view similar to the view of Fig. 2 illustrating a second or alternative embodiment of a tool according to the present invention,

Fig. 3f is a schematic and sectional view similar to the view of Fig. 3e illustrating a third or further alternative embodiment of the tool according to the present invention,

Fig. 4 is a schematic and sectional view illustrating a second embodiment of the method according to the present invention of in situ casting an encasing constituting a sewer encasing, and

Fig. 5 is a schematic and sectional view illustrating a third embodiment of the method according to the present invention of in situ casting a tunnel lining.

In Fig. 1, a machine 10 is shown, which machine constitutes a self-propelling machine for driving on the road, or alternatively on rails. The machine 10 comprises a driving chassis or carriage 12 on which a top frame 14 is supported in a journalling bearing 15 allowing the top chassis 14 to be rotated relative to the driving chassis or carriage 12 round a vertical axis defined by the journalling bearing 15. The top frame 14 supports a tool rig 16 which is raisable and lowerable relative to the top frame 14, allowing the tool supported by the tool rig 16 to be positioned in an intentional position relative to the ground, or alternatively raised and folded on top of the top frame 14 for storing the tool rig while the machine 10 is driving on the road or the rails. It is to be realized that the overall machine 10 illustrated in Fig. 1 is of a structure similar to the structure of the driving rig supporting machine described in greater detail in applicant's European Patents EP-B-0392309, EP-B-0392310 and EP-B-0392311, to which European Patents reference is made.

The machine 10 illustrated in Fig. 1 is primarily intended to be used for founding pylons relative to the ground, which pylons support an overhead contact wire supplying electric energy to an electric locomotive driving on the rails. The rails are designated the reference numerals 22 and 24 and are fixated relative to sleepers or crossties, one of which is shown and designated the reference numeral 20. The sleepers 20 are supported on a ballast or road bed 18.

As stated above, the machine 10 is a self-propelling machine which may drive on the road by means of road wheels 26 and 28, or alternatively drive on the rails 22 and 24 by means of rail wheels (not shown in the drawings). The driving chassis or carriage 12 further supports a pair of supporting legs or feet 30 and 32 which serve the purpose of providing stability to the machine 10, provided the supporting legs or feet are resting on the supporting ballast 18.

The top frame 14 supporting the tool rig 16 includes a balance weight or counterweight 34. The top frame 14 further supports the motor of the machine, which motor is housed within a motor housing 36. Furthermore, the top frame 14 supports a driver's cab 38 from which a driver or operator may operate or control the functions of the machine, including the drilling or hole-forming operation to be described below in greater detail. Adjacent to the driver's cab 38, a pivotal joint 40 links the tool rig 16 to the top frame 14, allowing the tool rig 16 to be rotated round a substantially horizontal axis defined by the pivotal joint for allowing the tool rig 16 to be raised from the position shown in Fig. 1 and swung above the top surface of the driver's cab 38, allowing the tool rig 16 to be transported along with the entire machine 10 as described in the above listed European patents. For raising and lowering the tool rig 16 relative to the top frame 14, an actuator 41, preferably constituted by a hydraulic cylinder, is provided. The pivotal joint 40 and the actuator 41 are connected to a beam or girder 42 which constitutes a supporting component of the tool rig 16. The girder 42 further supports a vertical stand 44 on which a shaft 45 is journalled. The shaft 45 constitutes a supporting shaft on which a bearing 46 is journalled, which bearing supports a bore tool 50, which is further guided relative to the stand 44 by a collar 48 circumferentially encircling the tool 50. The collar 48 constitutes a lower end guide relative to the bore tool 50 and serves the purpose of preventing the bore tool 50 from tilting as the bore tool is propelled into the ground 52 providing a bore hole 54, as will be described in greater detail below with reference to Fig. 2.

In Fig. 2, the bore tool 50 is shown, disclosing the structure of the tool 50 and also illustrating the deficiencies in establishing a perfectly cylindrical bore hole in the ground, provided the ground includes layers of varying material composition, as in Fig. 2 the top ground layer 52 constitutes a top soil layer below which a sand layer 56 is positioned and below which a solid or massive layer, such as a rock formation or chalk layer or chalk bed is present. As is evident from Fig. 2, the bore hole provided in the massive layer 58 constitutes a perfectly configurated cylindrical bore hole, whereas the inner surface of the bore hole within the sand layer 56 and the top soil 52 varies due to imperfections relative to the perfectly cylindrical inner surface of the bore hole defined within the massive layer 58. The bore tool 50 is basically of a structure wellknown within the art per se, as the bore tool 50 comprises a drill pipe 60 defining the outer cylindrical surface of the bore tool and constituting the central supporting component of the bore tool 50. At the lower end of the drill pipe 60, a drill bit 62 is journalled rotatably relative to the drill pipe 60, as the drill bit 62 is journalled on a central tube 64 which is mounted coaxially relative to and circumferentially enclosed within the drill pipe 60. The central tube 64, and consequently the drill bit 62, is rotated by means of a motor 66 which is mounted on a top end housing 68 of the bore tool 50 within which top end housing 68 two gear wheels 70 and 72 are journalled and connected to the central tube 64 and the output shaft of the motor 66, respectively, serving the purpose of transmitting and transforming the rotational motion of the output shaft of the motor 66 to a rotational motion of the central tube 64 and consequently of the drill bit 62. It is to be realized that the outer perimeter and the outer maximum diameter of the drill bit

62 are somewhat larger than the perimeter and the diameter, respectively, of the drill pipe 60 in order to allow the drill pipe 60 to be received within the bore hole produced by the drill bit 62.

As the drill bit 62 is rotated by the rotational motion produced by the motor 66, bore mud is supplied to the lower end of the drill pipe and supplied centrally to the bottom end of the bore hole through a central hole of the drill bit 62, as bore mud is pumped into a tube 74 which circumferentially encircles the central tube 64 and is forced down through an annular space defined between the outer wall of the central tube 64 and the inner wall of the tube 74. A pair of hoses 76 and 78 serve the purpose of inputting the bore mud to the above described annular space from an external pressurizing bore mud supplying source (not shown in the drawings) housed on the machine 10 shown in Fig. 1, which hoses are connected to the tube 74 through connectors or fittings 80 and 82, respectively. The bore mud is, as stated above, forced out through a central aperture of the drill bit 62 and due to the pressurized state of the bore mud forced upwardly within the drill pipe 60 above the drill bit 62 and expelled through a hose 84 which is connected to the central tube 64.

The central inner space defined within the central tube 64 communicates with the above-mentioned central hole of the drill bit 62 through a bottom end block 88 which also communicates with the above described annular space for guiding the bore mud in its intentional flow path, as indicated by arrows in Fig. 2. It is to be realized that the transportation or flow of bore mud may be altered in numerous ways without in any substantially manner affecting the drilling or bore operation, as the bore mud may alternatively be supplied to the outer perimeter of the drill bit 62 and removed through the above-mentioned central hole of the drill bit 62, as the input and output of bore mud through the hoses 76, 78 and 84, respectively, may simply be reversed.

Alternatively, the communication from the above described annular space defined between the inner wall of the tube 74 and the outer wall of the central tube 64 to the central aperture of the drill bit 62 and the communication through the central tube 64 to the top side of the drill bit 62 may be altered through modifying the block 88 so as to establish communication through the central tube 64 to the through-going aperture of the drill bit 62 and from the top side of the drill bit 62 to the above described annular space, in which instance the bore mud may be supplied through the hoses 76 and 78, or alternatively through the hose 84 for supplying the bore mud to the top side of the drill bit, or alternatively through the central aperture of the drill bit 62, and removing the bore mud from the central aperture of the drill bit 62 or alternatively from the top side of the drill bit 62.

The bore tool 50 is, as described above with reference to Fig. 1, kept in an upright or vertical position, as the bore bit 62 is caused to rotate and the bore mud is supplied to the bottom end of the bore hole, causing the removal of particulate material from the bottom end of the bore hole, which particulate material is removed with the bore mud which is pumped down to the bottom end of the bore hole. The bore tool may, dependent on the application, be forced into the bore hole through the application of pressure to the top end of the bore tool 50, e.g. by including a motor in the bearing 46 described above with reference to Fig. 1, or simply forced into the bore hole due to the weight of the bore tool itself. The bore tool 50 further includes two or more tubes 88 and 90 which extend from the top end of the bore tool 50 to a bottom end position above the drill bit 62, at which bottom end position the tubes 88 and 90 open into output apertures or orifices 94 and 96. The tubes 88 and 90 communicate at the top end of the bore tool 50 with hoses 98 and 100, through which concrete is pumped into and supplied to the tubes 90 and 92 after the bore hole has been drilled, as will be described in greater detail below with reference to Fig. 3a.

In Fig 3a, the above described bore tool 50 is disclosed illustrating a first step of founding a pier in the ground. In Fig. 3a, the process of drilling the bore hole is illustrated as indicated by an arrow representing the motion of the drill pipe 60. In Fig. 3a, the reference numeral 99 represents a further hose similar to the hoses 98 and 100 through which concrete is supplied to the tubes extending downwardly into the interior of the drill pipe 60, as will be described in greater detail below with reference to Fig. 3b. The reference numeral 102 represents the bore mud, including the material removed from the bore hole which is expelled from the hose 84. Also in Fig. 3a, the inner wall of the bore hole 54 is to some extent exaggerated illustrating the variation of the inner wall of the bore hole within the different materials of the layers 52, 56 and 58. In particular in Fig. 3a, the effect of the bore mud flushing the sand of the sand layer 56 away is clearly illustrated.

After the drill bit 62 has reached the intentional depth below the surface of the ground, the drilling or bore operation is stopped. Thereafter, the drill pipe 60 is, as illustrated in Fig. 3b, raised as indicated by the arrow pointing upwardly. At the time of initiating the raising of the drill pipe 60 and also the drill bit 62, rapidly solidifying concrete is pumped into the hoses 98, 99 and 100 and forced down through the tubes, such as the tubes 88 and 90, and expelled through the apertures or orifices, such as the apertures or orifices 94 and 96, respectively. The rapidly solidifying concrete is, as discussed above, produced from conventional concrete of the Portland cement type by the addition of water glass, i.e. silicate compositions and optionally acid, such as citric acid, adjusting the viscosity of the pasty concrete. The addition of the silicate compositions increases the speed of solidification of the Portland cement as is well-known within the art per se, and produces, dependent on the amount of water glass applied to the concrete composition, a specific rate of solidification of the concrete material. The rate of solidification may be ex-

pressed in the rate length per time unit, such as 1 m / 1 min., meaning that during the process of raising the drill pipe 60 and at the same time the drill bit 62 at a speed of 1 m / 1 min., the rapidly solidifying concrete solidifies into a self-supporting pasty substance within approximately 1 min. Provided the rate of solidification of the rapidly solidifying concrete is somewhat lower, e.g. requires 5 min. for producing a self-supporting pasty substance, the raising of the drill pipe 60 is delayed for a period of time and the rate of raising the pipe is reduced to a rate determined as follows.

The drill bit 62 is to be raised at a speed allowing the drill bit 62 to reach previously applied rapidly solidifying concrete before the concrete solidifies into solid material, meaning that the drill bit 62 should reach the previously applied concrete material while the previously applied concrete material is still pasty. Provided the distance from the position of applying the rapidly solidifying concrete, i.e. the distance from the apertures 94 and 96 to the drill bit 62, amounts to e.g. a m, and the rate of solidifying the rapidly solidifying concrete material is b min., the rate of raising the drill pipe 60 and also the drill bit 62 should amount to approximately a/b m/min.

The presence of the drill bit 62 which as stated above has an outer maximum diameter somewhat larger than the diameter of the drill pipe 60 provides a further advantageous feature, as the drill bit 62 during the raising of the drill pipe 60 forces or squeezes the pasty concrete material outwardly and compresses the pasty, partly solidified concrete material, ensuring that any cavities present in the applied rapidly solidifying concrete material or between the applied rapidly solidifying concrete material and the material of the ground formation adjacent the bore hole are eliminated producing a almost perfect in situ casting of a concrete bore hole casing. The rapidly solidifying concrete material applied into the bore hole through the apertures 94 and 96 is designated the reference numeral 104.

After the entire bore hole has been provided with an in situ castconcrete encasing, i.e. after the drill bit 62 has been entirely retracted from the bore hole 54, and after the rapidly solidifying concrete encasing has been allowed to further solidify, if necessary, a pier 106 is as illustrated in Fig. 3c positioned within the in situ cast encasing present within the bore hole 54. The solidifed concrete material 104 produces a regular or irregular inner surface, dependent of whether or not the drill bit 62 is rotated while the drill bit is raised, however, irrespective of whether or not the drill bit 62 is rotated or kept stationary, presents a minimum encasing diameter somewhat larger than the maximum diameter of the pylon 106. For fixating the pier 106 relative to the in situ cast concrete encasing 104, concrete is pumped or forced down centrally within the pier 106 and squeezed or pressed upwardly between the outer surface of the pier 106 and the inner surface of the in situ cast concrete encasing 104, as indicated by the reference numeral 108. In Fig. 3c, an inner through-going hole extending longitudinally through the pier 106 is illustrated in phantom line and designated the reference numeral 110 and the reference numeral 112 designates the hole through which the concrete material from which the concrete filling-out 108 is produced is supplied to the central aperture 110 as the hose 114 is connected to a pipe 116 through a connection or fitting 114 which pipe 116 extends, at least partly, down into the central aperture 110 of the pier 106 and is later on removed from the central aperture 110 after the concrete filling-out 108 has reached the ground level as indicated in Fig. 3c.

Finally, after the fixation of the pier 106 relative to the in situ cast concrete encasing 104 has been established, a mast, pylon or any other structural element, is as illustrated in Fig. 3d fixated to the head of the pier 106. The mast or pylon 118 is a mast or pylon to be used for the suspension of overhead connecting wires, however, the technique of founding a pier, such as the pier 106, in accordance with the teachings of the present invention may be used in connection with any appropriate engineering work, such as founding bridges, founding houses, founding fixation elements, supporting railways, supporting roads, etc.

In Fig. 3e, a differently configurated drill bit is shown, differing from the above described drill bit 62 in that the drill bit is substituted by a 3-element drill bit of a structure similar to the drill bit structure usually used in oil drilling. The drill bit 120 thus comprises a support structure 122 to which three drill crowns 124 are mounted. The drill bit 120, like the above described drill bit 62, presents a maximum outer diameter somewhat larger than the outer diameter of the drill pipe 60, thus providing the above described advantageous feature of forcing or squeezing the pasty, partly solidifed concrete material into cavities defined within the concrete material or between the concrete material and the irregularly configurated inner wall of the bore hole. In Fig. 3e, the above described tube 74 is omitted as the bore mud is simply pumped out within the drill pipe 60 and expelled through a hose similar to the hose 84, which hose communicates with the inner space defined within the drill pipe 60. Also in Fig. 3e, the arrows indicate the direction of transportation of the bore mud which is supplied through the central tube 64 and expelled centrally within the drill bit 120 and which is removed, as stated above, along the annular space circumferentially encircling the tube 64 within the drill pipe 60.

In Fig. 3f, a further embodiment of the bore tool according to the present invention is shown, which further embodiment differs from the above described second or alternative embodiment shown in Fig. 3e in that the drill bit 120 is substituted by a conventional worm 126 which is journalled within and encased within the drill pipe 60. Different from the above described first and second embodiments of the bore tool, the worm bore tool of Fig. 3f is operated without the application of bore mud as the bore tool shown in Fig. 3f is preferably used in soil of a

high content of clay as distinct from the above described first and second embodiments which are preferably used for drilling bore holes in composite layers and also layers of massive or solid type, such as rocks or chalk. In Fig. 3f, the reference numeral 128 designates the soil. The bore tool shown in Fig. 3f is, however, preferably operated in the same 2-step process as described above with reference to Figs. 3a and 3b, as the bore hole is first produced, whereupon the in situ cast encasing is produced during the raising of the drill pipe as the rapidly solidifying concrete is expelled from the apertures or orifices 94 and 96. It is to be realized that the drill pipe 60 of the above described first and second embodiments preferably is of cylindrical configuration, whereas the third embodiment of the bore tool shown in Fig. 3f may include a drill pipe which has an upwardly tapering lower end part allowing the upwardly tapering lower end part of the drill pipe to force or squeeze the rapidly solidifying concrete material into the cavities and irregularities of the inner wall of the bore hole produced by means of the worm 126.

In Fig. 4, a different application of the in situ casting technique according to the present invention is shown, according to which techniqe a sewer is reinforced by the casting of an in situ cast concrete encasing in accordance with the teachings of the present invention.

In Fig. 4, the reference numeral 130 designates the inner cylindrical wall of a sewer or drain pipe, such as a brick wall or a cast concrete wall which needs to be reinforced or simply sealed as the wall is perforated and leaks waste water to the earth below or adjacent to the sewer. The sewer wall 130 is cracked by means of a mandrel tool 134 which is pulled through the sewer by means of a wire 136 which is fixated to the front end of the mandrel 134. The mandrel 134 comprises a conical front end 138 to which the wire 136 is fixated and a cylindrical solid intermediate part 140. The conical front end 138 provides the cracking of the wall 130, whereas the solid intermediate part 140 positions the cracked wall part, such as a wall part 142 while compressing the earth formations adjacent the wall 130 for providing a substantially cylindrical through-going hole aligned relative to the axis of the sewer 130. The mandrel 134 further comprises a trailing end 144 which constitutes a hollow cylindrical part, optionally a slightly conical part tapering towards the front end 138 of the mandrel 140. At the front end of the hollow conical part 144, through-going apertures or orifices 146 and 148 are provided which serve the purpose of expelling rapidly solidifying concrete to the annular space defined between the outer surface of the hollow cylindrical part 144 and the cylindrical inner wall produced in the earth formation through the cracking of the sewer wall 130 by means of the conical front end 138.

The concrete expelled through the apertures 146 and 148 is designated the reference numeral 150 and the concrete is supplied to the apertures or orifices 146 and 148 through hoses 152 and 154, respectively. The rapidly solidifying concrete expelled from the apertures or orifices 146 and 148 and the speed of pulling the mandrel 134 through the sewer 130 is in accordance with the teachings of the present invention, as discussed in greater detail above with reference to Fig. 3b, adjusted so as to allow the rapidly solidifying concrete to solidify into a self-supporting plastic composition, while the concrete is supported by the outer cylindrical wall of the hollow cylindrical part 144.

In Fig. 5, a slightly modified technique of in situ casting a wall casing is illustrated, according to which technique an excavator 160 is mounted within a hollow cylindrical support structure 162 serving basically the same purpose as the above described hollow cylindrical end part 144. The excavator 160 has a front shovel 164 by means of which earth material is removed from a position in front of the excavator 160. The shovel 164 digs up the earth and puts it onto a conveyor belt 166 by means of which the earth is removed from within the bore produced by means of the machinery illustrated in Fig. 5. As the excavator 160 and the hollow cylindrical support structure 162 are moved forwardly at a speed determined by the excavation operation performed by the excavator 160 by means of the shovel 164, concrete is expelled through apertures or orifices 168 and 170 provided at the front end of the cylindrical wall 162 serving substantially the same purpose as the above described apertures 146 and 148.

The apertures or orifices 168 and 170 communicate with concrete supply hoses 172 and 174, respectively, through which concrete is supplied to the apertures or orifices 168 and 170 and expelled into the annular space defined between the outer surface of the hollow cylindrical support structure 162 and the inner wall of the bore produced by means of the shovel 164. By means of the machinery illustrated in Fig. 5, an in situ cast encasing is produced in accordance with the teachings of the present invention, as described in greater detail above with reference to Figs. 3a and 3b.

It is to be realized that the technique of producing the actual bore or hole extending horizontally, vertically or in any arbitrary orientation through the ground or the earth, may be produced by boring, drilling, pile-driving, digging, etc. in accordance with the teachings of the present invention, according to which teachings an in situ casting is produced for supporting the bore or hole extending through the ground or earth formation, fulfilling the advantageous purpose of filling out any irregularities or cavities present between the bore or hole produced in the ground or earth formation and the outer wall of the tool producing the bore or hole, such as the irregularities produced in the sand formation 56 described above with reference to Figs. 2, 3a and 3b adjacent to the outer wall of the drill pipe, or similarly the irregular wall produced through the cracking operation described above with reference to Fig. 4, or similarly produced through the excavation process described above with reference to Fig. 2.

Claims

1. A method of producing a concrete encasing in the ground, comprising:

   i) providing a hole in the ground, said hole defining a longitudinal and a transversal direction, and said hole defining a proximal end and a distal end,

   ii) providing a casing having an outer casing wall of a configuration allowing said casing to be moved within said hole in said longitudinal direction thereof from said distal end to said proximal end, said outer casing wall defining a first end and a second end, and said casing including a set of nozzles positioned at said second end of said outer casing wall for the expelling of liquid or pasty concrete material, and said casing including conductor means for the supply of said liquid or pasty concrete material to said set of nozzles from a source supplying said liquid or pasty concrete material,

   iii) positioning said casing at said distal end of said hole so as to position said first end of said outer casing wall juxtaposed said distal end and so as to position said second end of said outer casing wall facing towards said proximal end of said hole,

   iv) supplying said liquid or pasty concrete material to said set of nozzles through said conductor means for expelling said liquid or pasty substance therefrom for filling out the cavity defined between said outer casing wall of said casing and the inner wall of said hole, and

   v) moving said casing from said distal end of said hole towards said proximal end of said hole while expelling said liquid or pasty concrete material from said set of nozzles, thereby in situ casting said concrete encasing constituting a continuous concrete encasing and supporting said concrete encasing by said outer casing wall of said casing until said concrete encasing has solidified to a self-supporting structure.

2. The method according to Claim 1, said casing being moved continuously from said distal end to said proximal end and said liquid or pasty concrete material being expelled continuously or intermittently from said nozzles.

3. The method according to Claim 1, said casing being moved intermittently from said distal end to said proximal end, and said liquid or pasty concrete material being expelled continuously or intermittently from said nozzles.

4. The method according to any of the Claims 1-3, said longitudinal direction constituting a vertical or a substantially vertical direction, a horizontal direction or a substantially horizontal direction or any sloping direction relative to the vertical or horizontal directions.

5. The method according to any of the Claims 1-4, said hole being produced through driving a pile into the ground, through digging said hole by means of an excavator, or the like, or through cracking an existing bore by means of a mandrel or similar hole-producing instrument.

6. The method according to any of the Claims 1-4, said hole being produced through drilling by means of a drill tool.

7. The method according to any of the Claims 5 or 6, said step of providing said casing and positioning said casing at said distal end of said hole being performed in connection with or succeeding the step of producing said hole.

8. The method according to Claims 6 and 7, said drill tool comprising a drill pipe constituting said casing and a drill bit positioned at the one end of said drill pipe constituting said first end of said casing.

9. The method according to Claim 8, said drill bit protruding from said first end of said drill pipe and defining a maximum outer diameter exceeding the maximum outer diameter of said drill pipe and performing, while moving said drill pipe from said distal end to said proximal end, a compression action to said self-supporting concrete encasing exposed at said first end of said drill pipe.

10. The method according to any of the Claims 1-9, said liquid or pasty concrete material constituting an aqueous suspension of Portland cement, to which suspension water glass and optionally an acid is added, constituting a solidification accelerating component and a plasticizer or pH-controlling agent, respectively.

11. The method according to any of the Claims 1-10, further comprising:

    vi) providing a pier including an elongated fixation shaft and of a configuration allowing said elongated fixation shaft to be received within said concrete encasing,

    vii) positioning said elongated fixation shaft within said concrete encasing so as to circum-

ferentially encircle said elongated fixation shaft by said concrete encasing, thereby defining an annular space between the outer surface of said elongated fixation shaft and the inner wall of said concrete encasing, and

viii) fixating said elongated fixation shaft relative to said concrete encasing by applying a liquid or pasty concrete material into said annular space.

12. The method according to Claim 11, said pier further including an arresting head protruding from the one end of said elongated fixation shaft.

13. An apparatus for producing a concrete encasing within a hole in the ground, said hole defining a longitudinal and a transversal direction, and said hole defining a proximal end and a distal end, said plant comprising:

i) casing means having an outer casing wall of a configuration allowing said casing means to be moved within said hole in said longitudinal direction thereof from said distal end to said proximal end, said outer casing wall defining a first end and a second end, and said casing means including a set of nozzles positioned at said second end of said outer casing wall for the expelling of liquid or pasty concrete material, and said casing means including conductor means for the supply of said liquid or pasty concrete material to said set of nozzles from a source supplying said liquid or pasty concrete material,

ii) means for positioning said casing means at said distal end of said hole so as to position said first end of said outer casing wall juxtaposed said distal end and so as to position said second end of said outer casing wall facing towards said proximal end of said hole,

iii) means for supplying said liquid or pasty concrete material to said set of nozzles through said conductor means for expelling said liquid or pasty substance therefrom for filling out the cavity defined between said outer casing wall of said casing and the inner wall of said hole, and

iv) means for moving said casing means from said distal end of said hole towards said proximal end of said hole while expelling said liquid or pasty concrete material from said set of nozzles, thereby in situ casting said concrete encasing constituting a continuous concrete encasing and supporting said concrete encasing by said outer casing wall of said casing until said concrete encasing has solidified to a self-supporting structure.

14. The apparatus according to Claim 13, said means for moving said casing means being adapted to cause said casing means to move continuously and/or intermittently.

15. The method according to any of the Claims 14 and 15, said means for supplying said liquid or pasty concrete material to said nozzles through said conductor means being adapted to cause said liquid or pasty concrete material to be expelled continuously or intermittently from said nozzles.

16. The apparatus according to any of the Claims 13-15, said longitudinal direction constituting a vertical or a substantially vertical direction, a horizontal direction or a substantially horizontal direction or any sloping direction relative to the vertical or horizontal directions.

17. The apparatus according to any of the Claims 12-16, further comprising means for producing said hole.

18. The apparatus according to Claim 17, said means for producing said hole constituting pile-driving means for driving a pile into the ground, bore cracking means for cracking an existing bore by means of a mandrel means or similar hole-producing means, excavator means for digging said hole, or drilling means for producing said hole through drilling by means of a drill tool.

19. The apparatus according to any of the Claims 17 and 18, said means for positioning said casing means at said distal end of said hole being adapted to be operated in connection with or succeeding the operation of said hole-producing means.

20. The apparatus according to any of the Claims 18 or 19, said drill tool of said bore-producing means comprising a drill pipe constituting said casing means and a drill bit positioned at the one end of said drill pipe constituting said first end of said casing means.

21. The apparatus according to Claim 20, said drill bit protruding from said first end of said drill pipe and defining a maximum outer diameter exceeding the maximum outer diameter of said drill pipe and performing, while moving said drill pipe from said distal end to said proximal end, a compression action to said self-supporting concrete encasing exposed at said first end of said drill pipe.

22. The apparatus according to any of the Claims 13-21, said liquid or pasty concrete material constituting an aqueous suspension of Portland cement, to which suspension water glass and optionally an acid is added, constituting a solidification accelerating component and a plasticizer or pH-controlling agent, respectively.

23. The apparatus according to any of the Claims 13-22, further comprising:

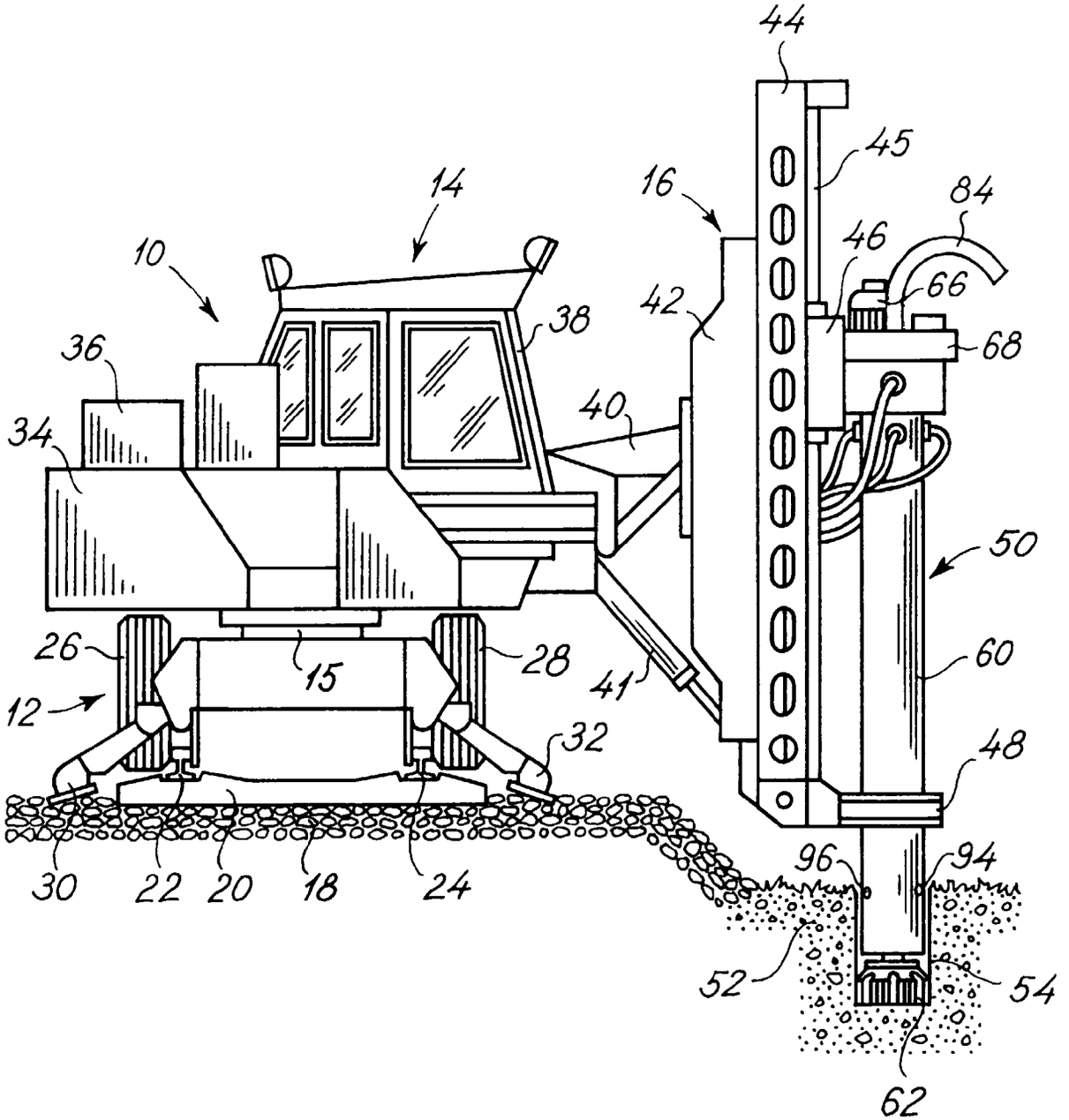
vi) means for positioning an elongated fixation shaft of a pier having a configuration allowing said elongated fixation shaft to be received within said concrete encasing so as to circumferentially encircle said elongated fixation shaft by said concrete encasing thereby defining an annular space between the outer surface of said elongated fixation shaft and the inner wall of said concrete encasing, and

vii) means for fixating said elongated fixation shaft relative to said concrete encasing by applying a liquid or pasty concrete material into said annular space.

24. The apparatus according to Claim 23, said pier further having an arresting head protruding from the one end of said elongated fixation shaft.

25. A concrete encasing provided within a hole in the ground, said concrete encasing being produced in accordance with the method according to any of the Claims 1-12 and/or by means of the apparatus according to any of the Claims 13-24, and said concrete encasing constituting an in situ cast continuous concrete encasing.

Fig. 1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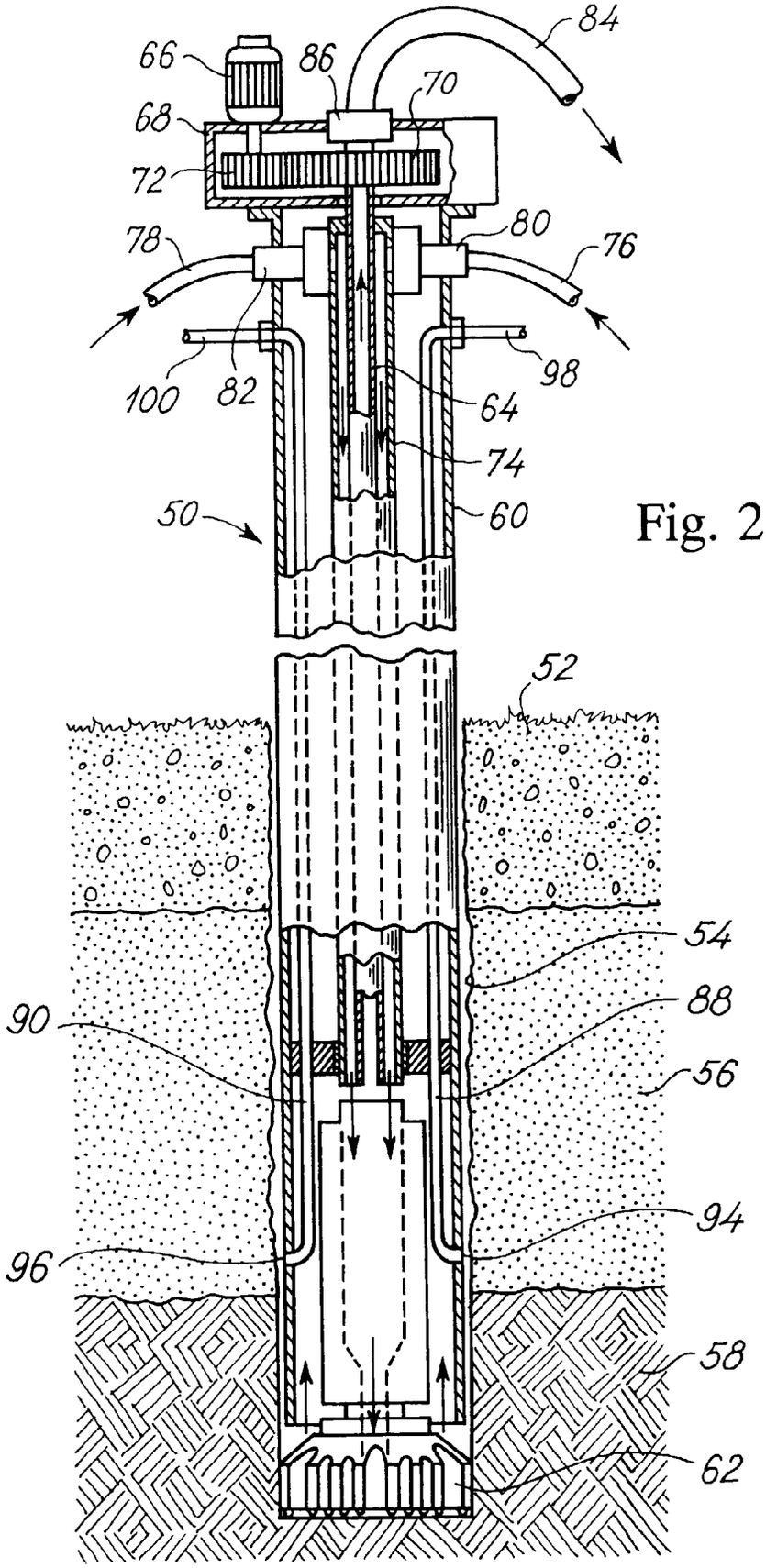
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Fig. 2

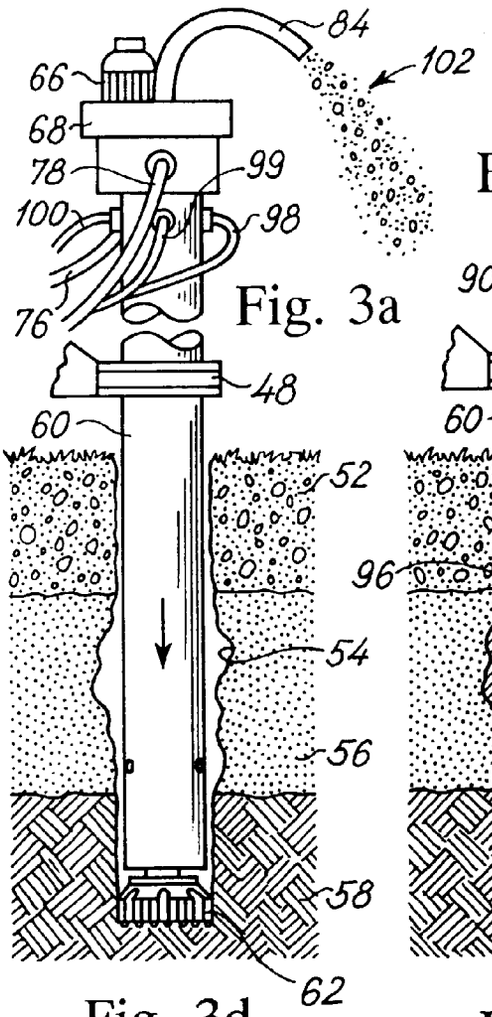

Fig. 3a

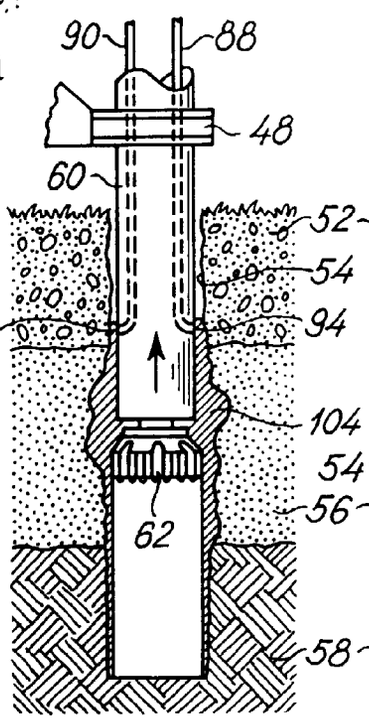

Fig. 3b

Fig 3c

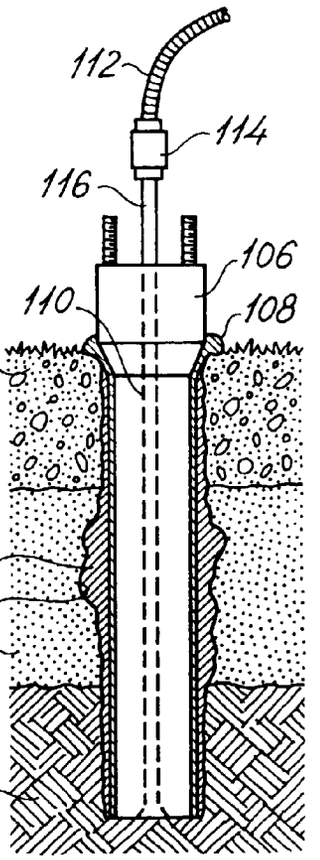

Fig. 3d

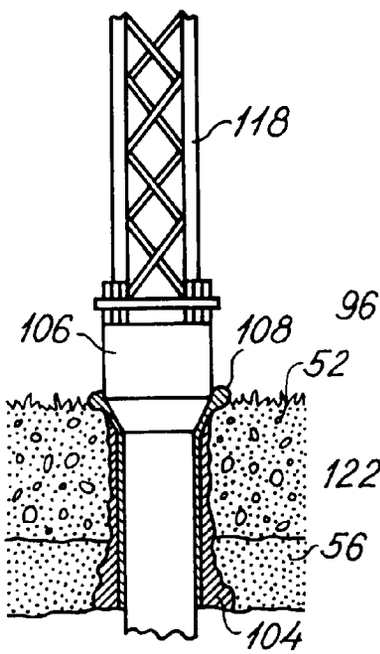

Fig 3e

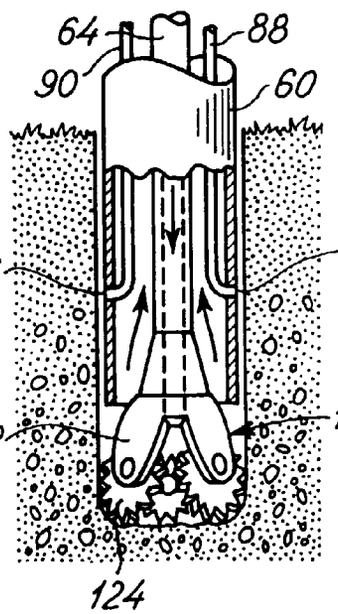

Fig. 3f

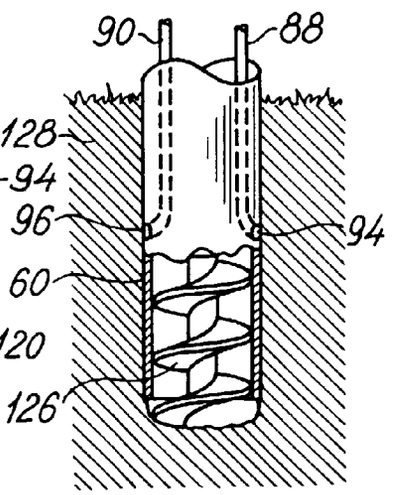

Fig. 4

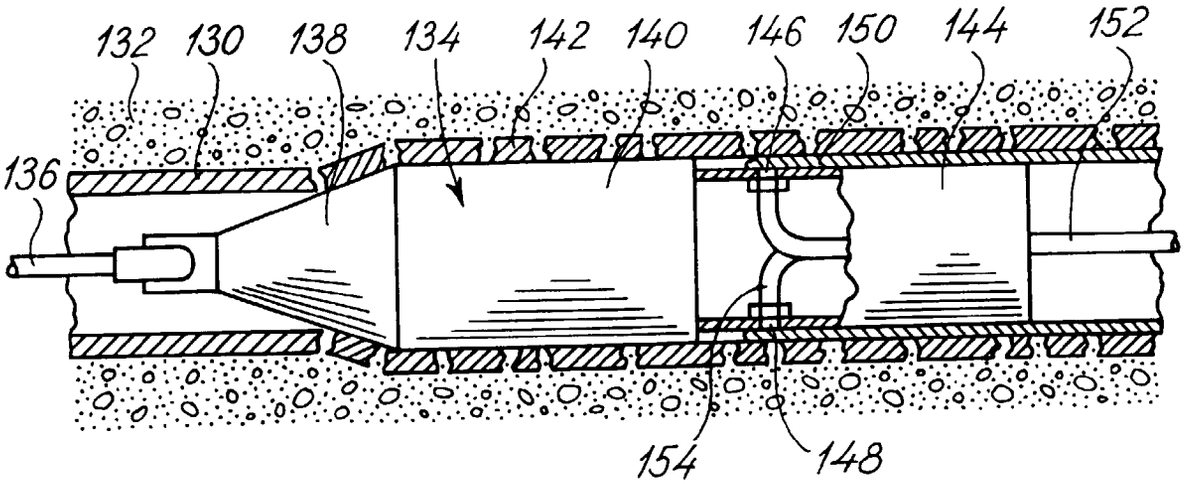
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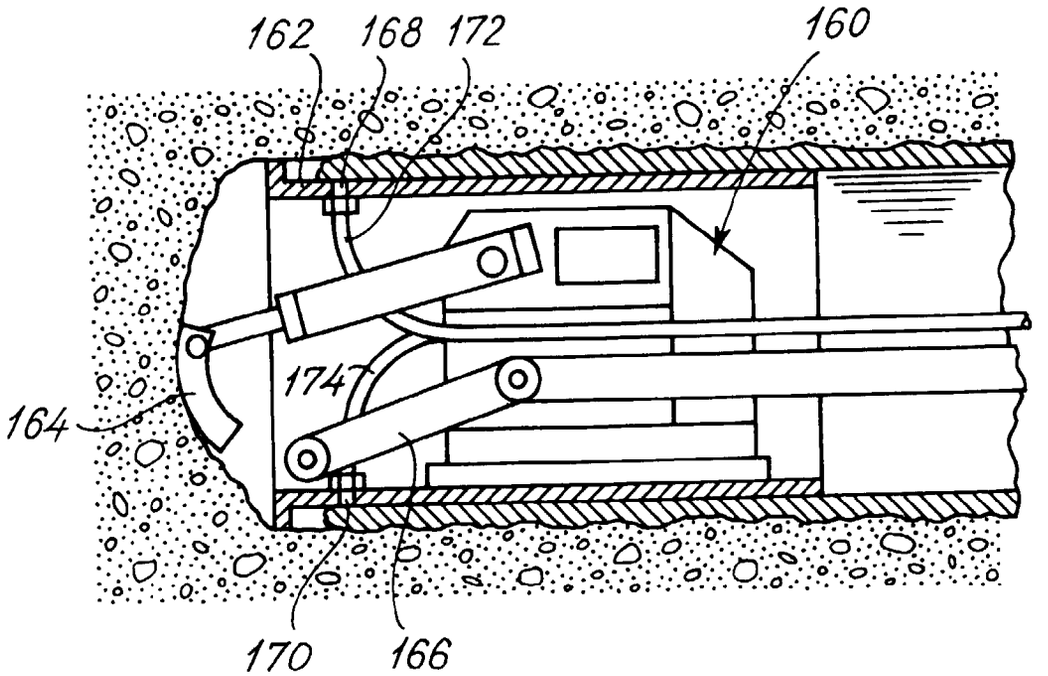
Fig. 5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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 61 0046

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	EP 0 229 425 A (SHELL INT RESEARCH) 22 July 1987 * column 2, line 20 - line 37 * * column 5, line 52 - column 6, line 36; figures 1,3 * ---	1,2,4-8, 13-20,25 3,9,10, 21,22	E02D5/34 E21B33/13
A	EP 0 403 025 A (SHELL INT RESEARCH) 19 December 1990 * the whole document * ---	1,4-8, 10,13, 16-20, 22,25	
A	US 4 055 958 A (HANSON RAYMOND A) 1 November 1977 * abstract; figures * -----	1,2,4,5, 10, 13-16, 22,25	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) E02D E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 January 1997	Blommaert, S

CATEGORY OF CITED DOCUMENTS

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