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Applicant: **Coelus, Gaspar, Astridlaan 53,
B-8450 Nieuwpoort (BE)**

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Inventor: **Coelus, Gaspar, Astridlaan 53,
B-8450 Nieuwpoort (BE)**

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Representative: **van der Beek, George Frans et al,
Nederlandsch Octrooibureau Johan de Wittlaan 15 P.O.
Box 29720, NL-2502 LS 's-Gravenhage (NL)**

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Process for placing a concrete pile in the ground and a screw drill and casing to be used in the process.

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A concrete pile is placed in the ground through a casing with a screw disposed on the bottom end thereof being screwed while rotating into the ground and on reaching the desired depth being brought up, while during this movement upwards concrete mixture is placed in the casing, said mixture being conveyed into the hole formed through a passage at the bottom end of the casing which is closed during the screwing in. In order to avoid a high resistance during the screwing of the casing into the ground and to prevent earth from being pressed downwards while the casing is being pulled out of the drilled hole, the screwing of the casing into the ground takes place by a screw fin with openings between the windings, with the ground directly above the screw fin being compacted by a displacer with a closed spiral part having the same screw direction as the fin and a closed spiral part above it having the opposite screw direction. The casing is rotated in the original screw direction during the pulling up thereof.

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Process for placing a concrete pile in the ground and a screw drill and casing to be used in the process

The invention relates in the first instance to a process for placing a concrete pile in the ground, in which a casing with driven rotating screw fitted on the bottom end thereof is screwed into the ground and after the desired depth has been reached is raised, and in which concrete mixture is fed into the casing during this upward movement, said mixture being conveyed into the hole formed through a passage at the bottom end of the casing which is closed during the screwing in.

Such a process is known from applicant's Dutch Patent 111,864.

The screw in this known method is closed, as a result of which the earth during screwing in is displaced and compacted around the casing. The chance of the wall of the drilled hole around the casing collapsing is reduced through the compacting. A disadvantage of the known process is that a high resistance is encountered during screwing into the ground. This can be so high that it is virtually impossible to penetrate through a hard bearing layer to the desired depth. Another disadvantage of the known process is that when the casing is being withdrawn from

the drilled hole the screw drill is turned in a direction opposite to the direction of drilling, in which case, if the upward pulling movement is not adapted to the pitch of the drill, the ground is pressed
5 downwards. This can lead to a conically tapering pile shoe.

The object of the invention is to avoid the above-mentioned disadvantages, and to this end the process mentioned in the preamble is characterized in that the
10 screwing of the casing into the ground takes place by a screw fin with openings between the windings, and in that the ground directly above the screw is compacted by a displacer with a closed spiral part having the same screw direction as the drill screw and a spiral part
15 above it with the opposite screw direction, while the casing is rotated in the original screw direction during the pulling up thereof.

The screw fin draws the casing relatively easily into the ground. The compacting of the ground takes
20 place as soon as a part of the drill has penetrated into the ground. Of course, the displacer will not have a greater external diameter than the screw fin. In principle, the maximum diameters are the same. The drill can penetrate through hard intermediate layers and
25 through into a hard bearing layer. Since the casing is turned in the same direction when going into and coming out of the ground, no earth is pumped downwards. The

concrete pile will be sound and cylindrical right to its bottom end.

It is usually preferable for a quantity of sand placed on the surface to be moved into the hole through
5 a screw provided on the top part of the casing, with screw direction opposite to that of the screw at the bottom end of the casing. This sand pressed from the surface into the hole ensures a compacted sand mantle around the casing. Negative adhesion (earth sinks more
10 than pile) is countered in this way.

The invention also relates to a tubular screw drill in particular intended for use in the process described above. This drill has according to the invention a screw fin which extends between one end of the drill and a
15 displacer successively comprising a closed spiral part having the same screw direction as the fin and a closed spiral part having the opposite screw direction.

In the bottom end of the drill there could be a non-return valve to prevent penetration of earth into
20 the casing, but to allow through the concrete mixture. It is, however, simpler to fit a shut-off point on the said bottom end in such detachable fashion that when the drill is taken upwards it remains behind in the ground.

It is generally advantageous to give extra
25 compacting to the ground all round the top part of the casing. For this purpose, the casing provided with a screw drill can have at a distance from the displacer

one or more screw fins whose screw direction is opposite to the screw direction of the fin of the screw drill.

Since the casing always turns in the same direction, no complex couplings are needed between the casing parts from which the casing is made up. The casing can consist of a number of sections which are linked together by a simple screw coupling, with the angle of inclination of the screw being at least 30 degrees relative to the horizontal. The coupling can be detached by turning in the opposite direction.

The invention will now be explained further with reference to the figures, which show a number of embodiments.

Fig. 1 shows a view of the drilling apparatus.

Fig. 2 shows a view of the bottom end of the screw drill to be used, on a larger scale.

Fig. 3 shows a cross-section along the line III-III in Fig. 2.

Figs. 4, 5, 6 and 7 show various phases of the process according to the invention.

Figs. 8, 9, and 10 show various phases of a variant of the process according to the invention.

The earth drill to be used in the process according to the invention is shown in Fig. 2. It is made up of various parts. On the under side is the shut-off point 1 of the casing 2 which prevents water or earth from penetrating into the casing. This point 1 is connected

to the casing by means of a screw connection with sharply slanting heads of screw. Wound around the casing 2 is a screw fin which is connected to the casing by welding.

5 Above the casing part with the screw fin 3 is the displacer, consisting of a bottom part 4 and a top part 5. The part 4 has a closed screw whose external diameter increases spirally from the external diameter of the casing 1 at the lowest point to a diameter equal to the
10 external diameter of the fin 3 at the highest point. The displacer part 5 also comprises a closed screw, but the diameter now reduces spirally to a value equal to the external diameter of the casing 2. A characteristic is that the screw direction of screw fin 3 is the same as
15 that of part 4, while the screw direction of part 5 is opposite to that of part 4. It is also characteristic that the displacer parts 4 and 5 never have a diameter which is greater than that of the screw fin 3.

 Above the displacer part 5 the drill is coupled to
20 other sections of the casing 2. The casing 2 with the screw drill at its bottom end must be rotated, and it must be possible to move it vertically downwards and upwards. Moreover, it must be possible to⁰ displace horizontally the derrick on which the casing 2 is fixed,
25 in order to be able to produce concrete piles at any desired point. For this, it is necessary to have an apparatus which has sufficient stability and can supply

sufficient energy. This apparatus is indicated schematically in Fig. 1. At the top end of the casing 2, at the point which will still just penetrate into the ground when the concrete pile is being made, the casing
5 is provided with two fin windings 6, 7 at a distance from each other. These fin windings have a screw direction which is opposite to that of the screw fin 3.

The casing 2 can be rotated by the drilling table 8. The casing 2 is connected by means of a universal
10 joint 9 to the hose 10 of a concrete pump. The table 8 is fastened in guiding fashion to a mast 11. This mast must be able to absorb the maximum moment of the table and must thus be fixed to a machine of sufficient stability. Since this machine must also be able to move
15 over the trench, a caterpillar vehicle 12 is preferably selected for it. The drilling table 8 can be driven hydraulically or electrically, in which case moment and speed are preferably regulable. A diesel engine 13 placed on the vehicle 12 can supply the necessary
20 hydraulic pressure or electric current. The casing 2 must not only be rotated, but must also first be moved downwards and then pulled upwards. Apart from the torque, the weight of the casing 2, 3, 4 and 5 and of the drilling table 8 alone is sufficient for the
25 movement downwards of the casing 2. A great upward pulling force is needed in order to be able to draw up the drill from the ground. This force is supplied in the

present case by a winch 14 which is fastened by means of a tackle to the mast and draws the drilling table upwards. Another possibility is the use of a hydraulic jack which can exert force on the casing with a clamp.

5 It is generally necessary to support the vehicle 12 by means of hydraulic supports 16.

The process for fixing a concrete pile in the ground is illustrated in Figs. 4 - 7. It is assumed that the piles are made in ground which consists of two
10 layers: a top layer 17 of low strength, and a good bottom layer 18. The piles are fixed as follows:

By moving and rotating the vehicle 12, the centre line of the casing 2 is first taken so as to be perpendicular above the place where the pile has to go
15 in the ground. The casing 2 is closed off at the bottom end by the shut-off point 1, and the casing 2 is lowered until it rests on the ground. For the first pile, a quantity of coarse-grained earth (sand or gravel) is brought in.

20 The drilling table 8 is put into operation and drives the casing 2 in such a way that the screw fin 3 pulls the casing 2 downwards. Through the dead weight of casing 2 with fin 3 and the table 8 and through the screw force of the screw fin 3, the casing 2 penetrates
25 into the ground. While the casing 2 penetrates into the ground, the earth fills the space between the windings of the fin 3. The earth with a volume equal to the

volume of the pipe part which has penetrated into the ground is displaced. In this way, the pore volume of the ground round the periphery of the casing 2 is reduced. If the point sinks less than the pitch of the fin 3 per
5 revolution, then the casing 2 works through the screw fin as a conveyor screw and transports earth upwards.

As soon as the part 4 of the displacer goes into the ground. A greater volume of earth must be displaced: the volume of a cylinder with a diameter equal to the
10 largest diameter of the displacer. This therefore requires a greater drilling moment and causes a smaller downward displacement of the casing per revolution and a greater earth transportation upwards, but also an increase in the pressure in the surrounding earth and a
15 proportional reduction in the pore volume. As a result of the compression of the earth, there is an open space above the displacer part 5 round the casing.

If the earth has good cohesion, little water pressure or great impermeability, that open space will
20 remain open for a longer period of time and over a great height. In earth with low cohesion, that space will soon be filled with infalling earth particles and water. But in this case also the ground exerts practically no resistance on the rotating casing. The resistance moment
25 thus remains limited to the fin 3 and the displacer 4, 5. So long as the displacer part 4 does not go into very compact ground, the resistance torque of the drill is

relatively small. When the first screw blade 6 on the casing 2 reaches the surface, the opposing screw takes the earth lying on the surface down with it.

As soon as the point of the drill has penetrated
5 deep enough into the compact ground to ensure the bearing force of the concrete pile to be produced, further sinking of the drill is prevented by holding fast the winch. Concrete mixture is now pumped into the casing 2 by the concrete pump via pipe 10 and universal
10 joint 9. The casing 2 is always rotated in the same direction here. As soon as the concrete pressure rises, one knows that the concrete casing is full, and the drilling table 8 with casing 2 are drawn up by the winch 14 (or possibly hydraulic jacks). Here the casing 2 is
15 always turned in the same direction and concrete is pumped into the casing 2. The drill point 1 remains behind in the ground, and the concrete mixture under pressure, via the casing 2, fills the space which is produced under the drill in the ground. The concrete
20 pressure helps the drill here to press upwards (see Fig. 6). Since the casing 2 continues to turn in the same direction during its upward movement, the earth remains between the windings of the fin 3, and from the beginning of the upward movement of the casing a
25 cylinder is formed in the ground. Above the fin 3, the displacer part 5 with opposite screw direction presses back laterally the earth which has fallen in against the

displacer. The only earth which is brought up out of the hole is thus the part which is lodged between the windings of the fin 3. In place of this quantity, the earth previously dumped on the surface is conveyed into
5 the hole. The earth around and underneath the concrete pile is not released from tension at any point. While the casing 2 is drilling into the ground, the earth is displaced over a volume equal to the content of the casing 2, while during drilling out the displacer part 5
10 displaces an earth cylinder with a diameter equal to the largest diameter of the screw box of the displacer. The concrete pressure maintained by the pump ensures that underneath the casing 2 no release of pressure on the earth can occur. Thus when the casing 2 comes out of the
15 ground, a cylinder of concrete is formed in the compressed earth (see Fig. 7).

The mantles 19, 20 and 21 are shown round the concrete pile. The mantle 19 corresponds to the quantity of earth which was transported by the screw blades 6, 7
20 into the hole. Mantle 21 is formed by the displacer part 5. The mantle 20 is less wide and is formed by displacement of a volume of earth corresponding to the volume of the casing 2. The material caught between the windings of the fins 3 is taken up.

25 Since the casing 2 always remains rotating in the same direction, it is simple to couple two sections of the casing together. A screw connection without lock is

adequate. The screw connection preferably has a great slope, for example the angle of the screw relative to the horizontal being at least 30 degrees. This makes detachment of the casing sections extremely simple.

5 The moment which has to be supplied for the casing to be able to penetrate deeply enough into the ground depends on the ground resistance and the diameter of the concrete pile to be formed. The casing length along which the fin 3 extends, the pitch of the parts 3, 4 and
10 5, and the diameter of the casing 2 play a not insignificant role in this. The possibility of producing piles of specific bearing power by a suitable choice of these values, with minimum output, is an important advantage of the invention.

15 When the next pile is placed in the ground, at the start of drilling of the casing 2 into the ground the quantity of earth which was still between the windings of the fin 3 from the first pile is displaced by the fresh earth. That quantity then remains lying on the
20 surface round the new pile.

 It can be seen from Figs. 8 - 10 that screw blades 22 to 26 can be placed on the casing 2 over a much greater distance, which means that a much greater quantity of coarse-grained earth can be taken down while
25 the casing 2 is being drilled into the ground. Here, by selecting the pitch of the screws 22 to 26 greater than the pitch of the displacer part 5 also when the casing 2

is being drawn out of the ground, earth can still be taken down, so that the compacted earth mantle becomes even wider and the compression thereof is even greater. This coarse-grained earth (gravel, coarse sand) must be
5 taken into a heap around the place where the casing 2 is being drilled into the ground. In these Figs. 8 to 10 it is assumed that the earth consists of five layers: layer 27 is a brought-in layer of coarse sand, which is needed to permit carrying out of the work in good transport
10 conditions; layer 28 is loose clay, layer 29 is sand with good resistance, but not thick enough, layer 30 is a low consolidated clay, and layer 31 is sand of good resistance and sufficiently thick for anchoring of the concrete piles in it. The screw blades 22-26 carry the
15 large heap of coarse-grained sand which was brought in around each pile down to the bottom, and it is displaced by the displacer part 5 into the surrounding ground when the rotating casing 2 is drawn out of the ground. The mantle 19 of compressed sand can widen in the process
20 and reach up to the first good sand layer 29. The subsidence in the original loose layer will be greatly reduced, even if the surface is later loaded. When such ground improvement around the pile is being made, it is mostly necessary to exert a greater vertical downward
25 force on the drill during the time that the casing is being drilled into the ground and while the coarse-grained sand is being introduced. This can take place by

making the winch 14 double-acting and drawing the drilling table downwards during drilling. It is then also better to provide hydraulic supports at the rear side of the vehicle 2.

5 The mantles around the concrete pile give the following advantages: they reduce the concrete loss in slack layers, they increase the resistance of the drilled hole against collapsing, and they avoid the occurrence of negative adhesion.

10 Various modifications and variants are possible within the scope of the invention. What is essential for the invention is that the casing is drilled by an open screw fin over a certain length into the ground before the ground is compacted by a displacer. It is also
15 important for the casing to be rotated in the original screw direction while it is being drawn up.

CLAIMS

1. Process for placing a concrete pile in the ground, in which a casing with driven rotating screw fitted on the bottom end thereof is screwed into the ground and after the desired depth has been reached is
5 raised, and in which concrete mixture is fed into the casing during this upward movement, said mixture being conveyed into the hole formed through a passage at the bottom end of the casing which is closed during the screwing in, characterized in that the screwing of the
10 casing into the ground takes place by a screw fin with openings between the windings, and in that the ground directly above the screw is compacted by a displacer with a closed spiral part having the same screw direction as the fin and a spiral part above it with the
15 opposite screw direction, while the casing is rotated in the original screw direction during the pulling up thereof.

2. Process according to Claim 1, characterized in that a quantity of coarse-grained material, such as sand
20 and/or gravel supplied on the surface is placed in the hole by a screw which is fitted on the top part of the casing and has a screw direction which is opposite to that of the screw at the bottom end of the casing.

3. Tubular screw drill in particular intended for
25 use in the process according to Claim 1, characterized

in that a screw fin extends between one end of the drill and a displacer which consists successively of a closed spiral part having the same screw direction as the fin and a closed spiral part having the opposite screw
5 direction.

4. Screw drill according to Claim 3, characterized in that a shut-off point is disposed on the said end in such detachable fashion that it remains behind in the ground when the drill is drawn up.

10 5. Casing provided with a screw drill according to Claim 3 or 4, characterized in that one or more screw fin windings are provided at a distance from the displacer, their screw directions being opposite to the screw direction of the fin on the screw drill.

15 6. Casing according to Claim 5, characterized in that it consists of a number of casing sections which are coupled together by means of a simple screw coupling while the angle of inclination of the screw relative to the horizontal is at least 30 degrees.

20

fig-1

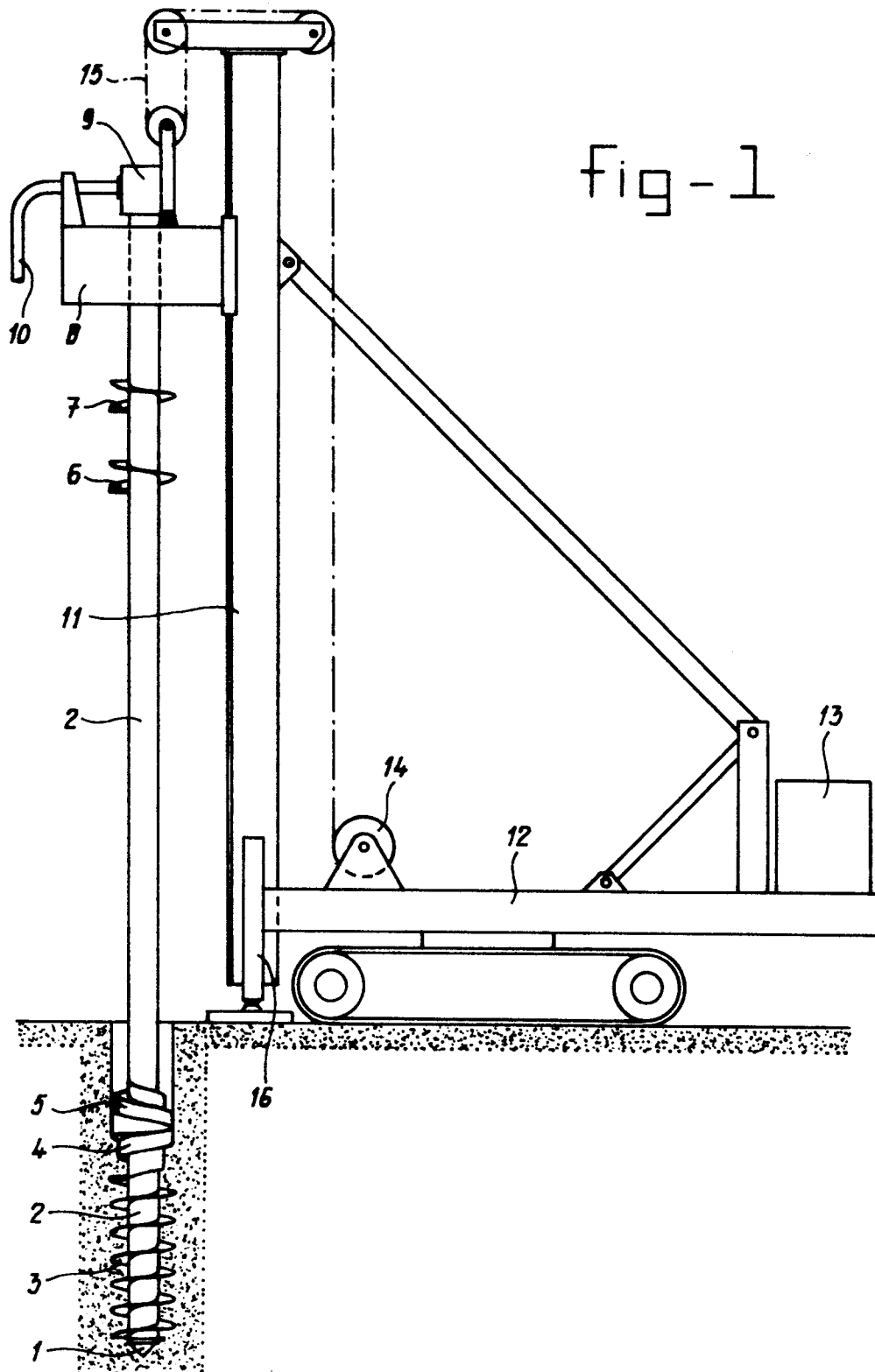


fig - 2

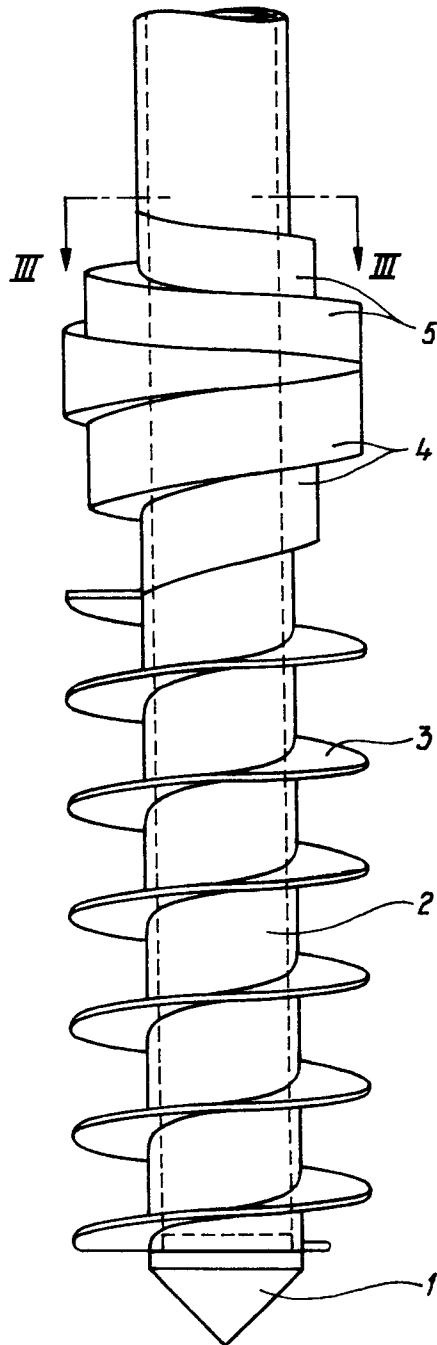


fig - 3

