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(54) Method and device for producing a pile in the earth

(57) Device for pumping a curable mass, in particular curing concrete, provided with at least one cylinder which can be filled with curable mass for pumping, at least one piston (2) which is movable through the at least one cylinder (3) over at least one pumping stroke distance in order to pump the curable mass out of the cylinder (3); and measuring means (5) which are adapted to measure the piston pumping stroke distance for the purpose of determining a quantity of curable mass pumped under the influence of the piston (2). The invention further provides a method for filling a cavity with a curable mass, in particular curing concrete, particularly for the purpose of producing a foundation pile.

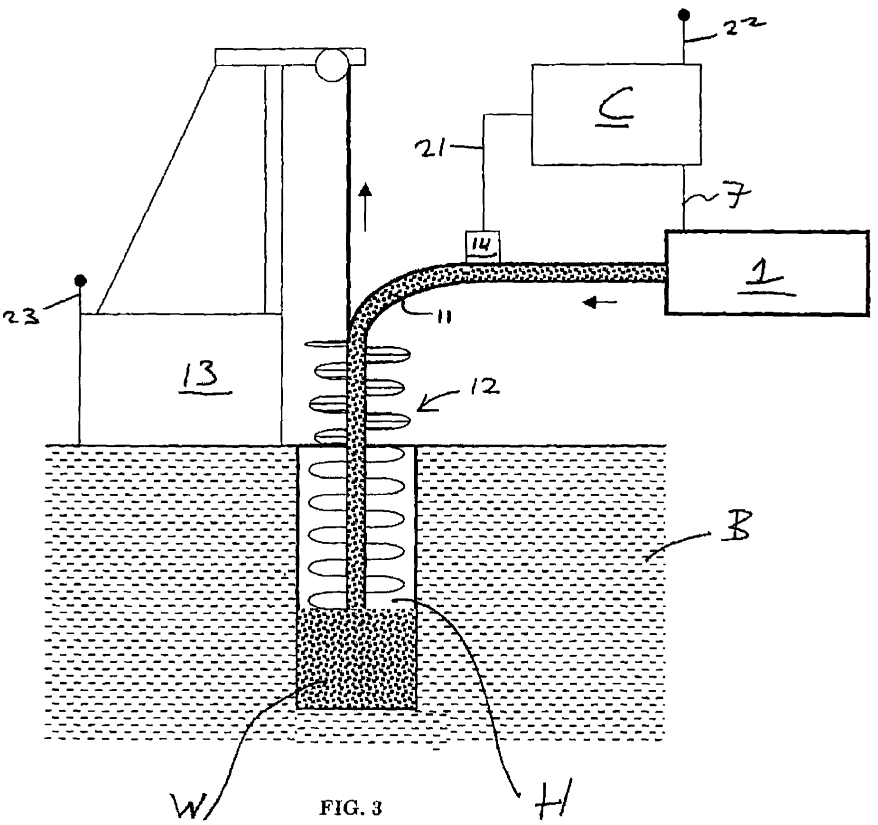

FIG. 3

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Description

[0001] The present invention relates to a method for producing a pile in the earth, wherein a displacement body with a supply channel for a curable mass is driven into the ground to a predetermined pile depth, the curable mass is fed into the supply channel of the displacement body and the displacement body, after reaching the pile depth, is removed from the ground while the curable mass flows out of an open end of the supply channel and into a cavity left in the earth. In addition, the invention relates to a device for arranging a pile in the earth, comprising a tube to be arranged in the earth and having a supply channel for supplying a curable mass to an outer end and pump means for pumping the curable mass into the supply channel. It is noted here that where reference is made in the present patent application to a tube, this must be understood to mean, unless expressly stated otherwise, any elongate displacement body with a supply channel through which the curable mass can be fed.

[0002] Such a method and such a device are known from International patent application WO 00/75436. In the method and device described herein a tube filled with concrete is driven into the ground to force a cavity, and withdrawn immediately after reaching. A shut-off valve situated at the end of the tube is here remotely controlled, and concrete is driven into the displacement body using a pump device so that concrete flows out of the outer end during withdrawal until the displacement body has reached ground level. The cavity left by the tube is thus completely filled with concrete, which thus forms a foundation pile after curing. An example of a pumping device used for this purpose is for instance described in German Offenlegungsschrift DE 3421371 A 1, and comprises a double cylinder pump with two cylinders and respective pistons for pumping the mass.

[0003] A drawback of the known method and device is that a shut-off valve is here applied at the end of the tube to prevent undesired outflow of concrete. Such a shut-off valve is however a mechanically vulnerable element, the more so as this component is exposed to considerable forces when the displacement body is driven into the ground and is subject to wear as a result of the concrete flowing therethrough. In practice, such a shut-off valve is therefore susceptible to malfunction and forms a source of irritation.

[0004] The present invention has for its object, among others, to provide a method and device of the type stated in the preamble, whereby the use of such a shut-off valve can be avoided.

[0005] For this purpose a method of the type stated in the preamble has the feature according to the invention that the supply channel is provided beforehand with a closing cover at the outer end, that a curable mass is fed into the supply channel only when a determined penetration depth has been reached, and that a quantity of curable mass fed into the supply channel is measured and precisely adapted to an intended pile volume. The closing cover is not intended to prevent the mass flowing out but to prevent soil entering the supply channel when the displacement body is driven into the earth. The cover can therefore lie wholly loose against the outer end of the supply channel, and a particular embodiment of the method according to the invention thus has the feature that a lost cover is used as closing cover which remains behind in the ground with the pile.

[0006] In the method according to the invention the supply channel is at least practically empty in the first instance when it is driven into the earth. It is not therefore necessary to retain a mass. The displacement body is then first driven into the earth to a certain penetration depth before the supply channel is supplied with the curable mass. The earth beneath the outer end of the supply channel now prevents the mass flowing out prematurely. The displacement body is then moved to the pile depth and withdrawn, while the mass simultaneously flows out for the purpose of forming the pile The total quantity of mass fed to the supply channel is here precisely adjusted to the pile volume so that the supply channel will be at least almost empty when it reaches ground level. A mechanically controllable shut-off valve as in the known method and device can thus be avoided, and a significantly more robust and reliable system is obtained.

[0007] A further preferred embodiment herein has the feature according to the invention that a cover with an anchoring member is applied as cover, and that the cover is fixed to a ground surface with the anchoring member. During the work preparation a number of such covers can thus be placed at the desired positions in accordance with the desired pile positions, whereafter during the work the displacement body is placed on one cover at a time and the above described method is repeated in order to realize an underground pile in each case. Since placing of the covers can be carried out entirely beforehand, an exceptionally high efficiency can thus be achieved with the method according to the invention.

[0008] A further particular embodiment of the method according to the invention has the feature that a pivoting flap cover resting against a seat under an inward directed spring tension is used as closing cover. Such a flap cover falls open as soon as a pressure is exerted thereon from the inside, but closes the displacement body adequately from outside against penetration therein of earth or mass which has meanwhile been injected into the earth. It is thus possible to form a thickened base on a pile by driving the displacement body down once more after pulling it up over some distance, and herein pushing the already injected mass to the side. The displacement body is subsequently withdrawn again while the mass flows out, for instance up to ground level, so that a pile with a thickened base is obtained for an increased stability. Although the method is suitable for the use of different types of curable mass, the method is highly suitable in principle for the application of all occurring types of concrete mortar.

[0009] A device of the type stated in the preamble has the feature according to the invention that dosing means are provided for the purpose of dosing a total quantity of mass fed to the supply channel, and that the dosing means are provided with a control which limits the total quantity of curable mass to an intended pile volume. For the method and device according to the invention it is important here that the quantity of mass fed to the displacement body is dosed more or less accurately. It is per se known to measure the flow rate of the stream of curable mass. In this manner it can for instance be determined whether sufficient curable mass has been pumped to completely fill a cavity with this mass. An example of a measuring device which is intended for the purpose of measuring the quantity of concrete flowing through a tube is for instance described in WO 00/57140. This measuring device comprises a rotor which can rotate under the influence of the flow of concrete and thus measures the rate of flow of the concrete. A drawback of this measuring device is that it requires frequent maintenance, jams relatively easily, can leak and is relatively inaccurate.

[0010] The present invention also has for its object to provide a device to at least largely obviate these problems. The invention has the particular object of providing a relatively low-maintenance and accurate device for measuring a quantity of pumped curable mass.

[0011] For this purpose a device of the type stated in the preamble has the feature according to the invention that the pumping device is provided with at least one cylinder which can be filled with curable mass for pumping, at least one piston which is movable through the at least one cylinder over at least one pumping stroke distance in order to pump the curable mass out of the cylinder; and measuring means which are adapted to determine said piston pumping stroke distance for the purpose of determining a quantity of curable mass pumped under the influence of the piston.

[0012] According to the invention the pumping device is herein provided per se with measuring means with which the quantity of pumped curable mass can be determined. The measuring means are adapted to measure the piston pumping stroke distance. The quantity of mass pumped during a determined pumping stroke then quite simply equals the internal diameter of the cylinder times the pumping stroke distance. The pumped quantity of mass can thus be determined particularly accurately, in reliable manner and with low-maintenance means. Each pumping stroke distance can include diverse distances, for instance a maximum distance over which the piston is movable through the cylinder, but also a part of this maximum distance. By means of the measuring means it is possible to accurately determine at any moment during use how much curable mass cumulatively has been pumped out of the cylinder by the piston, and for instance how many pumping strokes - with associated stroke distances - still have to be performed by the piston in order to pump a determined end quantity. In a particular embodiment the device according to the invention is therefore characterized in that the control is adapted to determine, on the basis of piston pumping stroke distances measured by the measuring means, how much curable mass the at least one piston pumps cumulatively.

[0013] The measuring means can be embodied in various ways. In a simple development the measuring means are provided with a measuring rule to measure the displacement of the piston. The pump means can moreover be provided with drive means adapted to displace the at least one piston over the at least one pumping stroke distance, and the measuring means are adapted to measure the pumping stroke distance on the basis of one or more movements, characteristics and/or drive modes of the drive means. The measuring means can for instance be adapted to measure each momentary piston position of the piston relative to the respective cylinder. The pumping stroke distance can easily be determined from momentary piston positions measured successively by the measuring means. The measuring means can for instance also comprise an encoder, which encoder is particularly adapted to detect a displacement and/or a position of the piston.

[0014] According to the invention a device for filling a cavity with a curable mass, in particular curing concrete, is provided with a supply channel for feeding the curable mass to the cavity and a dosable pumping device for pumping the curable mass into the supply channel. A particular embodiment of the device herein has the feature according to the invention that the control is adapted to control the retracting means and/or the pumping device during use such that the quantity of curable mass pumped into the supply channel is sufficient to fill the cavity substantially completely without the cavity herein being overfilled. In this manner the cavity can be filled precisely with a desired quantity of curable mass. It is herein possible to avoid too much mass being pumped into the cavity, which can result in a waste of material. Such overfilling can moreover result in instability of the cavity. Overfilling can further result in an undesired change in the properties and/or structure of the mass pumped into the cavity.

[0015] A further particular embodiment of the device according to the invention is characterized in that the supply channel forms part of a drilling gear for drilling a cavity in the earth, and that the drilling gear is provided with retracting means for retracting the drilling gear from the cavity while the curable mass is being fed to the cavity via the supply channel. The device can for instance be further provided with a pressure gauge adapted to measure the pressure of the curable mass pumped into the supply channel by the pumping device.

[0016] According to a preferred embodiment, the device according to the invention is characterized in that the control is adapted to control the retracting means and/or the pumping device during use such that the cavity is automatically filled substantially completely with the curable mass. In this manner filling of the cavity can be carried out in automated, accurate and rapid manner. The control can herein for instance make use of the stroke distance(s) measured by the measuring means and of the pressure of mass in the supply channel measured by the pressure gauge. In addition, the control can for instance make use of a predetermined internal diameter of the cylinder of the pumping device and/or of other data for the purpose of automatically controlling the filling of the cavity. The control can be adapted to process pressures of the curable mass measured by the pressure gauge, wherein the control is adapted to control the retracting means and/or the pumping device during use such that the curable mass pumped into the supply channel has a predetermined filling pressure in order to fill the cavity substantially completely with this mass.

[0017] According to a further aspect of the invention, a method for pumping a curable mass, in particular curing concrete, comprises of filling a cylinder with curable mass, wherein a piston is moved through the cylinder over at least one pumping stroke distance in order to pump curable mass out of the cylinder, wherein the piston pumping stroke distance is measured, wherein on the basis of the piston pumping stroke distance measurement there is determined how much curable mass has been pumped out of the cylinder. This produces the above stated advantages, wherein it is possible to determine almost instantly in accurate and simple manner how much curable mass is being pumped. The inner diameter of the cylinder can for instance also be used in determining pumped quantities of curable material. This can for instance be applied in a method for producing a foundation pile, wherein curable mass is pumped into a cavity for the purpose of forming the foundation pile. In this way a robust foundation pile can be produced relatively rapidly without material wastage.

[0018] The present invention also relates to a method for producing a foundation pile, with the feature that to this end the curable mass is pumped into the cavity in the earth fully automatically, for instance wholly under the influence of a computer control. To date it is not known to have the formation of a foundation pile in the earth, or at least pumping of the mass into the earth, take place in fully automated manner. By forming the foundation pile in the earth in fully automated manner the pile can be produced rapidly and accurately.

[0019] In a particular embodiment a method for producing a foundation pile herein has the feature according to the invention that a tube is driven into the earth using the above described device, and that the curable mass is introduced into the cavity via the supply channel while the displacement body is being withdrawn from the cavity, and that the displacement body is withdrawn at such a speed, while such a quantity of curable mass is fed to the cavity, that the cavity is filled substantially completely with the curable mass.

[0020] The invention also relates to a control program with control instructions, for instance computer code, which instructions are adapted to perform a method according to the invention when the control instructions are carried out by a control. Application of this control program produces the above stated advantages.

[0021] The invention will now be elucidated on the basis of an exemplary embodiment and an associated drawing. Herein:

- Fig. 1 shows a side view of an exemplary embodiment of a pumping device of a first embodiment of a device according to the invention;
- Fig. 2 is a partly cut-away top view of the side view shown in Fig. 1;
- Fig. 3 shows a schematic view of a device according to the invention;
- Fig. 4 shows a cross-section of an outer end of a supply channel of a displacement body applied in a first embodiment of the device and method according to the invention; and
- Fig. 5 shows a cross-section of an outer end of a supply channel of a displacement body applied in a second embodiment of the device and method according to the invention.

[0022] The figures are for the most part schematic and not drawn to scale. Some dimensions in particular are exaggerated to a greater or lesser extent for the sake of clarity. Corresponding parts are designated in the figures with the same reference numeral.

[0023] Figures 1 and 2 show a pumping device 1 for pumping a curable mass, in particular curing concrete or other curing or curable mass for use in an embodiment of a device and method according to the invention. Pumping device 1 is for instance a double cylinder pump. Pumping device 1 is provided with two cylinders 3 with two associated pistons 2. Cylinders 3 can each be filled with curable mass for pumping. Pistons 2 are movable in each case in opposite direction, preferably over the same distance, relative to each other. Movement of pistons 2 can for instance be realized by means of hydraulic drive means (not shown).

[0024] Device 1 is further provided with a supply container 8 for supplying the curable mass to cylinders 3. During a movement of a piston 2 away from supply 8, during a suction stroke, piston 2 can draw the mass into the respective cylinder 3. During a reverse pumping movement toward supply container 8, during a pumping stroke, curable mass is pressed out of cylinder 3 by piston 2 and into a supply channel 11 connected to device 1. Valve means for controlling feed/discharge of the curable mass between supply container-pistons-supply channel are not shown in the drawing.

[0025] During each pumping stroke of a piston 2, piston 2 is moved through a desired pumping stroke distance by the associated cylinder 3. A possible pumping stroke distance brought about by a piston 2 is indicated in fig. 2 with an arrow D. In the exemplary embodiment a quantity of mass can be pumped into supply channel 11 at each pumping stroke by pistons 2, this quantity being equal to the pumping stroke distance D times the diameter of the respective cylinder 3. A usual cylinder diameter lies for instance in the range of about 0.2-0.3 metre, for instance about 23 centimetres or other dimension. A maximum pumping stroke distance can for instance lie in the range of about 1-2 metres, and can amount for instance to about 1.1 metre or other distance. A possible maximum pumping stroke distance is indicated in fig. 2 with arrow M. A pumping stroke distance D travelled by a piston 2 can for instance comprise only a part of the maximum piston pumping stroke distance M. The pumping stroke distance D can thus lie for instance in the range of about 0-2 metres, in particular in the range of about 0-1.2 metre, or in a different range. The quantity of mass pumped by the device per piston pumping stroke can for instance lie in the range of about 0-100 litres, or in a different range.

[0026] According to the invention the device is provided with measuring means 5 (in the drawing: 5a, 5b) which are adapted to measure each pumping stroke distance D for the purpose of determining a quantity of curable mass pumped under the influence of pistons 2. Measuring means 5 are preferably adapted to measure each momentary piston position of pistons 2 relative to the respective cylinders 3.

[0027] Measuring means 5 can be embodied in various ways to measure momentary piston positions of pistons 2. The measuring means can for instance be adapted to measure the positions of the two pistons 2 independently of each other. In the exemplary embodiment the position of the one piston depends on the position of the other piston, since pistons 2 are always moved in opposite directions through equal distances during use. In this case measuring means can be provided solely for the purpose of detecting the position of one of pistons 2, wherein the position of the other piston can be derived in simple manner from the position of this one piston.

[0028] As shown schematically in fig. 2, the measuring means can for instance be provided with an electronic measuring rule 5a which is adapted to measure the position of a piston shaft 9 coupled fixedly to one of the pistons 2. Measuring rule 5a can for instance be adapted to detect an outer end of piston shaft 9. For this purpose the outer end of piston shaft 9 can for instance be provided with a means 9a detectable by measuring means 5a, for instance a detectable material, a detectable signal generator and/or other detectable means.

[0029] In similar manner one of pistons 2, or each piston 2, can be provided with a means 2a which can be detected by suitable detecting means 5b, for instance detectable material, a detectable signal generator and/or other detectable means.

[0030] Measuring means 5 can for instance further comprise one or more encoders, which encoders are particularly adapted to detect a displacement and/or a position of the piston. It will be apparent to the skilled person how such an encoder can be provided for the purpose of detecting piston positions.

[0031] The measuring means can for instance be adapted to measure the position of a piston 2 or of a component attached to a piston 2 while making use of an optical measurement, electrical measurement, magnetic measurement, electronic measurement and/or other type of measurement. One or more lasers can for instance be provided for the purpose of optical measurements.

[0032] In an accurate, simple and inexpensive measuring method the measuring means 5 for instance comprise a voltage divider, wherein the voltage divider is controlled by a part of the piston or by a component coupled to the piston such as piston shaft 9. A piston 2 or a piston shaft 9 can for instance be provided with a sliding contact or the like in order to change an electrical resistance of the voltage divider during a piston movement. The voltage divider can be adapted for co-action with a piston 2, or a component of device 1 coupled thereto, such that an electrical signal generated by the voltage divider is a measure for the momentary piston position of piston 2. By applying such a voltage divider a piston position can for instance be determined precisely to a hundredth of a millimetre. Such a voltage divider furthermore requires little maintenance.

[0033] In addition, measuring means 5 can for instance be adapted to measure the pumping stroke distance on the basis of one or more movements, characteristics and/or drive modes of drive means of device 1, for instance hydraulic drive means, which drive means are adapted to displace pistons 2. The measuring means can for instance be adapted to measure hydraulic oil pressures of a hydraulic piston drive, and/or to measure flow of the pump oil, which pump oil can drive the pistons.

[0034] Pumping device 1 is preferably provided with and/or can be coupled to a control, which control is adapted to determine, on the basis of piston pumping stroke distances measured by the measuring means, how much curable mass is being pumped cumulatively by the at least one piston 2. Such a control C is shown schematically in the device depicted in Fig. 3. In the present exemplary embodiment the measuring rule 5a can for instance be coupled to control C by means of a communication connection 7 in order to transmit to control C a measuring signal depending on the piston positions. Such a communication connection can be provided in diverse ways, for instance by a wire connection, a wireless connection and/or in other manner.

[0035] During use of the device shown in Fig. 1-2 the momentary piston positions can be precisely determined by means of measuring means 5. From these positions it is possible to determine precisely how much curable mass is pumped into supply channel 11 by pistons 2. In this manner it is moreover possible to determine precisely how much more pumping stroke distance the device 1 must cover cumulatively in order to pump a determined, desired end quantity of mass into supply channel 11. At the moment that this end quantity has been pumped into channel 11, device 1 can be stopped so as to prevent excessive curable mass being pumped into channel 11.

[0036] Figure 3 shows schematically a device for filling a cavity with a curable mass, in particular curing concrete. The device is used in particular to pump curable mass into a cavity H for the purpose of forming a foundation pile.

[0037] The device is provided with a pumping device 1 according to the invention, for instance an embodiment of the device shown in Fig. 1-2. The device is further provided with a drilling gear 12 for drilling the cavity H into the earth B. A supply channel 11 connected to pumping device 1 forms part of drilling gear 12, or at least extends therethrough. The device further comprises a lifting device 13 which serves, among other purposes, as retracting means for retracting drilling gear 12 out of cavity H. In accordance with the invention an outer end of the supply channel is provided with a closing cover, at least during operation. Figure 4 shows a first embodiment thereof, wherein supply channel 11 is provided at an open end with a loose cover 110. Such a so-called lost cover prevents earth being able to enter supply channel 11 while the displacement body is being driven into the earth. The cover then remains behind in the ground together with the formed pile. An alternative embodiment of such a cover is shown in figure 5. In this case the cover comprises a flap cover 120 which is connected on one side to the wall of supply channel 11 for pivoting about a hinge 121. The flap cover herein rests counter to a spring tension against the outer end of the supply channel which functions as valve seat. Such a flap cover automatically falls open under the weight of the mass in supply channel 11, but seals the supply channel hermetically when a pressure is exerted thereon from the outside.

[0038] It is advantageous when the device is further provided with a pressure gauge 14 which is adapted to measure the pressure of the curable mass pumped into supply channel 11 by pumping device 1. Such a pressure gauge 14 is per se known in practice and can be embodied in different ways.

[0039] The device preferably further comprises a control C, this control C being adapted to control retracting means 13 and/or pumping device 1 during use such that cavity H is automatically filled substantially completely with the curable mass. Such a control C can for instance form part of pumping device 1, lifting device 13, and/or can be coupled thereto via one or more suitable communication connections 7, 22, 23. Control C and lifting device 13 are for instance placed in mutual communication connection, such as via wireless communication means with antennas 22, 23 or the like. Control C is further coupled to pressure gauge 14 via a suitable communication connection 21. In preference the control C can precisely control the pump speed of pumping device 1 for the purpose of instantaneous control of the curable mass W flowing out of pumping device 1. Likewise, control C can preferably bring about an accurate control of a retraction speed produced by retracting device 13.

[0040] According to a development of the invention, control C can be adapted to process pressures measured by pressure gauge 14, wherein control C is adapted to control retracting means 13 and/or pumping device 1 during use such that the curable mass pumped into supply channel 11 by pumping device 1 has a predetermined pressure for filling cavity H substantially wholly with this mass. In an alternative development the control C is adapted to control retracting means 13 and/or pumping device 1 during use such that the quantity of curable mass pumped into supply channel 11 is sufficient to substantially completely fill cavity H. Diverse combinations of the developments of control C are also possible. The control can further be provided with diverse means, for instance one or more computers, microcontrollers, PLCs (Programmable Logic Controllers), PID controls and/or the like. The device can further be provided with a suitable control program with control instructions, for instance computer code, wherein the control instructions can be carried out by the control in order to automatically control for instance the pumping device and/or retracting means 13. It will be apparent to the skilled person how such a control or control program can be adapted within the scope of the present invention.

[0041] During use of the device shown in fig. 3 a cavity H is for instance first arranged in the earth by means of drilling gear 12. Cavity H can then be automatically filled with a curable mass W, for instance curing concrete. The two cylinders 3 of pumping device 1 are herein filled alternately with curable mass, while pistons 2 are moved alternately through different pumping stroke distances through cylinders 3 so as to pump a desired quantity of curable mass W out of cylinders 2 and into supply channel 11. A piston 2 can in particular first be moved through a plurality of maximal pumping stroke distances M, and then through a final end stroke distance D which is smaller than the maximum distance M, in order to pump a desired total quantity of mass W.

[0042] During each pumping stroke a respective pumping stroke distance of piston 2 is measured accurately by using measuring means 5. On the basis of the pumping stroke distance measurements, and for instance the cylinder diameter of the cylinders, control C can determine precisely how much curable mass has been pumped cumulatively by pumping device 1 into supply channel 11. The momentary piston positions of pistons 2 are preferably detected for this purpose by measuring means 5. Control C can use this information to fill cavity H precisely and rapidly with the mass, while the supply channel is preferably withdrawn simultaneously from cavity H by lifting device 13 at a determined retraction speed. During use control C can further determine for instance how great an end stroke distance D must be in order to fill the final part of cavity H.

[0043] In addition to the use of diameters of cylinders 3 of pumping device 1, control C can for instance have available one or more appropriate calibration tables for determining pumped quantities of mass on the basis of pumping stroke distances.

[0044] Control C can further have at its disposal for instance data relating to the diameter of drilling gear 12 and/or the diameter of the cavity H for filling, and data relating to the depth of cavity H, so that control C can calculate the volume of cavity H and can also determine how much curable mass will be required in total to completely fill cavity H.

[0045] In a starting situation a downstream end of supply channel 11 is for instance situated close to a bottom of cavity H, and supply channel 11 is empty. Pumping device 1 can then be started so that supply channel 11 is filled with curable mass W. The pump speed of pumping device 1 can here be controlled by control C for the purpose of controlling the flow rate of the mass pumped through supply channel 11.

[0046] When the curable mass flowing through channel 11 reaches the bottom of cavity H, a determined pressure build-up occurs in supply channel 11. This pressure build-up is recorded by pressure gauge 14 and transmitted to control C.

[0047] When a desired, predetermined pressure suitable for filling cavity H has been created in supply channel 11, lifting device 13 can be controlled by control C in order to pull supply channel 11 at a suitable speed out of cavity H. Control C can moreover adj ust the retraction speed and the pump speed of pumping device 1 to each other, for instance to realize a desired, complete filling of cavity H. The control can for instance here increase the pump speed and the retraction speed for a determined period of time in order to achieve a rapid filling of cavity H. Control C can further be adapted to adjust the retraction speed and the pump speed to each other such that the pressure in supply channel 11 remains within a determined filling pressure range, or close to a predetermined filling pressure, appropriate for filling the cavity H. The filling pressure can for instance be desired in respect of determined qualities and properties to be achieved of mass W in a cured state thereof. Adjusting retraction speed, pump speed and - optionally - pressure in supply channel 11 to each other can for instance be carried out wholly or partially by making use of theoretically and/or experimentally determined ratios, tables, equations and the like pre-stored in a memory of control C. In addition, it is possible for instance for only a desired filling pressure or a desired filling pressure range to be entered into control C, wherein control C controls the filling of cavity H fully automatically on the basis of this desired filling pressure and the feedback relating to the momentary, actual pressure in channel 11 supplied by pressure gauge 14.

[0048] In this manner the curable mass can be pumped into the cavity fully automatically, for instance wholly under the influence of computer control, for the purpose of forming the foundation pile.

[0049] When the desired part of the cavity is almost filled with curable mass W, control C can control pumping device 1 and lifting device 13 such that a final cavity part to be filled is filled with a precisely measured quantity of mass so that overfilling is avoided. For this purpose control C can use the measurement data from the measuring means of pumping device 1, which measurement data include the momentary piston positions of pistons 2. Control C can easily derive from the measured, momentary piston positions how much pumping stroke distance both pistons 2 of pumping device 1 still have to cover to provide the final cavity part with mass W. For very precise filling, control C can for instance determine how great a final, referred to above as the end stroke, distance of either of the pistons 2 must be. Pistons 2 can then run through the thus determined, final pumping stroke distance (and optional end stroke distance) under the influence of control C, and the final part of cavity H for filling is completely filled with mass W, without overfilling.

[0050] Measuring means (not shown) can for instance be further provided to measure the position of the downstream end of the supply tube relative to the ground surface. These measuring means can for instance form part of the lifting device, or be provided in other manner. Control C can for instance make use of information from the measuring means in order to determine the depth of a remaining part of the cavity to be filled.

[0051] It will be self-evident that the invention is not limited to the described exemplary embodiments. Diverse modifications are possible within the scope of the invention as stated in the following claims. The cavity can thus be arranged in diverse ways, for instance by means of drilling, vibration or in other manner.

Claims

1. Method for producing a pile in the earth, wherein a displacement body with a supply channel for a curable mass is driven into the ground to a predetermined pile depth, the curable mass is fed into the supply channel of the displacement body and the displacement body, after reaching the pile depth, is removed from the ground while the curable mass flows out of an open end of the supply channel and into a cavity left in the earth, **characterized in that** the supply channel is provided beforehand with a closing cover at the outer end, that a curable mass is fed into the supply channel only when a determined penetration depth has been reached, and that a quantity of curable mass fed into the supply channel is measured and precisely adapted to an intended pile volume.

2. Method as claimed in claim 1, **characterized in that** a lost cover is used as closing cover which remains behind in the ground with the pile.

3. Method as claimed in claim 2, **characterized in that** a cover with an anchoring member is applied as cover, and that the cover is fixed to a ground surface with the anchoring member.

4. Method as claimed in claim 1, **characterized in that** a pivoting flap cover resting against a seat under an inward directed spring tension is used as closing cov-

er.

5. Method as claimed in one or more of the foregoing claims, **characterized in that** a concrete mortar is applied as the curable mass.

6. Device for arranging a pile in the earth, comprising a tube to be arranged in the earth and having a supply channel for supplying a curable mass to an outer end and pump means for pumping the curable mass into the supply channel, **characterized in that** dosing means are provided for the purpose of dosing a total quantity of mass fed to the supply channel, and that the dosing means are provided with a control (C) which limits the total quantity of curable mass to an intended pile volume.

7. Device as claimed in claim 6, **characterized in that** the pumping device is provided with at least one cylinder (3) which can be filled with curable mass (W) for pumping, at least one piston (2) which is movable through the at least one cylinder (3) over at least one pumping stroke distance in order to pump the curable mass out of the cylinder (3); and measuring means (5) which are adapted to determine the piston pumping stroke distance for the purpose of determining a quantity of curable mass pumped under the influence of the piston (2).

8. Device as claimed in claim 7, **characterized in that** the measuring means comprise a measuring rule to measure displacement of the piston.

9. Device as claimed in claim 6 or 7, **characterized in that** the pump means are provided with drive means adapted to displace the at least one piston (2) over the at least one pumping stroke distance, and that the measuring means (5) are adapted to measure the pumping stroke distance on the basis of one or more movements, characteristics and/or drive modes of the drive means.

10. Device as claimed in one or more of the claims 6-9, **characterized in that** the measuring means comprise an encoder, which encoder is able and adapted to detect a displacement and/or a position of the piston (2).

11. Device as claimed in one or more of the claims 6-10, **characterized in that** the pump means are provided with at least two cylinders with at least two associated pistons, wherein particularly the pistons are movable in each case in opposite directions to each other during use.

12. Device as claimed in one or more of the claims 6-11, **characterized in that** the control (C) is adapted to determine, on the basis of piston pumping stroke distances measured by the measuring means, how much curable mass the at least one piston (2) pumps cumulatively.

13. Device as claimed in one or more of the claims 6-12, **characterized in that** the measuring means are adapted to measure each momentary piston position of the piston (2) relative to the respective cylinder (3).

14. Device as claimed in one or more of the claims 6-13, **characterized in that** the supply channel is provided with a closing cover at the outer end.

15. Device as claimed in one or more of the claims 6-14, **characterized in that** the supply channel (11) forms part of a drilling gear (12) for drilling a cavity (H) in the earth (B), and that the drilling gear is provided with retracting means (13) for retracting the drilling gear (12) from the cavity (H) while the curable mass is being fed to the cavity (H) via the supply channel (11).

16. Device as claimed in claim 15, **characterized in that** a pressure gauge (14) is provided which is adapted to measure a pressure of the curable mass pumped into the supply channel (11) by the pumping device (1).

17. Device as claimed in claim 16, **characterized in that** the control (C) is adapted to process pressures of the curable mass measured by the pressure gauge, wherein the control (C) is adapted to control the retracting means (13) and/or the pumping device (1) during use such that the curable mass pumped into the supply channel (11) has a predetermined filling pressure in order to fill the cavity (H) substantially completely with this mass.

18. Device as claimed in claim 15, 16 or 17, **characterized in that** the control (C) is adapted to control the retracting means (13) and/or the pumping device (1) during use such that the cavity (H) is automatically filled substantially completely with the curable mass.

19. Device as claimed in claim 18, **characterized in that** the control (C) is adapted to control the retracting means (13) and/or the pumping device (1) during use such that the quantity of curable mass pumped into the supply channel (11) is sufficient to fill the cavity (H) substantially completely without the cavity (H) herein being overfilled.

20. Method for producing a foundation pile as claimed in one or more of the claims 1-5, **characterized in that** to this end the curable mass is pumped into the cavity in the earth fully automatically, for instance wholly under the influence of a computer control.

21. Method as claimed in claim 20, **characterized in that** the displacement body is driven into the earth (B) using a device (12) as claimed in one or more of the claims 6-19, and that the curable mass is introduced into the cavity via the supply channel (11) while the displacement body (12) is being withdrawn from the cavity (H), and that the displacement body is withdrawn at such a speed, while such a quantity of curable mass is fed to the cavity, that the cavity (H) is filled substantially completely with the curable mass.

22. Control program with control instructions, for instance computer code, which instructions are adapted to perform a method as claimed in any of the claims 1-5, 20 and 21 when the control instructions are carried out by a control (C).

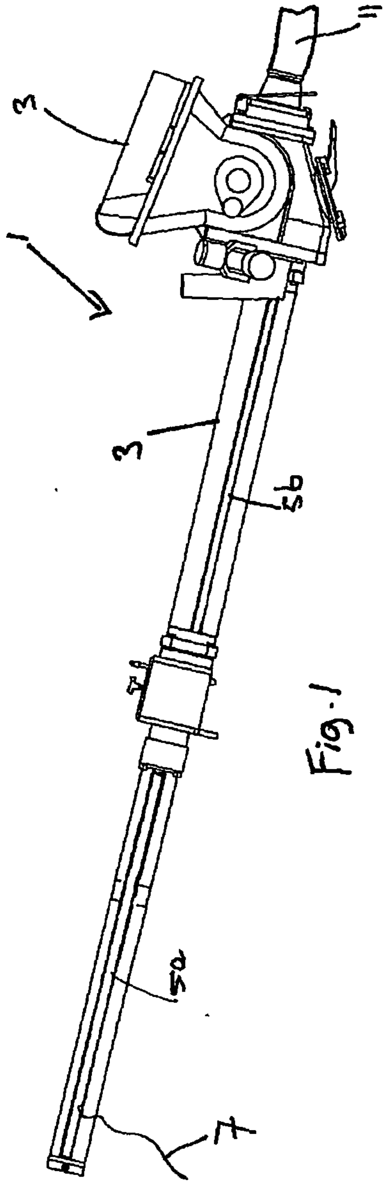

Fig. 1

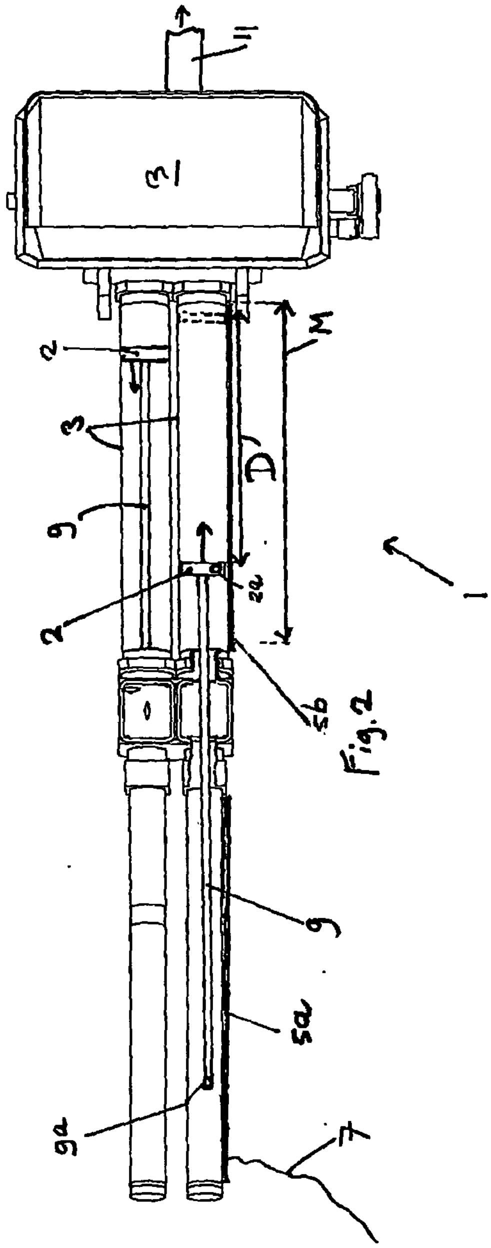

Fig. 2

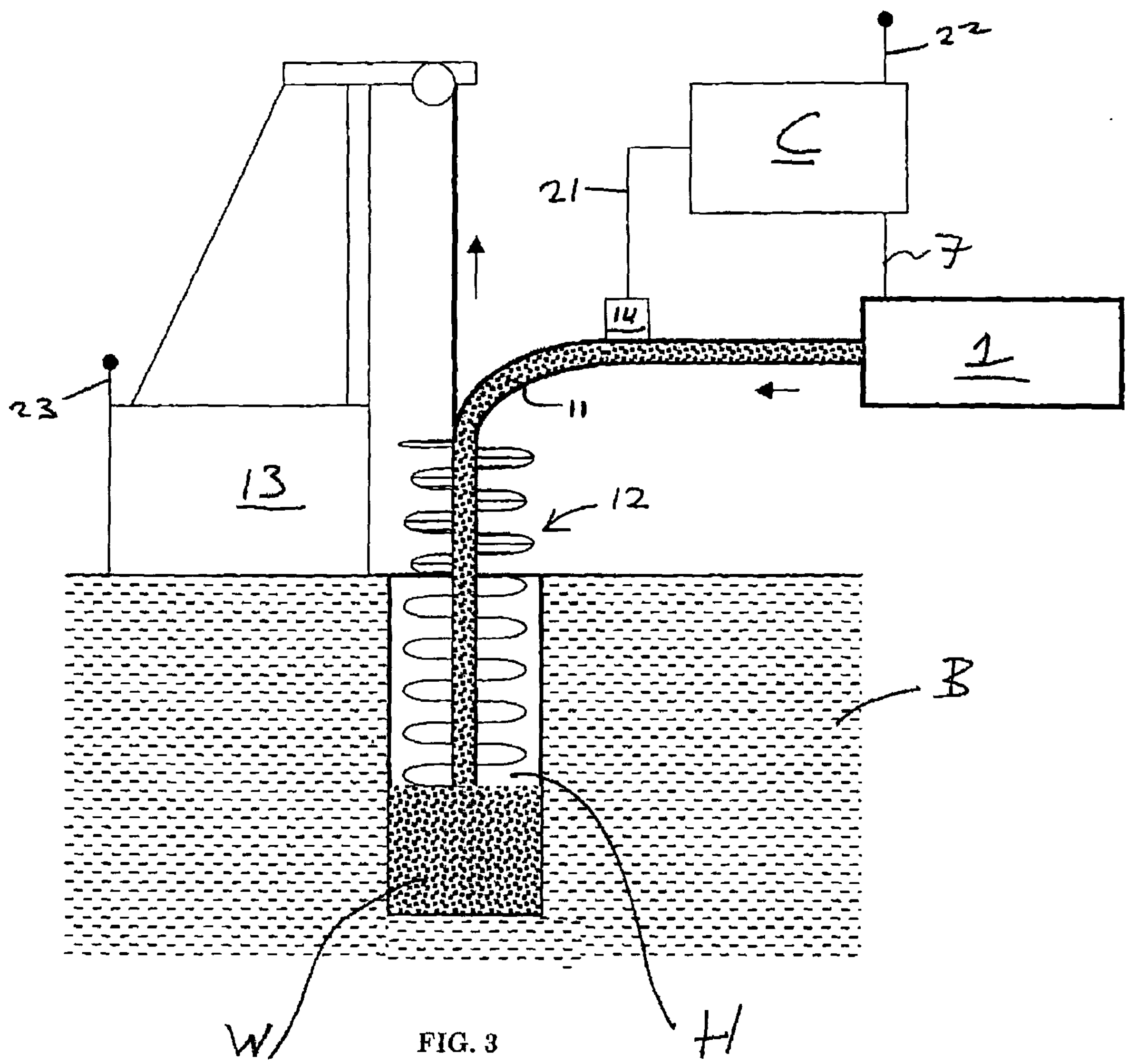

FIG. 3

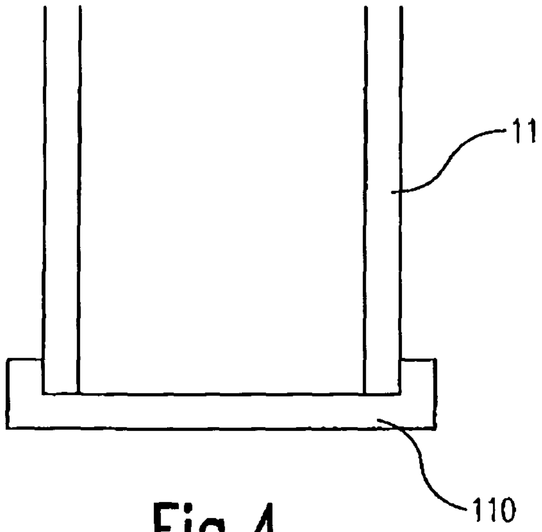

Fig.4

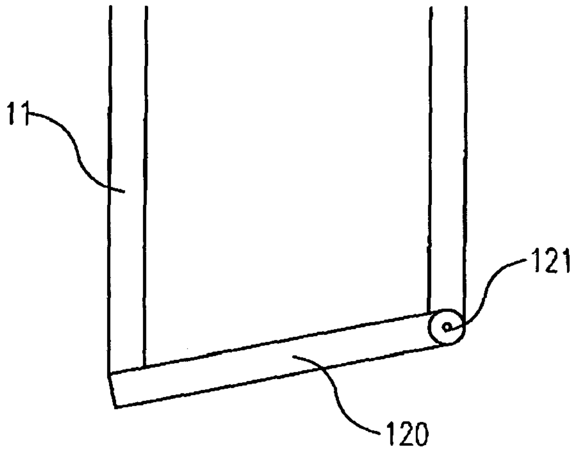

Fig.5

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EUROPEAN SEARCH REPORT

Application Number
EP 06 07 5194

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	3 May 2006	Kergueno, J

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