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Bacmanak

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[54] **PROCESS OF PRODUCTION OF PILES, PILE PACKS, AND SUBTERRANEAN PILE WALLS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**..... **61/35,** 61/50, 61/53.52, 61/53.64, 61/56.5, 61/63

[51] **Int. Cl.**..... **E02d 5/18,** E02d 5/38, E02d 11/00

[58] **Field of Search** 61/53.64, 53.66, 35, 56, 61/63, 50, 59

[56] **References Cited**

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Primary Examiner—Jacob Shapiro

[57] **ABSTRACT**

Piles or subterranean pile walls are produced by using a pack of parallel tubes, composed of filling tubes closed at the bottom and of collecting tubes open at the bottom, which pack of tubes is driven into the earth, the filling tubes displacing the earth to the side and later being filled with concrete. The collecting tubes collect a part of the earth, thereby enabling its removal, the amount of removed earth being adjusted by pressure air acting on top of the earth cores in the collecting tubes.

4 Claims, 13 Drawing Figures

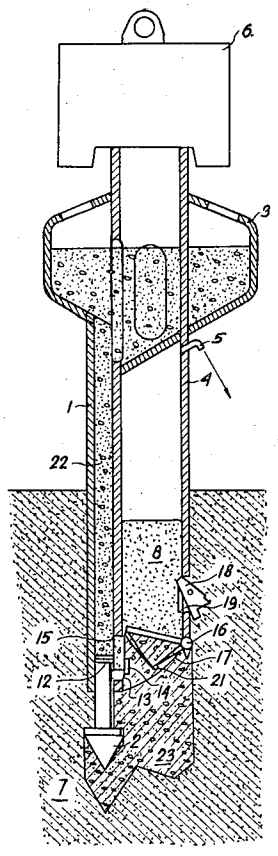

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Fig.1

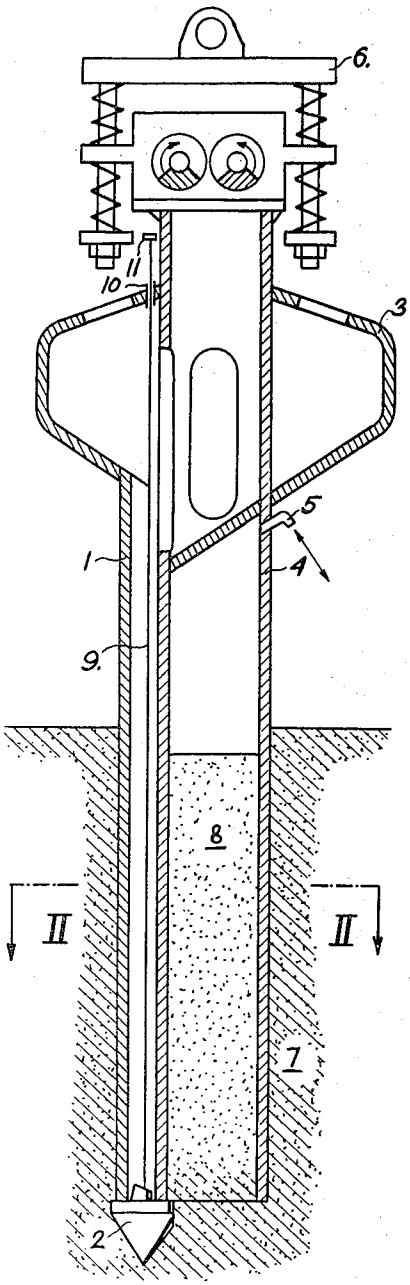

Fig.3

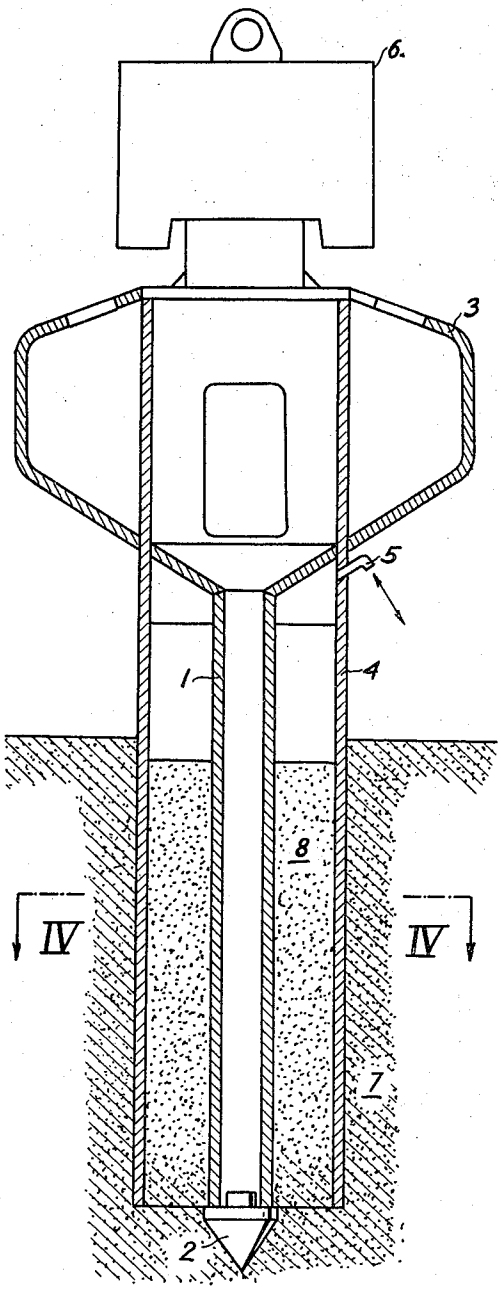

Fig.5

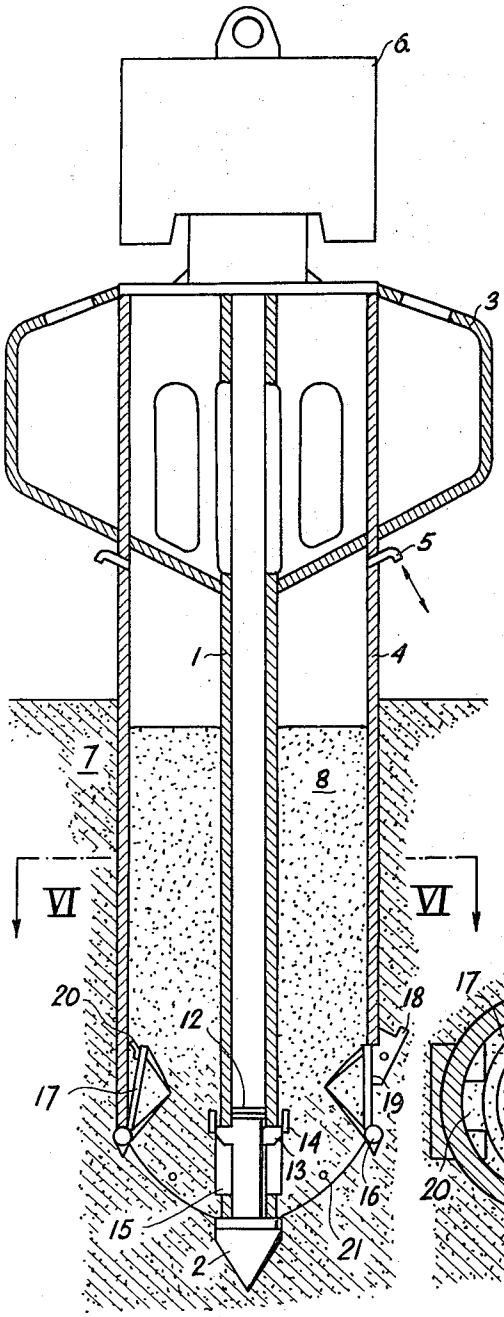

Fig.2

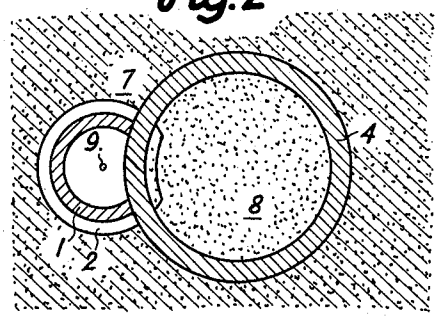

Fig.4

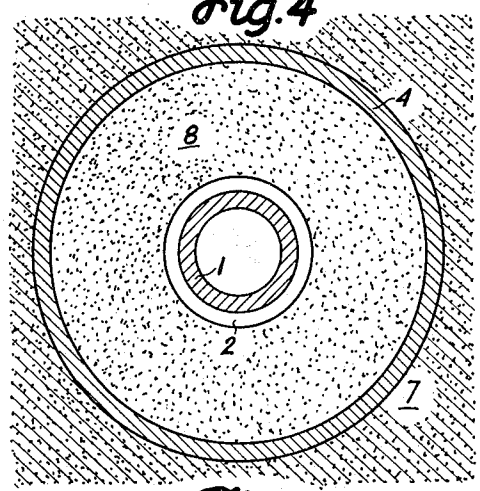

Fig.6

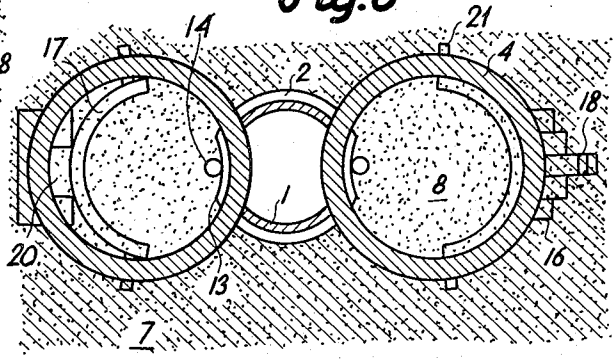

Fig.7

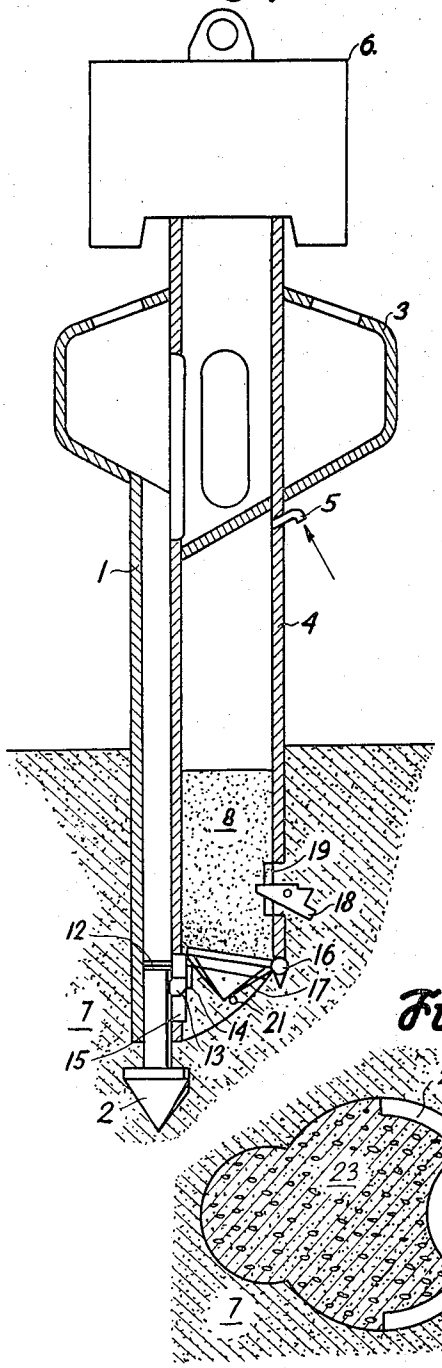

Fig.8

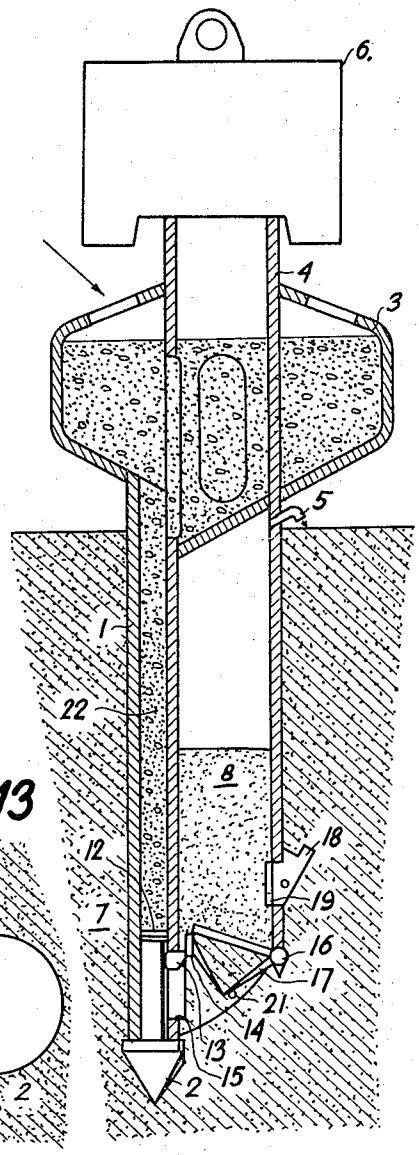

Fig.13

Fig. 9

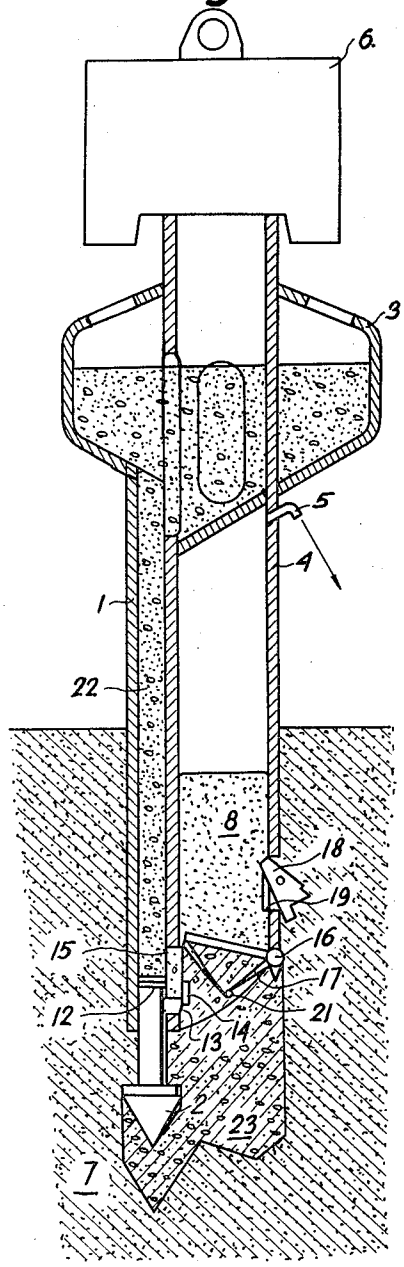
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Fig. 10

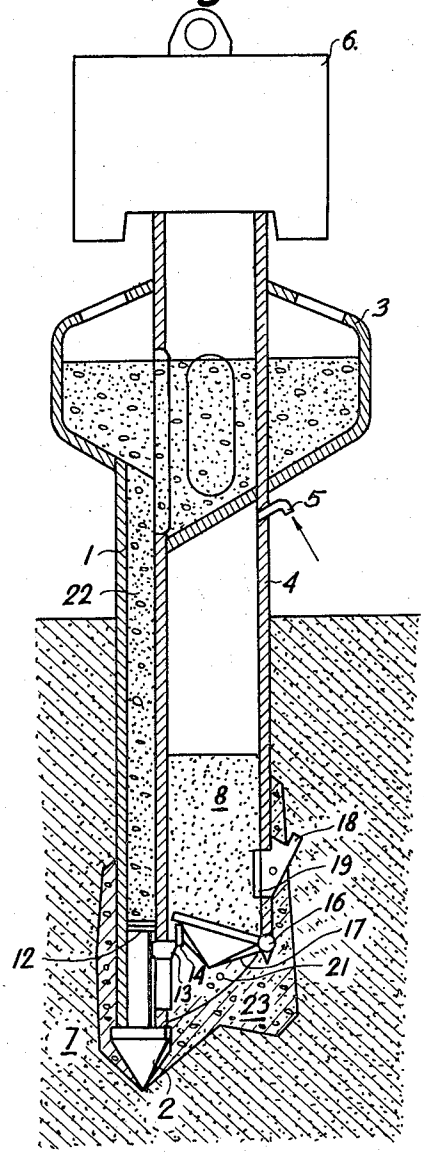
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Fig.11

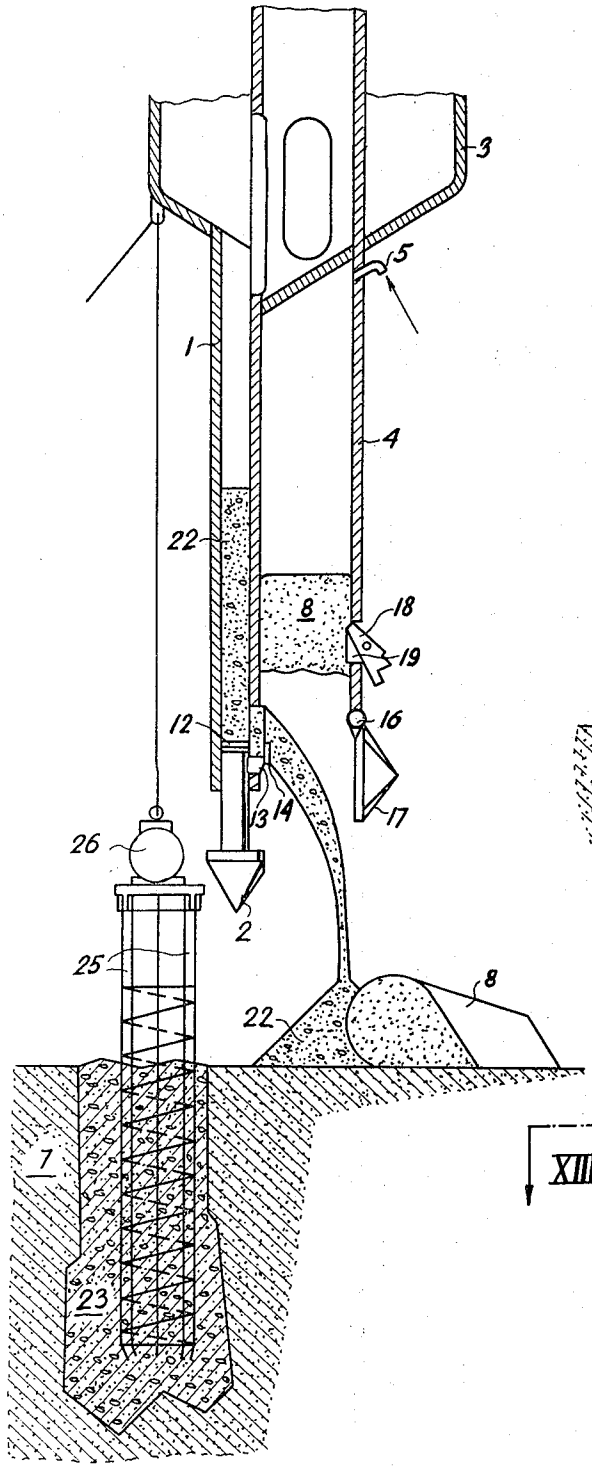
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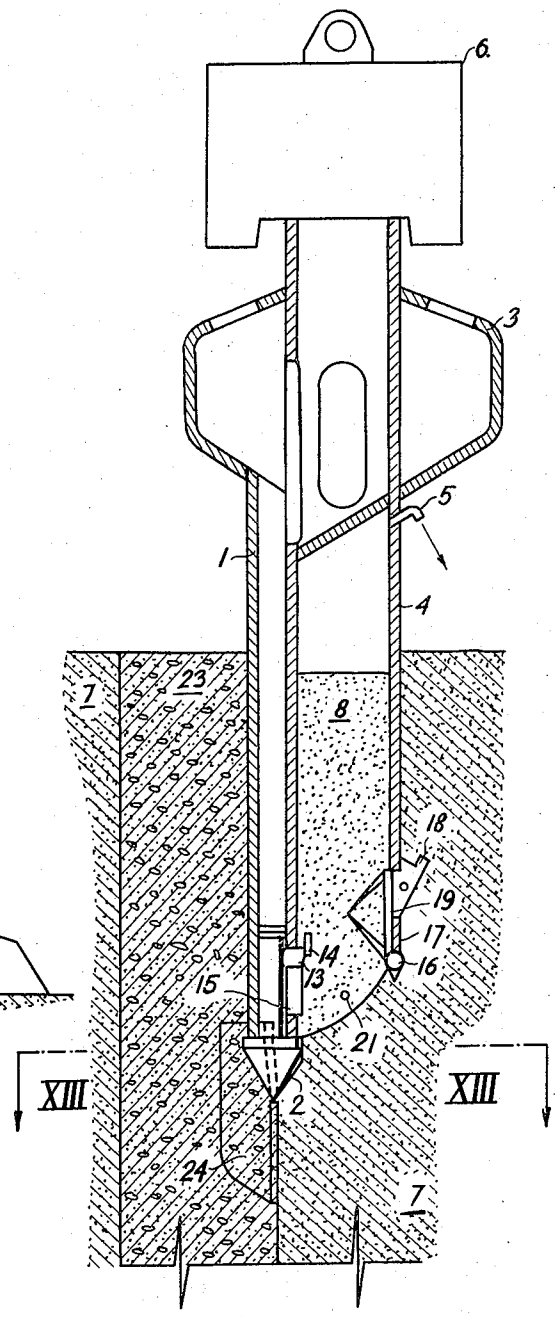
Fig.12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PROCESS OF PRODUCTION OF PILES, PILE PACKS, AND SUBTERRANEAN PILE WALLS

BACKGROUND OF THE DISCLOSURE

This invention relates to a process of production of piles and of subterranean pile walls in situ, using a single apparatus or arrangement, or additions to this arrangement, and to the apparatus or arrangement and its additions for carrying out this process.

A number of processes for the production of piles or subterranean pile walls are known wherein a single arrangement is used. The piles or pile walls are for instance produced by means of a hollow earth auger, terminated by a displaceable closure and fixed to a pipe set provided with a screw for continuous removal of the earth loosened in the course of boring; in the course of lifting the arrangement some fluid pressure medium is introduced via the bore and the pipe is set into the cavity produced in the ground. According to another known process, the earth is loosened and mixed with a binding liquid, which is supplied via the drill and the pipe set, the mixture being compacted by the drill rotating at high speed. There are also known processes of manufacture of piles using an open tube provided below the upper end with a pressure storage container, whereby the tube is driven into an uncased bore and is lifted together with the earth, the tube being emptied, closed by a lost bit, inserted into the bore, filled with a concrete mixture and driven into the earth to the required depth; after this the opening at the top is closed air tight, is subjected to a simultaneous vibration and air pressure on the concrete mixture, and the tube is then removed.

There is another known process for the production of piles by means of a hollow enlarged head provided with a helix and terminated by a slidable closure, which is bored into the earth by means of a pipe set and is lifted with a rotating movement, whereby the filling is conveyed into the hollow space made by the enlarged head via the pipe set. There are furthermore known processes for the production of piles by devices consisting of single or several coaxial tubes, driven in simultaneously, which tubes are temporarily closed on their lower ends by a closure of a concrete mixture, by a lost bit, or by different permanent flaps or closures. Sometimes these devices are driven in with an enlarged bit, whereby into the annular space between the earth and the external tube there is introduced a pressure filling which is supplied via a central pipe or via a special supply pipe terminating in a separated space between coaxial tubes in the lower part of the device. The driven-in tubes displace all earth laterally along the whole depth of the pile. The tubes remain permanently or temporarily in the earth; they are lifted in one stroke or intermittently, one after another, and the uncased hollow space is filled via a central tube or via special supply conduits arranged on the external tubes under the simultaneous action of shocks, vibration, pressure on the filling, or by their combination. The permanent flaps or closures allow the filling to pass into this space, and in the course of a repeated driving-in the pipes are closed and press the filling against the surrounding earth.

The process of manufacturing a subterranean wall by using the last mentioned arrangements includes an alternate driving-in and lifting of two individual tubes arranged side by side provided with lateral locks or grooves, or of a tube and two guiding casing pipes, one of the tubes or one of the guiding casing pipes remaining in the earth between the driven-in tube and the preceeding, freshly filled pile.

In addition, subterranean pile walls are known which consist of individual piles of circular or rectangular cross section, overlapping one another or being in contact at contact surfaces, which piles are driven in after the solidifying or hardening of adjacent piles.

The drawbacks of processes of actual manufacturing piles, using a single device, and the drawbacks of these devices, are that they are suitable solely for fine grain and little settled loose earth or for soft up to pasty binding earth; the surrounding earth is not compacted in the course of producing the piles, a part of the removed earth is smeared on the wall of the tube, the center of the opening has to be specially arranged to prevent losses of removed earth by a further pipe set, an injection device for conveying the pressure filling and an auxiliary device for conveying the lifted earth from the drill are part of the arrangement. An additional drawback is that spaces drilled by rotating drills are of circular cross section, whereby the piles have the smallest circumference and the lowest bearing capacity of the mantle.

Drawbacks of other processes consist in that the high penetration capacity of an open tube can be used solely to the depth of an uncased bore, the boring is thereafter interrupted, the wall of the space remains temporarily uncased and can be damaged to a substantial degree, a lost bit has a high resistance to penetration by vibrations and can penetrate only to a limited depth below the level of the bore, and finally it is impossible to control the widening of the pile and utilize the increased volume of the filling in the most advantageous manner to increase the bearing capacity.

Drawbacks of other processes are that the arrangements press the earth to all sides along the whole depth of the pile, the penetration of the arrangement depends on the external diameter of the tube or of the bit, on the consistency and degree of settling of the earth, and on the distance to adjacent piles, which should be as large as possible and can influence unfavorably the dimensions of construction bases above the piles; it is possible to widen a space by a high efficiency ram up to a certain limited diameter, the tubes are frequently filled and lifted intermittently or devices consisting of more parts are lifted part by part, in each pile there is left a large lost bit of cast iron, steel or reinforced concrete.

Drawbacks of actual processes for the production of subterranean pile walls and of the respective arrangements consist in that adjacent spaces can be produced in the earth up to a limited depth by application of a high efficiency ram and two equal alternately driven-in and lifted tubes or by a single tube and two alternately fixed guiding casing pipes.

Drawbacks of other processes are that one-half of pile spaces of the subterranean pile wall has to be produced partly into adjacent solidified piles, or the contact surfaces of the piles are prepared by auxiliary appliances introduced into spaces created hydraulically and are removed only after the solidifying of the filling, the intermediate or following pile spaces are bored only after the solidifying of the adjacent piles, the pile spaces are filled by less efficient or subsequently ad-

justed devices, the surrounding earth is not compacted and has thus a reduced bearing capacity or acts on pile walls with higher pressures; sometimes the loose earth is specially treated at the bottom of the hollow spaces and spaces hollowed hydraulically are widened irregularly and their filling has unwanted effects on supporting walls. In general these processes are time consuming and intermittent; they require different machines or individual additional devices and personal supervision in the course of operation.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a process and an arrangement whereby piles are produced continuously, that is, wherein the hollow space for the pile is immediately filled in the course of the lifting of the tube which defines the pile space.

It is another object of this invention to provide for an easy and efficient compacting of the walls of the hollow pile space without using special devices for this purpose.

It is still another object of this invention to provide a process and an arrangement for building continuous subterranean pile walls without waiting for the solidifying of piles made earlier.

According to this invention a pile or a pile wall is produced by the application of a pack of parallel, but mutually separated tubes, wherein some tubes are predetermined to supply the filling and to fill hollow spaces in the earth, and other tubes are predetermined to collect and to raise a part of the earth displaced by the driven-in tubes. In a first phase of operation, the pack of tubes is driven into the earth with the application of vibration up to the required depth, whereby the filling tubes displace the earth material laterally, whereas the collecting tubes are substantially open, or partially closed by the filling tubes, or provided with flaps which are urged by the collected earth against the internal wall of these tubes. The entrance of earth into these tubes can be adjusted by air pressure on the earth core within the tube, or can be prevented by flaps which, after raising the arrangement, automatically close openings in the collecting tubes and, in the course of a following repeated driving-in, compact the earth, forcing it to all sides.

In the second phase of operation, the filling is supplied via the filling tubes and under a simultaneous vibration, the tube pack is raised, whereby the collecting tubes are closed by the earth which penetrated into the lower part of the tubes, or the collecting tubes at the beginning of raising (so far they have not been already closed in the course of driving-in) are closed by suspended flaps, whereas the filling tubes are opened after raising the tube pack to pass the filling into the uncased space in the earth; finally the fully raised tube pack is emptied. The tube pack can be furthermore provided on its lower extremity with an advance spade which is driven-in under vibration into the earth and, in the case given, also into a part of the circumference or cross section of an adjacent recently filled pile, whereby the advance spade guides the tube pack along the wall of the adjacent pile space and prevents any forcing of the earth into its filling,

The arrangement for producing piles and subterranean pile walls according to this invention comprises a pack of parallel and mutually separated tubes, some of which, the filling tubes, are temporarily or permanently provided with closures at their lower ends, other tubes, the collecting tubes, are substantially open at the bottom or partially closed by filling tubes, or have lateral discharge openings from the filling tubes and on opposite sides suspensions with flaps which in a raised position rest against the internal wall of the collecting tubes and in the lowered position close these tubes, whereby they are seated on internal rests, temporarily fixed on the internal wall of these tubes.

The upper parts of the filling tubes terminate in an open storage bin for the concrete mixture which is arranged below the top of the collecting tubes, which are closed at the top and are provided with a supply for adjustment of the air pressure inside the collecting tubes, whereby above the storage bin a vibration ram provided with a spring suspension is fixed to the collecting tubes, thus creating a unit for suspension on a hoist and finally the lower part the arrangement is provided with an advance spade parallel with the longitudinal axis of the tube pack.

The technical advantages of the described process consist in the possibility of displacing the earth material up to the required depth and simultaneously to collect a part of the earth, whereby the ratio of the collected earth can be adjusted according to the resistance against driving-in, according to properties of the earth material and their significance for the bearing capacity of the pile, whereafter the hollowed space is filled and the earth material compacted by the concrete mixture at a simultaneous removal of a part of the earth. The pile spaces are hollowed and filled continuously, the whole arrangement being filled once and emptied after filling the pile space. The high penetration capacity of open collecting tubes makes the driving-in into the required depth easy, whereby the surrounding earth is compacted due to vibration and due to pressure of partly or completely closed collecting tubes, or by driving-in of a closed tube pack into a filled part of the pile space. The piles have a uniform structure and, if required, a complicated mantle of increased cross section, so that the bearing capacity of the adjacent compacted earth and the reinforced cross section of the piles are fully utilized. The manufacturing process enables, with the use of a single arrangement provided with a simple addition, the production of piles one after another as parts of a pack of piles or of a continuous pile wall. The arrangement is complex, all parts are firmly connected, whereby the closures are removable and are arranged so as to enable the displacement and the collection of the earth material and the reliable filling of the pile space or the pressing of the filling against the walls of the pile space; the arrangement is simultaneously simple, ready for use, mobile, and requires little attendance and maintenance.

The process and arrangement can be advantageously utilized in different earth material and for the production of piles of different depths. The process is speedily practised with reduced requirements on the efficiency of the ram, with permanently attached closures, small sizes of possibly used lost bits, and high bearing capacity of the piles with a perfectly utilized filling. With the proper process of production and the limited width of the reinforced subterranean wall, production costs are substantially reduced and all mechanical devices may be utilized continuously and efficiently.

DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the object of this invention are schematically shown in the attached drawings in which:

FIG. 1 is a view partly in elevation and partly in cross section of a driven-in arrangement comprising two tubes fixed parallel and separated by a common part, whereby the filling tube is provided with a slidable closure and the collecting tube is substantially open;

FIG. 2 is a cross section along a plane indicated in FIG. 1 by the line II—II;

FIG. 3 is an elevation of a driven-in arrangement comprising two tubes which are coaxial, fixed parallel and mutually separated, whereby the lower opening of the collecting tube is partially covered by a filling tube closed by a lost bit;

FIG. 4 is a cross sectional view of the arrangement along a plane indicated in FIG. 3 by the line IV—IV;

FIG. 5 is an elevation of a driven-in arrangement comprising three tubes fixed parallel and separated by common parts, the filling tube being provided with a slidable closure at the bottom, with side stops in a lateral part of the collecting tubes which tubes are open at the bottom, with suspended flaps opposite to said ports;

FIG. 6 is a cross sectional view of this arrangement along a plane indicated in FIG. 5 by the line VI—VI;

FIG. 7 is an elevation of an arrangement comprising two tubes, fixed parallel and separated by a common part, the arrangement being shown in the course of driving-in, when partially raised and the flap closing the opening of the collecting tube;

FIG. 8 is an elevation partly in section of an arrangement in the course of filling by the concrete mixture after being driven-in into the required depth;

FIG. 9 is an elevation of the arrangement in the course of raising and filling of the uncased pile space in the earth;

FIG. 10 is an elevation of the arrangement in the course of a repeated driving-in and displacement of the earth material by the filing;

FIG. 11 is an elevation of the completely raised arrangement in the course of emptying a filled pile into which a reinforcement is introduced;

FIG. 12 is an elevational view of the arrangement as in FIG. 11 provided on the sliding cover with an advance spade in the course of driving-in into a part of the circumference and cross section of an adjacent, just filled pile; and

FIG. 13 is a cross sectional view of this arrangement along a plane indicated in FIG. 12 by the line XIII—XIII.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The arrangement as shown in FIGS. 1, 3 and 5 comprises a pack of tubes with at least one filling tube 1, closed at the bottom by a lost bit 2, which displaces the earth 7, to the sides in the course of driving-in and with at least one collecting tube 4 which is either substantially open (FIG. 1, 5 and 12) or is partially closed by the filling tube 1 (FIG. 3) or is provided with lateral ports 15 for the passage of the filling and on opposite sides with flaps 17 which in the course of driving-in are pressed by the collected earth core 8 against the internal wall of the collecting tubes 4 and against arms of levers 18 in slots 19 of the collecting tubes 4, or are eventually pressed against leaf springs 20 on the back of the flaps 17. In the course of driving-in of the arrangement as shown in FIG. 5, the lateral ports 15 of the collecting tubes 4 are closed by the sliding closure 13 of the filling tube 1.

It is generally possible to adjust the passage of the earth 7 through the collecting tubes 4 by air pressure on the raised earth core 8, the pressure air being supplied via supply pipes 5. It is furthermore possible to prevent entrance of earth 7 into the collecting tube 4 by the flap 17, which in case of raising of the arrangement (see FIG. 7) is first turned due to pressure of the flat spring 20, or due to pressure of the external lever 18 in the slot 19, and subsequently drops due to the impact of the loosened earth core 8. In the course of a further driving-in, the flaps 17 are pressed into the openings of collecting tubes by the weight of the earth core 8; the flaps may also be thus pressed by air pressure, which is adjusted via the supply pipe 5.

After the tube pack has been driven-in into the required depth, the up-to-now empty filling tube 1 and a part of the open storage bin 3 are filled (see FIG. 8) by a concrete mixture 22 and with a simultaneous vibration the tube pack is either entirely or only partly raised (FIG. 9) whereby the concrete mixture 22 flows by gravity through the filling tube 1 and the lateral port 15 into the uncased space created by the pack of tubes in the earth 7. In the course of the raising of the arrangements shown in FIGS. 1 and 3, the collecting tube 4 is closed either by the earth core 8. In the course of raising of the arrangement the sliding closure or lost bit 2 is pulled out by its own weight and by the pressure of the concrete mixture 22, suspended on a pole 9 (FIG. 1) and on a top stop 11 seated on a rest 10 fixed on the arrangement, or the sliding closure 2, remains suspended on a lateral extension 13, which is seated against the lower edge of the lateral port 15 of the collecting tube 4.

The partially raised arrangement can be again driven-in into the fresh concrete 23 (FIG. 10) which is pressed by the automatically closed tubes against the surrounding earth 7.

The described process of filling the pile space and of compressing the fresh concrete can be, according to need, repeated in the same section or section after section, or in the whole depth of the pile space. Finally the raised arrangement is moved to come beyond the pile space 23 (FIG. 11) and after removal of internal stops 21 from the collecting tube 4 is emptied. Simultaneously the excess concrete mixture 22 is emptied from the filling tube 1 via the open lateral port 15. If needed, a reinforcement 25 fixed to a vibrator 26 can be inserted into a just filled pile 23 (FIG. 11).

The process of producing pile packs and subterranean pile walls differs from the above-described process in that an advance spade 24 is fixed to the sliding closure or bit 2; such advance spade 24 may be made from a part of a longitudinally cut collecting tube 4. The arrangement is driven-in into the earth 7 (FIGS. 12 and 13) and simultaneously into a part of the circumference and cross section of a just filled pile space 21.

The arrangement shown in the drawings consists of parallel tubes fixed together with their tube spaces separate. At least one tube in the tube pack, the filling tube 1, is provided at its lower end with a slidable closure 2,

which forms a lost bit (FIG. 3) or is a permanent part of the filling tube 1, where it can be suspended on a pole 9 and a top step 11 above a guiding tube 10 permanently fixed on stable parts of the arrangement (in the case given on an open storage bin 3), or it can be arranged as a permanent sliding bit provided in the inserted part with a packing 12 and with lateral extensions 13 cooperating with stops 14 in the lateral ports 15 of the second so called collecting tubes 4 (FIGS. 5, 7 and 12).

The collecting tubes 4 are substantially open at the bottom (FIG. 1) or partially closed by the filling tube 1 (FIG. 2), or can be provided with lateral ports 15 into the filling tubes, provided with flaps 17, and with external levers 18 in slots of the collecting tubes 4, the flaps 17 resting in their lifted position against the internal wall of the collecting tubes 4 and on arms of the external levers 18, or rest against flat springs 20, whereas when turned into the openings of the collecting tubes 4 they rest with their edges on stops 21 temporarily fixed on the internal wall of the collecting tubes 4.

The filling tubes 1 terminate at their top part into an open storage bin 3 with a cone shaped bottom, which is arranged below the top of the collecting tubes 4, which themselves are closed at the top and provided with supply pipes 5 for adjusting air pressure on the earth core 8 in the collecting tube 4, with a vibration ram 6 with a resilient suspension for suspending on a hoist being fixed to the collecting tubes 4 above the storage bin 3.

In FIG. 12 and 13 there is schematically shown an advance spade 24 fixed to the slidable bit 2, said advance spade 24 being situated so as to penetrate, in the course of driving-in of the arrangement, into a part of the circumference and cross section of a just filled adjacent pile 23.

In a further, unillustrated arrangement according to this invention, there are tubes fixed parallel, mutually separated, and of different cross section, whereby the lower end of some tubes, the filling tubes, is provided with slidable closures 2, flaps or lost bits, whereas other tubes, so-called collecting tubes, are substantially open at the bottom or partly closed by filling tubes 1, or are provided with lateral ports 15 into filling tubes 1 and on opposite walls with suspensions 16 with internal flaps 17.

In addition the lower parts of the tube pack can be provided with advance spades 24 of different shapes and sizes. The open storage bin 3 can have a special supply conduit, through which the filling 22 is pneumatically or hydraulically conveyed both in the course of raising the arrangement and the course of filling the pile space in the earth 7.

The invention is illustrated and described with a reference to a plurality of preferred embodiments thereof and it is to be understood that it is in no way limited to said plurality of embodiments but is capable of numerous modifications according to the appended claims.

What is claimed is:

1. A process of producing piles in earth material, comprising driving-in at the required place a pack of parallel, mutually firmly connected but laterally separated tubes to a predetermined depth, at least one of said tubes, a filling tube, being closed at the bottom, in the course of driving-in displacing the earth material to the sides, other tubes, collecting tubes, being substantially open at the bottom to allow the earth material to enter said collecting tubes in the course of driving-in, closing the collecting tubes at the bottom prior to raising them after the driving-in has been finished, opening the filling tubes at the bottom, filling the filling tubes with pile-forming material, raising the tube pack, and, subsequently discharging the pile-forming material through openings at the bottom of filling tubes into the uncased bottom part of the pile space until the pile space is completely filled by the pile-forming material after the tube pack has been completely raised, and emptying the collecting tubes of the raised tube pack of the earth material after displacing it beyond the produced pile.

2. A process as set forth in claim 1, comprising adjusting the amount of earth material collected by a collecting tube by pressure air acting from the top on the earth core in the collecting tube.

3. A process as set forth in claim 1, comprising repeatedly driving-in the tube pack closed at the bottom after a part of the pile space has been filled and the tube pack has been partially raised, and compacting the earth material by exerting pressure on the fresh filling of this space.

4. A process as set forth in claim 1, comprising driving-in a lateral extension of the tube pack, in the course of its driving-in into a part of the circumference and cross section of a just filled adjacent pile, thereby permitting a continuous production of pile packs and pile walls.

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