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Method of making a foundation pile.

A hollow tube (3) is introduced into the ground (4) in such a manner that the tube, in the introduced condition, is internally empty, a priorly made bearing element (13) having a smaller outside dimension than the inside diameter of the hollow tube is introduced into the empty hollow tube in such a manner that all round between the bearing element (13) and the hollow tube (3) a free space remains, the space between the bearing element and the inner wall of the hollow tube is filled with a suitable lubricant (11) and the hollow tube is subsequently removed from the ground.

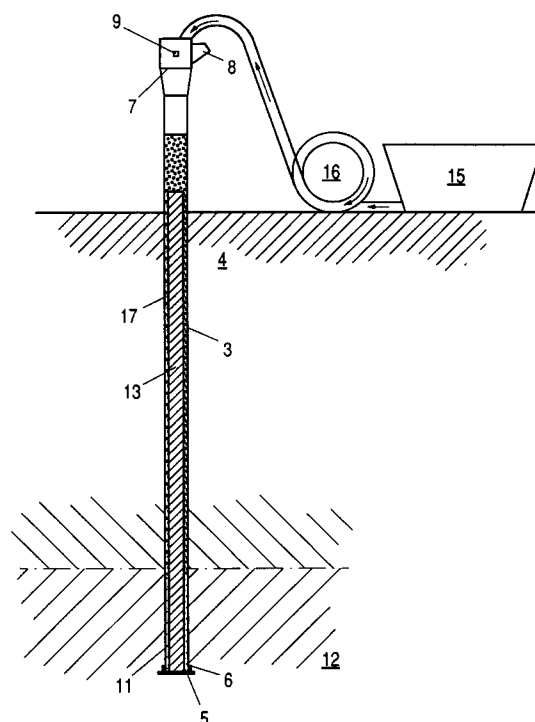


FIG. 4

This invention relates to a method of making a foundation pile.

There already exist many methods of making a foundation pile. Such methods comprise driving or screwing ready-made foundation piles into the ground, as well as bringing a hollow shell into the ground, removing the soil from the shell so that an empty space is formed which is subsequently filled up with concrete, whereafter the shell is optionally removed. Still other methods are known from the literature.

In certain types of soil conditions, the phenomenon of so-called negative adhesion occurs in the part of the soil above the bearing layer which the foundation pile is eventually to rest on or in the upper part of which the lower end of the foundation pile eventually comes to rest. In the case of negative adhesion, the corresponding part of the soil "binds" to the foundation pile and as this part of the soil sets, draws the pile downwards along with it.

Heretofore, it has been attempted to prevent the phenomenon of negative adhesion by providing a layer of a suitable lubricant such as bentonite all round a ready-made foundation pile, for instance, when screwing it into the ground, *inter alia* by injecting bentonite from the tip of the pile over the path along which the tip traverses the soil part that exhibits negative adhesion.

The object of the invention is to provide a method for making a foundation pile in which the problem of the so-called negative adhesion occurs to a far lesser extent than in the case of ready-made foundation piles driven or screwed into the ground in the conventional manner.

The object contemplated is accomplished according to the invention with a method in which a hollow tube is introduced into the ground in such a manner that the tube, in the introduced condition, is internally empty, a priorly made bearing element having a smaller outside dimension than the inside diameter of the hollow tube is introduced into the empty hollow tube in such a manner that all round between the bearing element and the hollow tube a free space remains, the space between the bearing element and the inner wall of the hollow tube is filled with a suitable lubricant and the hollow tube is subsequently removed from the ground.

Introducing the hollow tube into the ground in accordance with the invention can be done in different manners which are known per se, for instance by ramming or by screwing. The hollow tube can be introduced in a manner whereby the soil is displaced, so that the tube is empty when being introduced and remains so after being introduced. However, it is also possible to introduce a hollow tube which is open at the lower end and remove the soil in the hollow tube when introduced,

for instance with an auger, so as to obtain an empty tube. If the tube is introduced by ramming whereby the soil is displaced, this is preferably effected in a manner with the hollow tube having provided at the lower end thereof a watertight closure in the form of a suitable shoe, this shoe being connected to the hollow tube in such a manner that upon later removal of the tube the shoe is released and remains behind in the ground. If the hollow tube is screwed into the ground, whereby soil is displaced, a so-called lost screw point can be used. The shoe preferably used in pile driving can for instance have the shape of a round flat plate provided with a round ring extending upright relative thereto, which round ring fits more or less closely onto the end of the hollow tube. By means of a suitable sealing cement, such a shoe can be connected to the end of the hollow tube.

In a suitable embodiment of the method according to the invention, prior to the introduction of the bearing element into the hollow tube, an amount of grout or similar material is poured into the tube, so that after the introduction of the bearing element the lowermost part thereof is surrounded by a grout covering below the lubricant covering which is subsequently formed. Such a grout filling, which is optionally provided, depending on the bearing capacity contemplated and on the local soil conditions, provides a solid base for the eventual foundation pile, which pile base can be located for instance in the bearing part of the ground below the part that exhibits negative adhesion.

The bearing element to be introduced into the hollow tube in accordance with the invention can be any element suitable for the purpose, for instance a prefabricated concrete pile or beam, a steel pile or the like; the cross-section can be of any suitable shape, for instance round, rectangular or T-shaped. The lubricant to be used according to the invention can be bentonite or another suitable lubricant, for instance a bituminous material.

According to the invention, after arranging the bearing element and surrounding it with the lubricant, the hollow tube is removed, for instance by pulling it out. In a suitable manner, the bearing element can then be extended in upward direction, for instance using a pile coupling.

The result of the method according to the invention is a foundation pile provided with a layer of lubricant over that portion of its length where it is surrounded by a layer of soil exhibiting negative adhesion. Thus, the phenomenon of negative adhesion is counteracted. In foundation piles which have been made in this manner, it has been observed that the negative adhesion was only 10% of the negative adhesion which had been calculated for a similar pile without the layer of lubricant.

The invention will now be elucidated with reference to the drawings, wherein Figures 1-6 are schematic sectional views of a number of successive stages of an embodiment of the method according to the invention.

Fig. 1 shows how, using a piling frame 1 comprising a hydraulic ram 2, a hollow tube 3 is introduced into the ground. The hollow tube 3 is provided at the bottom end thereof with a shoe essentially consisting of a circular plate 5 having an upright ring 6 connected thereto. By means of a suitable sealing cement, the shoe is watertightly secured to the lower end of the hollow tube 3, so that the tube 3 remains completely empty as it is introduced.

The hollow tube 3 consists for instance of steel having a thickness of 25 mm and can have a diameter or for instance 600 mm. The round plate 5 can in that case have a diameter of 700 mm and consist of steel plate having a thickness of 16 mm for instance. The hollow tube 3, for instance at the top thereof, comprises a wider portion 7 fitted with a feed extension 8. In the wall of the widened portion 7, drawing ears 9 may be provided as a point of engagement for drawing the hollow tube 3 to be described hereinafter.

After the tube 3 has been introduced to the desired depth, as shown in Fig. 2, from a grout reservoir 10 an amount of grout 11 is fed into the tube, so that a part of the tube 3, which is located for instance in the bearing layer 12, is filled therewith. Hypothetically, it is assumed that the soil 4 above the layer 12 exhibits the phenomenon of negative adhesion. The amount of grout or similar material to be introduced is chosen such that the bearing element to be subsequently arranged is completely surrounded by grout precisely at the point where positive adhesion is to be transferred, i.e., in the bearing layer 12.

Fig. 3 shows how, after the grout filling 11 has been provided in the hollow tube 3, a priorly made bearing element, for instance the prefab pile 13, is lowered into the tube 3. The prefab pile 13 consists for instance of prestressed concrete and can, in the case shown, have outside dimensions in section of 380 x 380 mm. The beam comprises a central suspension rod 14 and is provided at the top thereof with a pile coupling, so that upward extension is possible. The length of the beam 13 is chosen such that in introduced condition the beam extends to about ground level.

After the beam 13 has been placed in the hollow tube 3, as shown in Fig. 4, the space between the inside wall of the hollow tube 3 and the outside of the beam 13 is filled with bentonite or a similar suitable lubricant. To that end, by means of the pump 16, bentonite is pumped from a reservoir 15 into the widened portion 7 of the tube

3. The result is the bentonite layer 17 around the beam 13. Optionally, the bentonite can initially be supplied to an excess height, so that more pressure is exerted on the grout present at the bottom of the tube 3 around the beam 13, so that this grout can be properly compressed and forms a strong pile base.

Fig. 5 shows how subsequently the hollow tube 3 is drawn from the ground. This is effected with the aid of the frame 1, which now has a suitable drawing mechanism 18 connected to it, which appropriately engages the tube 3 via the drawing ears 9 in the widened portion 7 at the top of the tube. The drawing action can be effected by hammering where the tube 3 must be drawn from the layer 12 exhibiting positive adhesion. When drawing the tube from the part of the soil 4 above the layer 12, which exhibits negative adhesion, drawing can be effected by drawing in sliding fashion. During drawing, the shoe, consisting of round plate 5 having upright ring 6 connected thereto, is released so that it remains behind in the ground.

Fig. 6 represents the final situation. The hollow tube has been removed entirely. Remaining in the ground is the prefab pile 13 which is surrounded by a bentonite layer 17 in the part of the soil 4 exhibiting negative adhesion. Thus, the phenomenon of negative adhesion is largely obviated. In the soil layer 12 exhibiting positive adhesion, the bearing element 13 is surrounded by a grout covering 11. Above the ground 14, the completed foundation pile has been elongated by means of an extension piece 20 connected thereto via the pile coupling 19. Optionally, from the ground level, a grout injection around the pile can be effected over a length of 1-1.5 m, so that the bentonite anti-adhesion coat 17 is bounded by a grout covering at the top and at the bottom thereof.

Claims

1. A method of making a foundation pile, characterized in that a hollow tube is introduced into the ground in such a manner that the tube, in the introduced condition, is internally empty, a priorly made bearing element having a smaller outside dimension than the inside diameter of the hollow tube is introduced into the empty hollow tube in such a manner that all round between the bearing element and the hollow tube a free space remains, the space between the bearing element and the inner wall of the hollow tube is filled with a suitable lubricant and the hollow tube is subsequently removed from the ground.
2. A method according to claim 1, characterized in that the hollow tube is introduced into the

ground while having provided at the lower end thereof a watertight closure in the form of a suitable shoe, which shoe is connected to the the hollow tube in such a manner that upon later removal of the tube, the shoe is released and remains behind in the ground. 5

3. A method according to claims 1-2, characterized in that, prior to introducing the bearing element into the hollow tube, an amount of grout or similar material is fed into the tube, so that, after the introduction of the bearing element, the lower part thereof is surrounded by a grout covering below the lubricant covering which is subsequently formed. 10 15
4. A method according to claims 1-3, characterized in that after removal of the hollow tube, the bearing element is extended in upward direction. 20

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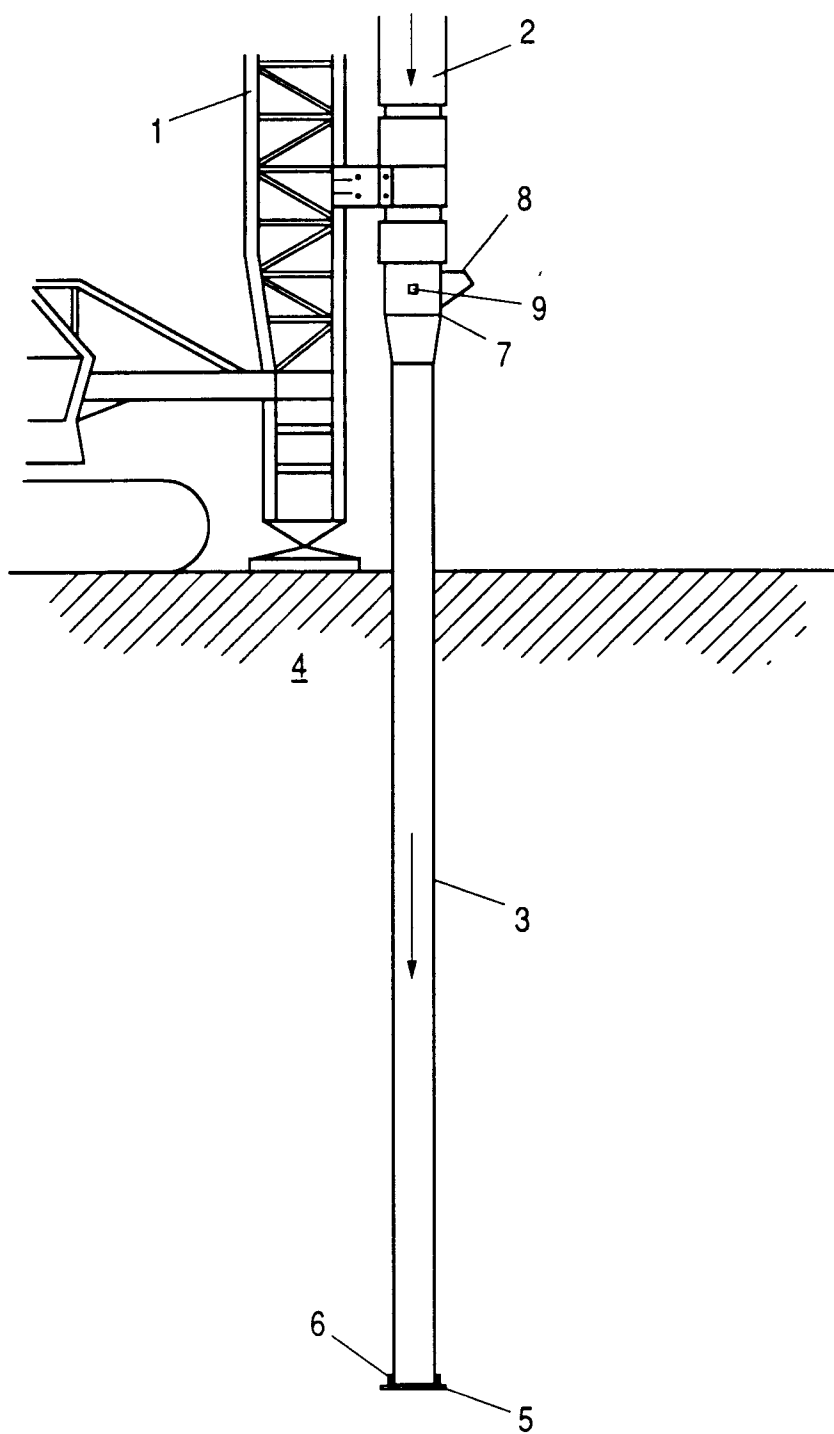


FIG. 1

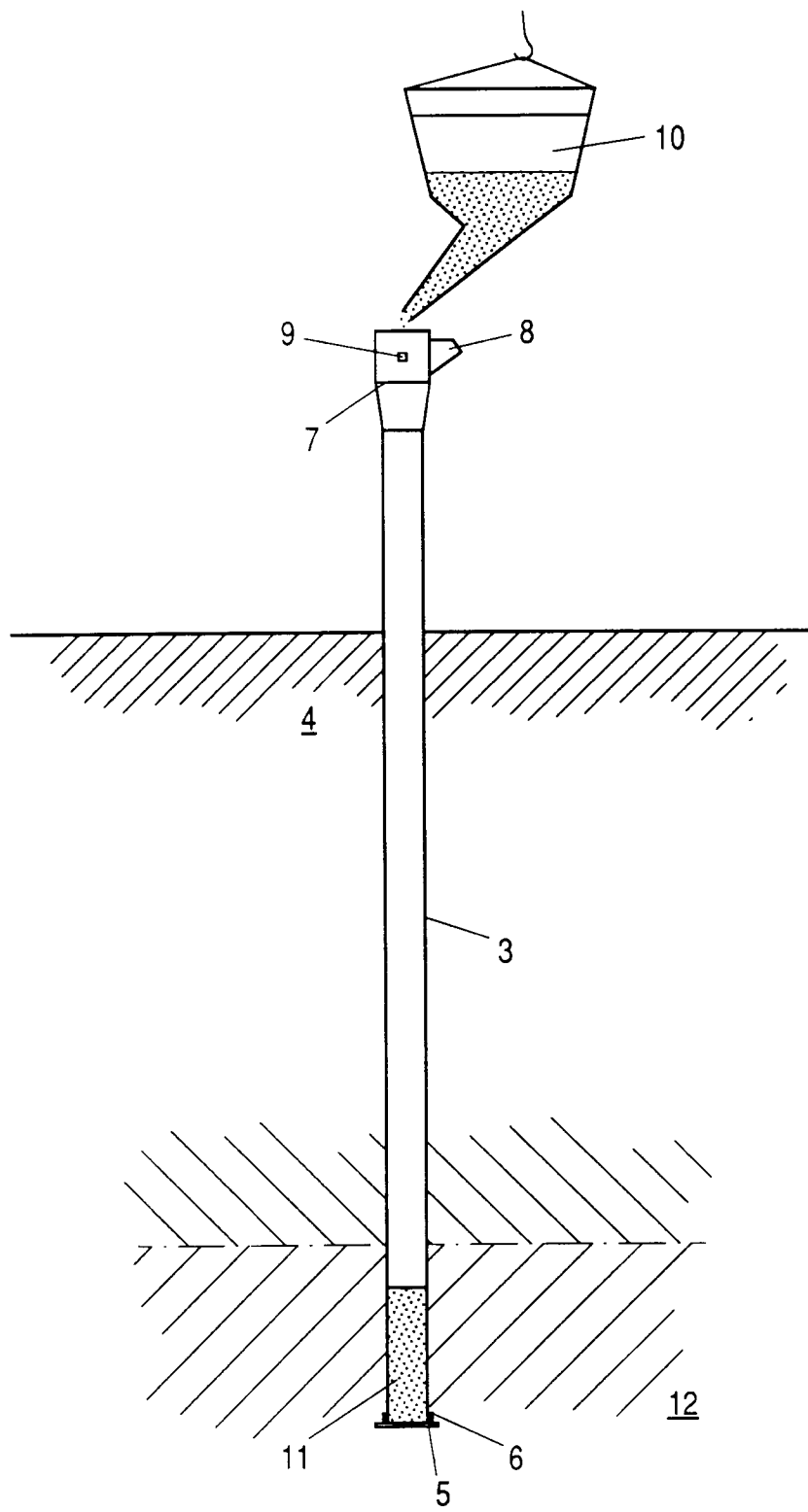


FIG. 2

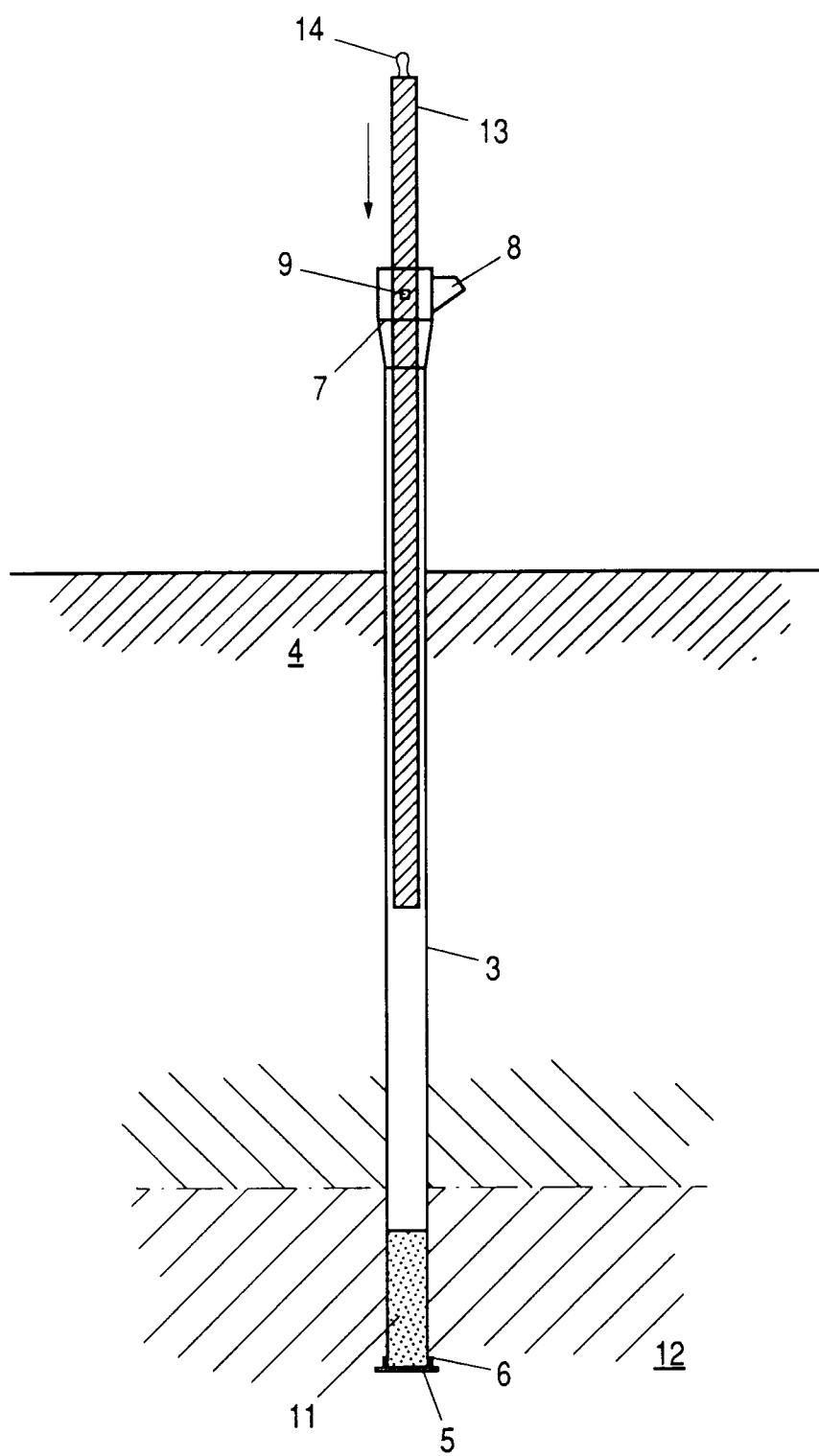


FIG. 3

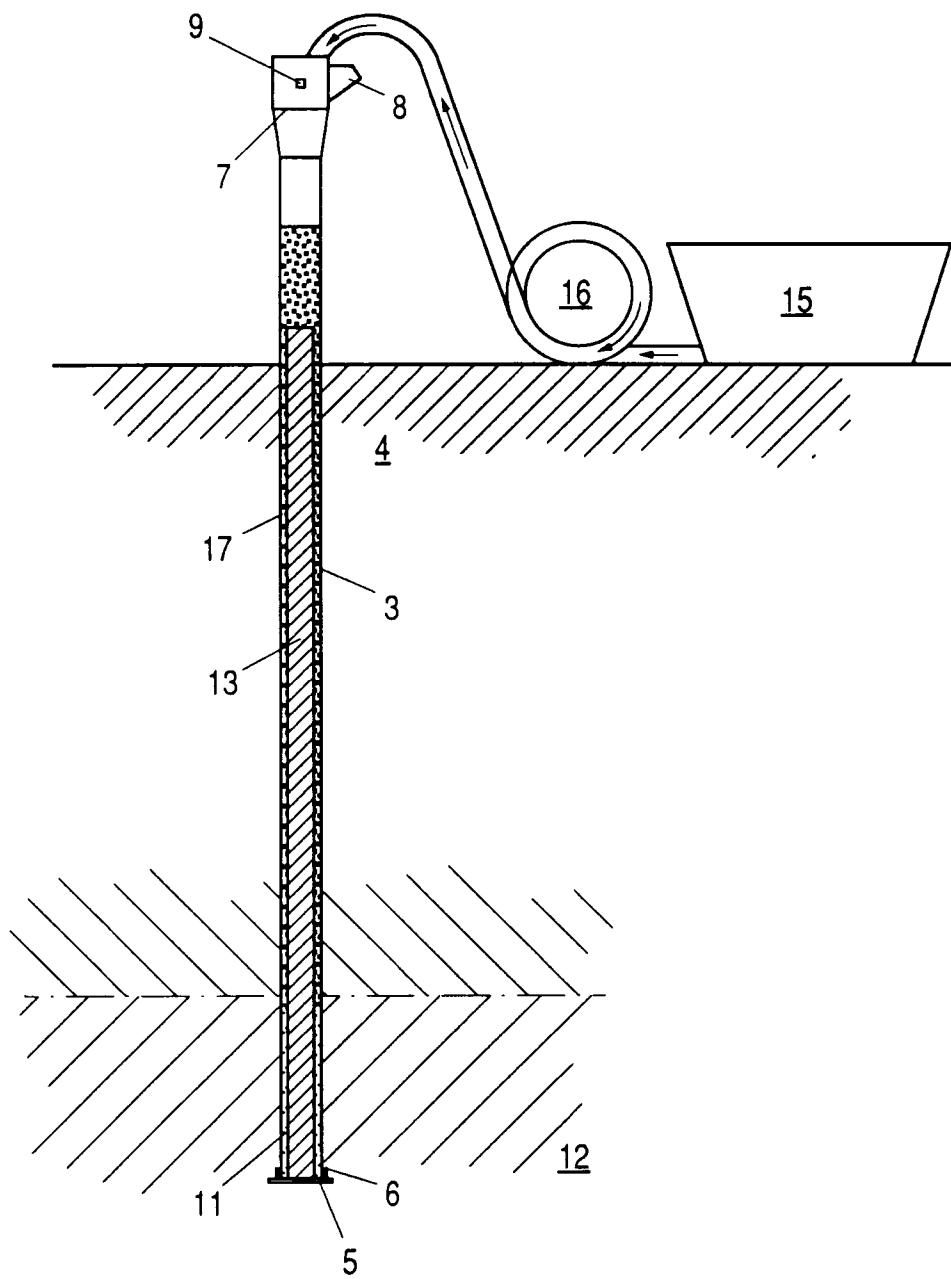


FIG. 4

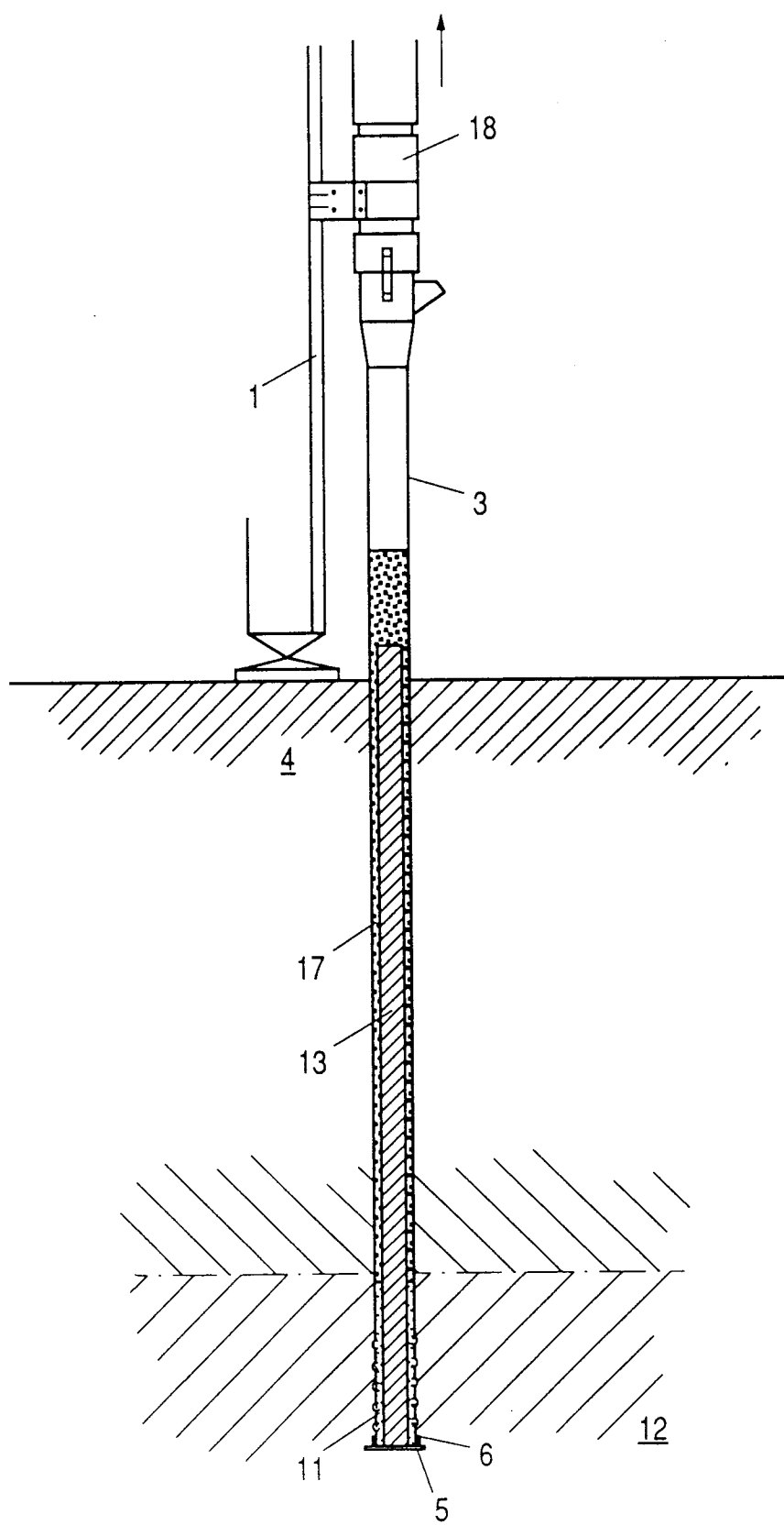


FIG. 5

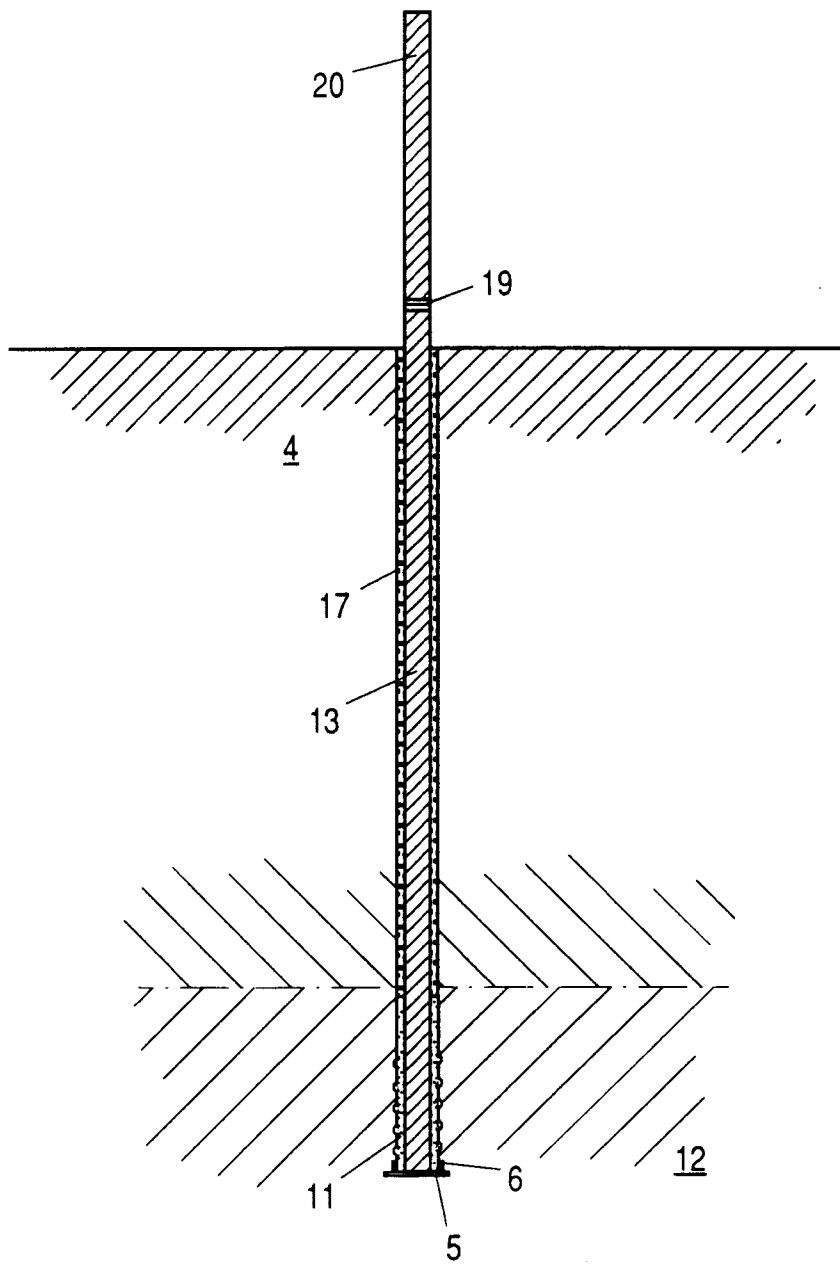


FIG. 6



European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 92 20 1832

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	DE-A-2 120 691 (JEBENS) * page 7, line 5 - page 9, line 3; figures 1-5 *	1,2	E02D7/30 E02D5/50 E02D31/08 E02D31/14 E02D5/38
A	US-A-3 630 037 (HOWARD) * column 1, line 49 - line 63 * * column 2, line 10 - column 3, line 17; figures 1-4 *	1-3	
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 115 (M-474)(2172) 30 April 1986 & JP-A-60 246 917 (TAKENAKA KOMUTEN) 6 December 1985 * abstract *		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			E02D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 30 SEPTEMBER 1992	Examiner BELLINGACCI F.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			