

(19)



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(11)

EP 0 872 595 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.10.1998 Bulletin 1998/43

(51) Int. Cl.⁶: **E02D 7/28**

(21) Application number: **98201152.0**

(22) Date of filing: **09.04.1998**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **15.04.1997 NL 1005814**

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(54) **A method for inserting a foundation pile into the ground**

(57) The invention relates to a method for inserting a foundation pile (1) into the ground, which foundation pile comprises a cutter head (2) disposed near the bottom end thereof. Grout is transported to the bottom end of the foundation pile (1), via a pipe (7) extending through the interior thereof, during said insertion of the pile (1). Said grout is injected into the ground near the cutter head (2), which is being rotated during the insertion of the pile. The cutter head (2) is rotated from a drive mechanism disposed above the ground surface, via the pipe (7) for transporting the grout, which is connected to the cutter head (2).

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Description

The invention relates to a method for inserting a foundation pile into the ground, which foundation pile comprises a cutter head disposed near the bottom end thereof, wherein grout is transported to the bottom end of the foundation pile, via a pipe extending through the interior thereof, during said insertion of the pile, and wherein said grout is injected into the ground near the cutter head, which is being rotated during the insertion of the pile.

With a known method of the above kind the foundation pile is rotated during the insertion of the foundation pile by means of a drive mechanism which engages the end of the foundation pile that projects above the ground surface, so that a torque exerted on said pile must be taken up by the material of the pile. The taking up of such torsional forces makes heavy demands on the material of the pile, which has an influence on the selection of the diameter of the pile and/or on the composition of the material from which the pile is made. Generally the pile no longer needs to satisfy such high demands with regard to the taking up of torsional forces and the like once it has been inserted into the ground, so that the construction of the pile must be unnecessarily strong and/or expensive for the sole purpose of being able to insert it into the ground.

According to the invention the cutter head is rotated from a drive mechanism disposed above the ground surface, via the pipe for transporting the grout, which is connected to the cutter head, wherein said cutter head displaces the ground while mixing it with the grout.

When the method according to the invention is used, the torque required for inserting the pile into the ground does not need to be transmitted via the pile itself, but said torque is transmitted to the cutter head independently of the pile, via the pipe extending through the pile. By simultaneously using the pipe for transporting the grout, which is being supplied under high pressure, an effective and inexpensive method for inserting a foundation pile into the ground can be realised while effecting an effective mixing of the grout with the ground which is being displaced laterally by the cutter head.

According to another aspect of the invention, a particularly suitable combination for inserting foundation piles according to the invention is made up of a cutter head, which is provided with an unround hole, into which a part of a pipe for transporting the grout, which has a corresponding section, is inserted.

The invention will be explained in more detail hereafter with reference to the accompanying Figures.

Figure 1 is a diagrammatic longitudinal section of a lower part of a foundation pile, showing a cutter head disposed thereunder and a pipe extending through the foundation pile.

Figure 2 is a cross-sectional view of a possible embodiment of a foundation pile.

Figure 3 is a larger-scale view of the encircled part

III in Figure 1.

Figure 4 is a view of the cutter head, seen in the direction indicated by arrow IV in Figure 1.

Figure 5 diagrammatically shows various stages of the insertion of a foundation pile into the ground.

Figure 1 diagrammatically shows the bottom end of a concrete foundation pile 1, which may have an octagonal section, for example, as shown in Figure 2. The foundation pile 1 may also have other sectional configurations, however. Furthermore it is possible to use the method according to the invention as described hereafter with a foundation pile in the form of a steel pipe, for example, rather than with a concrete foundation pile.

As is furthermore shown in Figure 1, the bottom end of foundation pile 1 is supported on a cutter head 2, which is built up in the illustrated embodiment of a plate 3 extending perpendicularly to the longitudinal direction of pile 1, on which plate the bottom end of the foundation pile 1 rests, and of cutting elements 4 extending in downward direction from plate 3.

As is apparent in particular from Figure 4, an unround recess 5, which is square in the illustrated embodiment, is provided in plate 3, which recess is in line with a cavity 6 present in the centre of foundation pile 1, which extends along the entire length thereof. A pipe or hollow shaft 7 extends through said cavity, which pipe or hollow shaft is provided near its bottom end with a projecting flange 8, which rests on the upper side of plate 3 (Figure 3). At least the part of pipe 7 that extends under flange 8 has a sectional configuration which corresponds with that of unround hole 5, so that pipe 7 cannot rotate relative to the cutter head. Pipe 7 is closed at its bottom end by a bottom plate 9, whilst bores 10 are provided in the pipe wall, near said bottom end of the pipe, which bores connect the interior of the pipe to the space present outside the pipe.

Plate 3 may be fixed to pipe 1, in the case of a concrete pile, for example, it may be connected to the reinforcing steel of the concrete pile, or in the case of a steel pipe it may be welded to the bottom end of the pipe. It is also conceivable, however, for the bottom end of pile 1 to be loosely supported on plate 3 of cutter head 2, whereby means may be provided for preventing cutter head 2 from moving in a direction transversely to the longitudinal axis of pile 1.

When the pile is to be inserted into the ground, the end of pipe 7 that projects above pile 1, which is diagrammatically illustrated in Figure 5, is coupled to a drive mechanism, by means of which pipe 7 can be rotated, as indicated by means of arrow A. By rotating pipe 7, the cutter head 2 coupled to the bottom end of pipe 7 will be rotated so as to bore a hole into the ground. Simultaneously with said rotating of the cutter head, grout is supplied through hollow shaft 7 under high pressure (for example more than 100 bar), so as to be injected into the ground surrounding the cutter head via bores 10. As will furthermore be apparent from Figure 5, said grout, possibly mixed with the ground loos-

ened by cutter head 2, will form a shell of grout 11 round the foundation pile as the foundation pile gradually moves downwards into the ground, which shell of grout 11 acts as a kind of lubricating film, which facilitates the insertion of the pile into the ground. After the pile has been inserted, the grout will harden, and a proper bond between the ground and the pile will have been effected, in particular via the hardened grout.

It will be apparent that by driving the cutter head 2 directly by means of the pipe or hollow shaft 7 extending through the interior of the foundation pile 1, only small torsional forces will be exerted on the foundation pile during the insertion thereof into the ground, so that the pile need not be dimensioned such that it will be capable of taking up such torsional forces. This enables an optimum selection of the material and the configuration of the pile in dependence on the forces that will be exerted on the pile that has been inserted into the ground. By simultaneously using the hollow shaft 7 used for driving the cutter head 2 for the transport of the grout therethrough, it is furthermore possible to obtain a simple construction of the equipment needed for inserting the foundation piles.

Once the foundation pile has been inserted, pipe 7 can be withdrawn from the pile and be reused for inserting other piles.

Claims

1. A method for inserting a foundation pile into the ground, which foundation pile comprises a cutter head disposed near the bottom end thereof, wherein grout is transported to the bottom end of the foundation pile, via a pipe extending through the interior thereof, during said insertion of the pile, and wherein said grout is injected into the ground near the cutter head, which is being rotated during the insertion of the pile, characterized in that the cutter head is rotated from a drive mechanism disposed above the ground surface, via the pipe for transporting the grout, which is connected to the cutter head, wherein said cutter head displaces the ground while mixing it with the grout.
2. A method according to claim 1, characterized in that once the foundation pile has been inserted, the pipe is withdrawn from the cutter head and from the foundation pile.
3. A combination for inserting a foundation pile by using the method according to the invention, characterized in that said combination comprises a cutter head, which is provided with an unround hole, into which a part of a pipe for transporting the grout, which has a corresponding section, is inserted.
4. A combination according to claim 3, characterized in that said cutter head is provided with a plate

which butts against the bottom end of the pile, to which plate cutting elements projecting under said plate are attached.

5. A combination according to claim 3, characterized in that said cutting elements are made up of plate-shaped means, which are staggered at an angle with respect to each other.
6. A combination according to any one of the claims 3 - 5, characterized in that said pipe is provided with a projecting collar, which rests on a part of the cutter head that butts against the bottom end of a pile.
7. A combination according to any one of the claims 3 - 6, characterized in that passages are provided in a part of the pipe which projects under a part of the cutter head that butts against the bottom end of the pile.

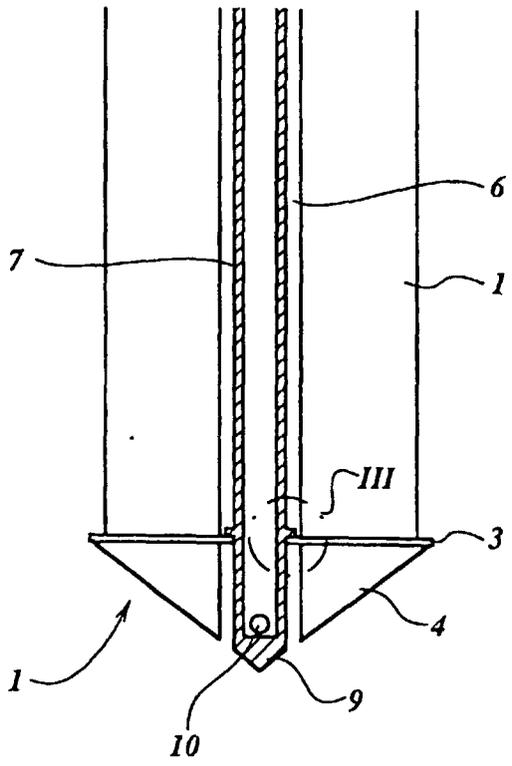


Fig. 1

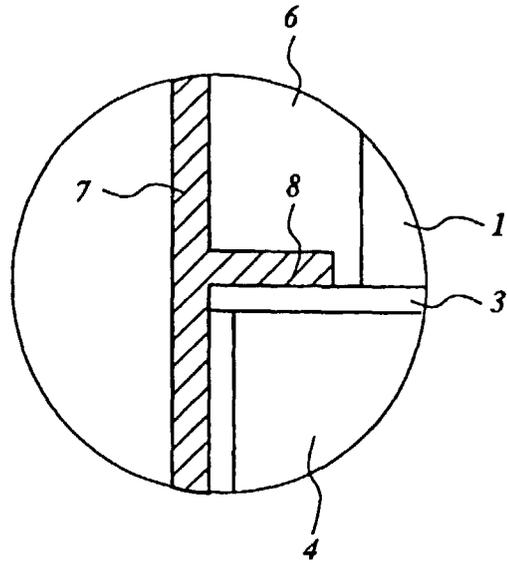


Fig. 3

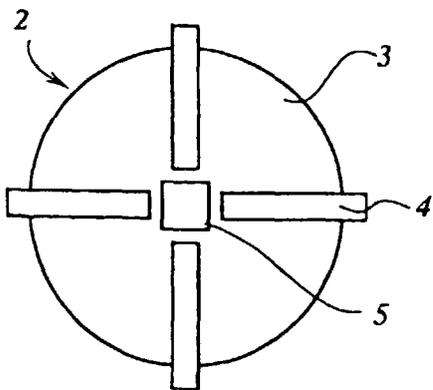


Fig. 4

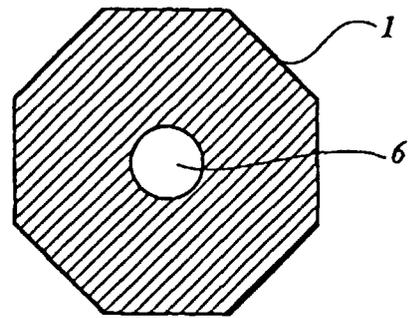


Fig. 2

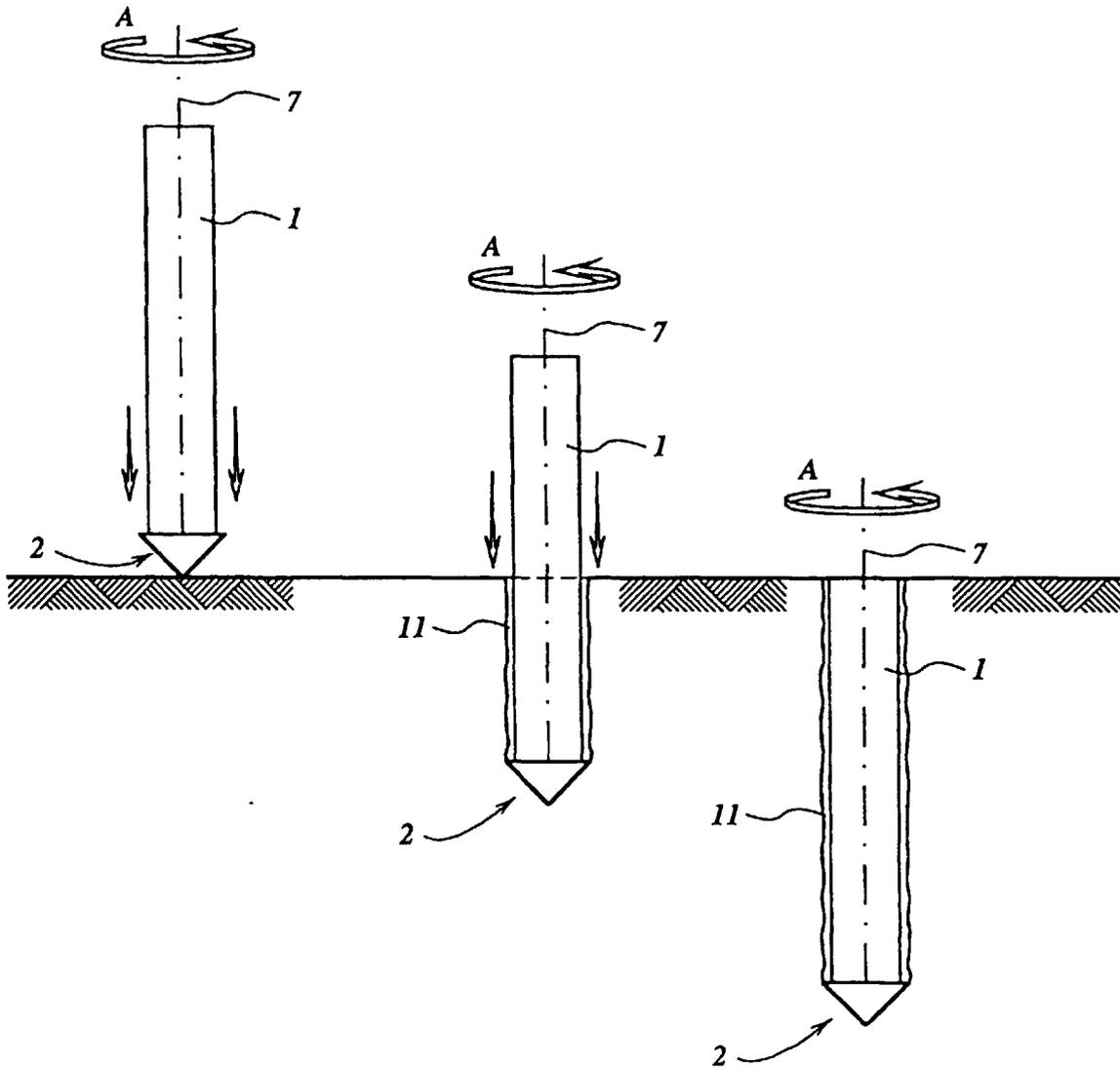


Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 98 20 1152

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 9, no. 100 (M-376) '1823! , 2 May 1985 & JP 59 224721 A (HIROSHI WATANABE), 17 December 1984, * abstract *	1,2	E02D7/28
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A	DE 16 34 488 A (MARUTAI DOBOKU COMPANY LTD) 6 August 1970 * page 4, line 1 - page 8, line 13; figures 1-4 *	3-5	
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 40 (M-454) '2097! , 18 February 1986 & JP 60 192024 A (KUBOTA TEKKO KK), 30 September 1985, * abstract *	1-7	
A	PATENT ABSTRACTS OF JAPAN vol. 8, no. 128 (M-302) '1565! , 14 June 1984 & JP 59 031313 A (YOKIO MATSUMOTO), 20 February 1984, * abstract *	1-7	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E02D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		16 July 1998	Tellefsen, J
CATEGORY OF CITED DOCUMENTS		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	
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			

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