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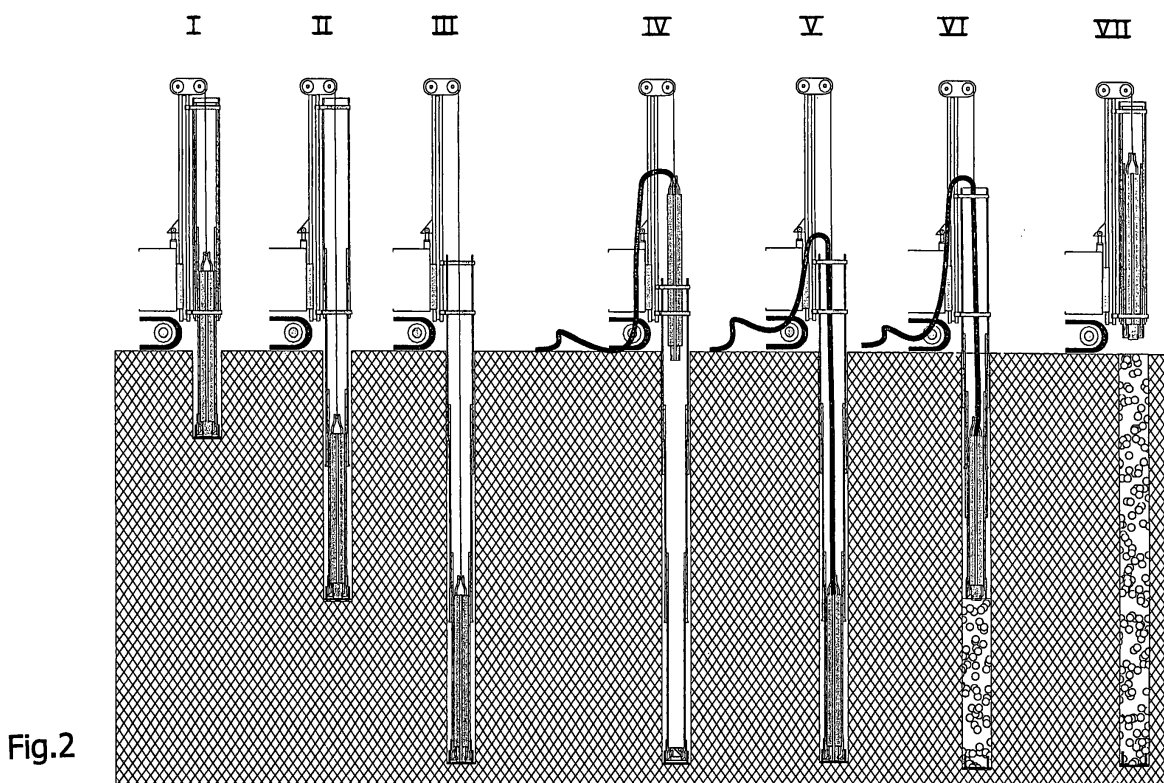
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(54) **Method and pile-driving device for inserting foundation piles into the ground**

(57) Method for inserting foundation piles into the ground, comprising the steps of positioning at least two telescopically connected pipe segments above a base plate, moving a pile-driving hammer up with a pile-driving device, moving the pile-driving hammer down through the pipe segments, and letting the pile-driving hammer ram the base plate and at least one of the pipe segments.

The invention is characterized in that the method furthermore comprises the steps of withdrawing the pipe segments from the ground using a withdrawal element, so that a hole is left in the ground; leaving the base plate behind in the hole that is left; and introducing a setting substance on top of the base plate in the hole that is left. After the substance has set, a foundation pile is obtained in the ground.



## Description

**[0001]** The present invention relates to a method for inserting foundation piles into the ground. The method comprises the following steps:

positioning at least two telescopically connected pipe segments above a base plate;  
moving a pile-driving hammer up with a pile-driving device;  
moving the pile-driving hammer down through the pipe segments;  
letting the pile-driving hammer ram the base plate and at least one of the pipe segments.

**[0002]** US 3,131,543 discloses such a method. According to this method, various pipe segments that are telescopically connected to each other are first driven into the ground together with a base plate by means of a pile-driving hammer. The pile-driving hammer is of a cylindrical shape and increases stepwise in diameter, in such a way as to produce shoulders which during the pile driving rest upon the edges of the various pipe segments. The telescopic extension of the pipe segments will cause the pile-driving hammer in each case to be brought into ramming contact with the edges of the pipe segments having a larger diameter. As a result of this, the pipe segments will sink increasingly further into the ground.

**[0003]** A disadvantage of this method is that the method is inefficient and expensive.

**[0004]** A further disadvantage of this method is that the edges and the walls of the pipe segments are damaged by the pile-driving hammer ramming the edges. The damage to the edges of the pipe segments causes the various pipe segments to become jammed in one another.

**[0005]** Another disadvantage of this method is that the pile-driving hammer is quite long, with the result that the pile-driving hammer is difficult to handle in use. On sites with little space in particular, the great length of the pile-driving hammer is a problem. If on account of the space problem the pile-driving hammer is composed of a number of machined parts, the production of a large pile-driving hammer is expensive, which is reflected in the overall cost of the pile-driving work. A pile-driving hammer made up of a number of parts furthermore has the disadvantage that the project takes longer because of the working time required for assembly of the pile-driving hammer.

**[0006]** The object of the present invention is at least partially to overcome at least one of the abovementioned disadvantages, or to provide a useful alternative. In particular, the object of the invention is to provide an effective and a cost-saving method of inserting foundation piles into the ground, in which method the risk of damage to the pipe segments is considerably reduced.

**[0007]** This object is achieved by the method for driving foundation piles into the ground according to claim 1.

**[0008]** The invention is characterized in that the method furthermore comprises the following steps: withdrawing the pipe segments from the ground using a withdrawal element, so that a hole is left in the ground; leaving the base plate behind in the hole that is left; and introducing a setting substance on top of the base plate in the hole that is left. After the substance has set, a foundation pile is obtained in the ground.

**[0009]** It is an advantage of the method according to the invention that the method is efficient and cost-saving.

**[0010]** It is an advantage that the pipe segments can be reused for inserting the next foundation pile. This means that there is efficient use of the equipment and a considerable cost saving is achieved.

**[0011]** The advantage of the base plate being left behind in the hole which is left in the ground after the withdrawal of the pipe segments and the advantage of setting substance being introduced on top of the base plate is that the base plate contributes to the bearing capacity of the foundation pile obtained. A flat base plate is preferably used because a greater bearing capacity is obtained with a flat base plate. If foundation piles with a greater bearing capacity are inserted, fewer foundation piles will be needed. This again is cost-saving.

**[0012]** In an advantageous embodiment of the method according to the invention a pile-driving hammer that can also be used as the withdrawal element is used. After the pile driving, the pile-driving hammer is provided with at least one connecting element for withdrawal of the pipe segments. The connecting element on the withdrawal element is preferably equipped to engage in a bayonet opening in at least one of the pipe segments, in order to form a bayonet closure. After connection of the withdrawal element to the pipe segment, the pipe segment is withdrawn from the ground. The withdrawn pipe segment can be reused for inserting the next foundation pile. The withdrawal of the pipe segments from the ground by means of a bayonet closure is a simple and reliable procedure, so that the risk of damage to the pipe segments is small.

**[0013]** The connecting element is preferably positioned on the distal end of the withdrawal element and is preferably in the form of a pin. At least one pin projects radially beyond the withdrawal element and will come into contact with the circumferential edge of a pipe segment when the withdrawal element is lowered. The edges of the pipe segments comprise slanting edge parts, in such a way that the pins of the withdrawal element are driven in the direction of the bayonet opening in the pipe segment. This will cause the withdrawal element to rotate slightly as it moves down. During withdrawal of the withdrawal element in the axial direction the pins engage in the bayonet opening of a pipe segment in such a way that the pipe segment moves up along with the withdrawal element.

**[0014]** In an alternative, likewise advantageous embodiment of the withdrawal element at least one movable connecting element is provided. The connecting element is movable in the radial direction from a first position, in

which the connecting element lies back, to a second position, in which the connecting element engages upon the pipe segment to be withdrawn. In order to obtain a reliable engagement of the connecting element, it is preferable to provide a groove or an upright wall part in the pipe segment in the circumferential direction. The wall part preferably extends over the inside wall of the pipe segment around the entire circumference, so that turning of the withdrawal element does not affect the engagement of the connecting element upon the pipe segment.

**[0015]** The connecting element preferably comprises a pin that is movable in the radial direction through the fact that the pin is provided with a slanting edge which interacts with a wedge-shaped element. Moving the wedge-shaped element up or down in the axial direction of the pipe segment enables the connecting element to move in the radial direction. Moving the wedge-shaped element up or down can be achieved, for example, by moving up or down a shaft which extends in the axial direction of the pipe segment and is connected to the wedge-shaped element. The shaft is preferably provided with a screw thread profile, so that the shaft can be moved up and down by means of a nut. Providing the withdrawal element with such a construction makes it possible to move the connecting element easily and reliably in the radial direction.

**[0016]** In a further preferred embodiment of the method according to the invention, during the pile driving the pile-driving hammer in the first instance rams the base plate, in such a way that the base plate drops a certain distance. After that, in the second instance the pile-driving hammer rams the pipe segment, in such a way that the pipe segment also moves down.

**[0017]** As a result of this, during the pile driving the total ramming energy is transmitted by the pile-driving hammer to the pipe segments and the base plate. It is advantageous that most of the total ramming energy is dissipated by the base plate. This means that the ramming energy is used effectively to achieve a certain depth in the ground.

**[0018]** Through the effective transmission of the ramming energy to the base plate, lighter pile-driving devices will be needed for inserting the pipe segments into the ground. The lighter pile-driving devices are not only cheaper, but can also be used in situations in which the space or height for placing a pile-driving device is limited, or in which minimal ground damage is permitted.

**[0019]** A small part of the total ramming energy is used for moving the pipe segments down. Moving the pipe segments down takes less energy because a hole has already been created in the ground by the base plate. Owing to the fact that the pile-driving hammer rams the pipe segment only in the second instance, the ramming energy dissipated by the pipe segment is considerably less than the ramming energy dissipated by the base plate. The risk of the pipe segment being damaged is significantly reduced. Furthermore, the risk of two telescopically connected pipe segments being inseparably

jammed together is considerably reduced. The pipe segments can advantageously be reused more often.

**[0020]** A further advantage is that the pipe segments can be made with thinner walls, which makes the pipe segments cheaper to produce. Moreover, materials other than steel, for example aluminium or plastic, can be used for the pipe segments.

**[0021]** In order to obtain a foundation pile with a reinforcement, in a special embodiment of the method according to the invention a reinforcing element can be supplied in one step. The reinforcing element can be, for example, a reinforced concrete steel construction, drill rods, a steel cable etc. The reinforcing element can be fed into the hole left in the ground after the withdrawal of the pipe segments. The setting substance can then be introduced.

**[0022]** The withdrawal element is preferably used for positioning and guiding the reinforcing element into the hole in the ground. For this purpose, through holes can be provided in the withdrawal element, through which holes concrete steel rods, for example, can be inserted, which concrete steel rods are then left behind as a reinforcing element in the hole in the ground when the withdrawal element is withdrawn. The reinforcing elements can be guided down to the bottom of the hole, but they can also, for example, be guided halfway down the hole in the ground. In this way a foundation pile that is partially provided with a reinforcement, for example in the top half, can be obtained. After the infeed and setting of the setting substance, a foundation pile with reinforcement is obtained.

**[0023]** In a preferred embodiment of the method according to the invention a pile-driving device with specific device features is used for inserting foundation piles into the ground. The invention also relates to a pile-driving device.

**[0024]** The pile-driving device according to the invention preferably comprises a hoisting winch for moving the pile-driving hammer up. From the point of view of design, the hoisting winch is a simple and reliable solution, which increases the usability of the method according to the invention in widely different circumstances. Furthermore, the hoisting winch is preferably also used for withdrawing the pipe segments from the ground.

**[0025]** In an alternative embodiment according to the invention, instead of a hoisting winch, a pneumatically or hydraulically driven pile-driving hammer or a vibrating unit for vibrating the pipe segments into the ground can also be used.

**[0026]** The pile-driving hammer for use in the method according to the invention is provided with a ramming face, which is equipped to ram the base plate in a base plate ramming zone. Furthermore, the pile-driving hammer comprises a collar with a collar face, which is equipped to ram the pipe segment in a pipe segment ramming zone. The distance in the axial direction between the ramming face and the collar face is greater than the distance between the base plate ramming zone

and the pipe segment ramming zone. The difference in distance is preferably greater than 2 cm. Through the difference in distance, the ramming energy will be fully utilized during the pile driving in the first instance for moving the base plate down. In the second instance the pile-driving hammer rams the pipe segment, with the result that the pipe segment will move down. Advantages of the method according to the invention already described above are achieved with the pile-driving hammer according to the invention.

**[0027]** The pipe segments are preferably telescopically connected to each other in such a way that by pile driving on the inside pipe segment with the smallest diameter the larger pipe segments are driven along with it. A major advantage is that the pile-driving hammer is of relatively short length, so that the pile-driving hammer is easy to handle in use. The length of the pile-driving hammer is preferably a maximum of 3 metres. This means that the pile-driving hammer can be used in circumstances where the working space is limited.

**[0028]** In a special embodiment of the pile-driving device according to the invention the pile-driving hammer is equipped as a withdrawal element and is furthermore provided with a feed-through channel. In this way the pile-driving hammer can serve as a means for introducing the setting substance. Simultaneously with the withdrawal of the pipe segments, or after the pipe segments have been removed, the hole that is left in the ground is filled with the setting substance. For this purpose, a supply line, preferably a supply hose, for supplying setting substance is connected to the pile-driving hammer. The setting substance will pass through the feed-through channel in the pile-driving hammer into the hole left in the ground.

**[0029]** In a further preferred embodiment of the pile-driving device according to the invention a sock is fixed over the distal end of the supply line. The sock is preferably made of an elastic material and rolled up over the distal end of the supply line. During the introduction of setting substance the sock will fill and be left behind in the hole left in the ground. The advantage of using such a sock is that the setting substance introduced cannot be washed away into the ground. By means of the sock it is ensured that an unnecessarily large quantity of setting substance does not have to be introduced in order to obtain a foundation pile.

**[0030]** In a special embodiment of the pile-driving device according to the invention the withdrawal element has at least one through hole around the feed-through channel, for the insertion of a reinforcing element.

**[0031]** The base plate preferably comprises a collar with a diameter that is larger than the largest diameter of one of the pipe segments. This means that when the base plate is inserted into the ground a hole with a larger diameter than the largest diameter of the pipe segments is obtained. The pipe segments will consequently move more easily down into the ground and can be withdrawn more easily later. Furthermore, there is less of a risk that

the hole made by the pile driving will partially cave in during the withdrawal of the pipe segments.

**[0032]** Further preferred embodiments are described in the other subclaims.

**[0033]** The invention will be explained in greater detail with reference to the appended drawings, which show a practical embodiment of the invention, but must not be regarded as limiting, in which drawings:

- 10 Figure 1 is an elevational view of the pile-driving device for use in the method according to the invention; Figure 2 is a diagrammatic view of various steps in the method according to the invention;
- 15 Figure 3 is a detail view of the pile-driving device according to the invention with a pile-driving hammer that in the first instance rams a base plate;
- 20 Figure 4 is a detail view of the pile-driving device according to the invention with a pile-driving hammer that in the second instance rams a pipe segment;
- 25 Figure 5 is a diagrammatic view of a foundation pipe system according to the invention with a bayonet opening in a first pipe segment; and
- 30 Figure 6 is a view in section of the distal end of a pipe segment;
- Figure 7 is a view in detail of the withdrawal element; Figure 8 shows two elevational views of a pile-driving hammer according to the invention, which can also be used as a withdrawal element; and
- Figure 9 shows a view in cross section of the pile-driving hammer as shown in Figure 8.

**[0034]** Figure 1 shows an overall elevational view of the pile-driving device for use in the method according to the invention, in which foundation piles are inserted into the ground. The figure shows an above-ground machine 9 with a guide 8 and a hoisting winch 7. A foundation pipe system is positioned on the guide, above a base plate. The foundation pipe system has pipe segments 3 which are telescopically connected to each other. By means of the hoisting winch 7, a pile-driving hammer 1 can be moved up and released, so that the pile-driving hammer 1 falls through the pipe segments and rams the base plate. The ramming will cause the base plate and the telescopically connected pipe segments to move down into the ground.

**[0035]** Figure 2 shows in a diagrammatic view a number of steps of the method according to the invention. The steps are indicated by Roman numerals I - VII.

**[0036]** In step I the foundation pipe system is positioned above a base plate. The pile-driving hammer is moved up and down by means of the winch. The pile-driving hammer ramming the base plate and the first pipe segment drives the base plate and the first pipe segment into the ground.

**[0037]** The situation in which the first pipe segment goes into engagement with the second pipe segment is illustrated in step II. Through the engagement, the second pipe segment is taken along with the first pipe seg-

ment into the ground.

**[0038]** The desired depth in the ground has been achieved in step III.

**[0039]** The connection of a supply line to the pile-driving hammer is shown in step IV. The pile-driving hammer has a feed-through channel for feeding through a setting substance. Before it is moved down into the ground as a withdrawal element, the pile-driving hammer is provided with connecting elements.

**[0040]** In step V a connection is obtained between the pile-driving hammer as the withdrawal element and the first pipe segment.

**[0041]** The withdrawal of the withdrawal element is shown in step VI. The withdrawal can be performed with the hoisting winch that is used during the pile driving, but in an alternative embodiment of the method an additional withdrawal element can also be provided. This can be advantageous, for example, when great forces which cannot be produced by the hoisting winch have to be generated during the withdrawal of the foundation pipe system. The withdrawal device can be, for example, a hydraulic device with hydraulic motors and cylinders.

**[0042]** The pipe segments are withdrawn from the ground simultaneously with the withdrawal element, and a setting substance, for example concrete, is fed through the feed-through channel of the withdrawal element. The withdrawal element is preferably connected in a sealing manner to the inside of the first pipe segment, so that no groundwater or setting substance goes inside the pipe segment. The seal is obtained, for example, by a rubber ring situated around the outer circumference of the withdrawal element. The seal ensures that the foundation pipe system stays clean and can be reused easily after withdrawal from the ground.

**[0043]** Finally, in step VII the hole left after the foundation pipe system has been withdrawn is filled up completely with setting substance. After setting, a foundation pile is obtained by means of the method according to the invention. Figure 3 shows diagrammatically a detail view in section of the distal end of the pile-driving hammer 1 and the base plate 2 with a first pipe segment 3.1. The pile-driving hammer 1 has on the end face a ramming face 1a and a collar with a collar face 1b. During the pile driving the pile-driving hammer 1 will ram the base plate 2 with the ramming face 1a. After the base plate 2 has dropped, the pile-driving hammer 1 in the second instance will ram the pipe segment 3.1 in a pipe segment ramming zone with the collar face 1b. The distance 'lv' on the pile-driving hammer between the collar face 1b and the ramming face 1a is greater than the distance 'la' on the foundation pipe system between the base plate ramming zone 2a and the pipe segment ramming zone 3.1b. In this way it is ensured that the ramming energy is used effectively for inserting the base plate 2 further into the ground, and the risk of damage to the pipe segment is reduced.

**[0044]** The pipe segment 3.1 shown is of a thin-walled design, being reinforced at the position of the pipe seg-

ment ramming zone 3.1b for transmitting the ramming forces to the base plate 2. The base plate too is reinforced at the position of the base plate ramming zone 2a.

**[0045]** As Figure 3 shows, the base plate is preferably of a flat design on the underside. After the pile driving and withdrawal of the pipe segments, the base plate is left behind in the ground. Compared with a pointed base plate, a flat base plate has the advantage that the bearing power of the foundation pile is considerably greater. This means that pipe segments with a smaller diameter will suffice, which results in lower costs. Moreover, a flat base plate has little self-locating capability, so that the pipe segments with the base plate do not tend to deviate in the wrong direction during insertion into the ground. In this way it is ensured that telescopic pipe segments which have gone askew do not become jammed in one another, which would make withdrawal from the ground difficult or totally impossible. If the telescopic pipe segments have gone askew, the risk of groundwater leaking into the pipe segments is greater. This risk is reduced with a flat base plate.

**[0046]** The base plate preferably has a collar with a large external diameter 2d. The large external diameter is advantageous when inserting the pipe segments into and withdrawing them from the ground.

**[0047]** The base plate 2 preferably has a raised edge 2b. The raised edge 2b ensures that the base plate remains positioned below the pipe segment 3.1. The base plate 2 is movable in the axial direction relative to the pipe segment 3.1. The raised edge 2b furthermore has a sealing effect and in this way ensures that during the movement hardly any groundwater penetrates into the pipe segment 3.1. Water must be prevented as far as possible from going into the pipe segment because this damps the movement of the pile-driving hammer.

**[0048]** Furthermore, the raised edge 2b has an advantageous effect during withdrawal of the pipe segments if the raised edge 2b encloses the pipe segment 3.1. The raised edge ensures that less soil adheres to the pipe segment. The raised edge 2b is preferably at least 7 cm high.

**[0049]** Figure 4 shows a simple embodiment of the base plate 2. The pile-driving hammer 1 is in ramming contact with the base plate 2, with the result that the base plate is displaced relative to the pipe segment. In Figure 4 the pile-driving hammer is also in ramming contact with the pipe segment by way of the collar face 1b.

**[0050]** Figure 5 shows in a view in detail two pipe segments 3.1 and 3.2. On the proximal end of the first pipe segment 3.1 a flange is provided for a telescopic connection to a second pipe segment 3.2. The further the base plate has dropped into the ground, the more pipe segments in engagement with one another by means of the telescopic connection will follow the base plate. Inserting the telescopically connected pipe segments into the ground in this way has the advantage that little space is needed for the pile-driving device. The length of the pile-driving hammer can remain limited. In the embodi-

ment shown the length of the pile-driving hammer is substantially determined by its weight and/or diameter. The collar face of the pile-driving hammer here comes into ramming contact with the proximal end of the first pipe segment 3.1. The ramming face of the pile-driving hammer comes into ramming contact with the base plate on the distal end of the pipe segment 3.1. It is advantageous here that the entire telescopic foundation pipe system can be inserted into the ground by means of only one collar face (1b) on the pile-driving hammer. The pile-driving hammer remains compact and consequently easy to handle. The length of the pile-driving hammer is preferably a maximum of 3 metres.

**[0051]** As already shown in Figure 3, the first pipe segment 3.1 can also have a pipe segment ramming zone 3.1b on the distal end. This is advantageous if the length of the pile-driving hammer has to remain limited to, for example, no more than 1 metre. Furthermore, this means that the pipe segment can be made with thinner walls, because the pipe segment is inserted into the ground by subjecting to a tensile load, and is subjected to little compressive load.

**[0052]** Owing to the fact that the pile-driving hammer passes through the pipe segments, the vibrations and noise nuisance above ground remain limited. Another advantage of the telescopic connection of the pipe segments is that no labour-intensive actions, such as welding or screwing down, are necessary on the site of the pile driving operations.

**[0053]** Figure 5 also shows in the pipe segment 3 a bayonet opening 3a positioned in the proximal end. The bayonet opening 3a is formed by a slit lying in the axial direction and having a lead-in part 3b. A number of bayonet openings 3a are provided around the circumference of the proximal end of the pipe segment 3. This produces a pattern of hook-shaped projections around the circumference. The bayonet opening 3a is arranged in such a way that in the method according to the invention it interacts with a connecting element on the withdrawal element. The bayonet openings 3a shown in Figure 3 are equipped to interact with pin-shaped connecting elements on the withdrawal element.

**[0054]** Figure 6 shows the distal end of a pipe segment 3.1 with a detachable part 2c. The detachable part 2c encloses the pipe segment 3.1 and is provided with various bayonet openings 3a. When the connecting elements of the withdrawal element engage upon the detachable part 2c and the detachable part is withdrawn from the hole in the ground, the pipe segment 3.1 will be withdrawn along with said detachable part. Through the collar with large external diameter 2d, the pipe segments enclosing the pipe segment 3.1 will rest against the detachable part 2c and will also be withdrawn along with it out of the ground. It is advantageous that the pipe segments can be produced in a simple and therefore cost-effective manner.

**[0055]** Figure 7 shows a detail view of the withdrawal element 4 to which a supply hose, which is provided with

a sock 6, can be connected. The withdrawal element 4 is used in the method according to the invention for withdrawing the pipe segments 3 from the ground. When the pipe segments 3 have been withdrawn a hole is left in the ground, which hole is filled up with setting substance. The rolled-up hose 6 on the distal end of the withdrawal element is filled with setting substance and prevents setting substance from being washed away into the ground.

**[0056]** Figure 8 shows two related views of a pile-driving hammer 1. The pile-driving hammer 1 is positioned inside a first pipe segment 3.1. The pile-driving hammer 1 has a ramming face 1a and a collar face 1b. The pile-driving hammer can also be used as a withdrawal element 4. For this purpose, the pile-driving hammer has a feed-through channel 23 for feeding through setting substance such as concrete. Controllable connecting elements 20, which serve to withdraw the pipe segments, are also provided. The connecting elements 20 comprise pins 21, which are provided with a wedge-shaped face and interact with wedge-shaped elements 22. When the wedge-shaped elements 22 move up the pins are pressed radially outwards. The radially projecting pins then engage upon a pipe segment and rest against a wall part 3.1c of the pipe segment extending in the radial direction, which part is obtained here by making a groove in such a way that the pipe segment can be drawn up along with the pins. This is illustrated in the view on the right in Figure 8. In an alternative embodiment the pipe segment 3.1 can also be provided with an upright wall part extending in the radial direction.

**[0057]** The wedge-shaped elements 22 are connected here to at least one shaft 26. In one embodiment according to the invention the shaft 26 is provided with a screw thread profile on the distal end. By rotating the shaft, the wedge-shaped element can be moved up and down in the axial direction of the pipe segment. In an alternative embodiment the shaft 26 can be rigidly connected to the wedge-shaped element 22 and a screw thread profile is provided on the proximal end of the shaft. The shaft 26 can be moved up and down together with the wedge-shaped element 22 by means of a nut. All kinds of rotary or elevating constructions are conceivable for moving up the shaft 26 with wedge-shaped element 22. Furthermore, a groove is made near the distal end of the pile-driving hammer on the circumferential side, in which groove an inflatable band 25 is provided. The inflatable band 25 acts as a seal between the pile-driving hammer and the first pipe segment. This ensures that when setting substance is being fed through, the setting substance does not flow along the withdrawal element and soil the pipe segments.

**[0058]** Figure 9 shows a view in cross section of the pile-driving hammer along the line IX-IX shown in Figure 8. The pile-driving hammer is provided with at least one through hole 24. In this case four through holes 24 are provided for the purpose of placing reinforcing bars in the foundation pile. The holes are made in a regular, symmetrical pattern around the feed-through channel 23. Re-

inforcing elements, such as concrete steel rods, strands or cables, can be placed through the holes. The reinforcing elements preferably have a diameter of no more than 15 mm and a length of no more than 12 m. The through holes 24 in the pile-driving hammer determine the ultimate position of the reinforcing elements in the foundation pile. This can prevent the reinforcing elements from becoming exposed and possibly becoming corroded. Furthermore, in this way the reinforcing elements can serve as a guide when withdrawing the withdrawal element.

**[0059]** Many variants besides the embodiments shown in the figures, but remaining within the scope of protection of the invention, are possible.

**[0060]** For instance, in one variant the base plate can be of a pointed design or can be composed of a number of parts. The foundation piles obtained according to the invention can have all kinds of cross sections. For instance, a foundation pile can have a round, square or oval cross section.

**[0061]** The invention therefore provides a method in which the risk of damage to the pipe segments is considerably reduced, and in which, furthermore, a relatively simple, quick and cost-effective method for inserting foundation piles into the ground is provided.

## Claims

1. Method for inserting foundation piles into the ground, comprising the following steps:

- positioning at least two telescopically connected pipe segments (3.1, 3.2) and a base plate (2);
- moving a pile-driving hammer (1) up with a pile-driving device (9);
- moving the pile-driving hammer (1) down through the pipe segments (3.1, 3.2);
- letting the pile-driving hammer (1) ram the base plate and at least one of the pipe segments,

**characterized in that** the method furthermore comprises the following steps:

- withdrawing the pipe segments (3.1, 3.2) from the ground using a withdrawal element, so that a hole is left in the ground;
- leaving the base plate (2) behind in the hole that is left; and
- introducing a setting substance on top of the base plate (2) in the hole that is left.

2. Method according to claim 1, in which for the withdrawal of the pipe segments from the ground a connecting element of the withdrawal element is connected to a bayonet opening (3a) in one of the pipe segments.

3. Method according to claim 1, in which for the withdrawal of the pipe segments from the ground a connecting element movable in the radial direction is operated, the connecting element engaging upon a wall part (3.1c) of one of the pipe segments.

4. Method according to one of claims 1 - 3, in which the pile-driving hammer (1) is moved down and in the first instance rams the base plate (2), in such a way that the base plate drops a certain distance, after which in the second instance the pile-driving hammer (1) rams the pipe segment (3.1), in such a way that the pipe segment drops.

5. Method according to one of claims 1 - 4, in which furthermore a reinforcement is provided.

6. Method according to one of claims 1 - 5, in which the method furthermore comprises the following steps:

- connecting to the withdrawal element a supply line for feeding in setting substance;
- introducing the withdrawal element with connected supply line into the hole that is left;
- feeding a setting substance through the supply line;
- withdrawing the withdrawal element and the connected supply line from the hole.

7. Pile-driving device for use in a method according to one of claims 1 - 6.

8. Pile-driving device according to claim 7, in which the pile-driving hammer comprises:

- a ramming face (1a) which is equipped to ram the base plate (2) in a base plate ramming zone (2a); and
- a collar with a collar face (1b), which is designed to ram a pipe segment (3.1) in a pipe segment ramming zone (3.1b), the distance 'lv' in the axial direction between the ramming face and the collar face being greater than the distance 'la' between the base plate ramming zone (2a) and the pipe segment ramming zone (3.1b).

9. Pile-driving device according to claim 7 or 8, in which the length of the pile-driving hammer (1) is a maximum of 3 metres.

10. Pile-driving device according to one of claims 7 - 9, furthermore comprising a withdrawal element with at least one connecting element for withdrawing the pipe segments (3.1) from the ground, the connecting element being movable in the radial direction from a first position, in which the connecting element lies back, to a second position, in which the connecting element engages upon a wall part (3.1c) of the pipe

segment to be withdrawn.

11. Pile-driving device according to one of claims 7 - 10, in which on the distal end the withdrawal element comprises at least one projecting connecting element for engaging in a bayonet opening (3a) of one of the pipe segments. 5
12. Pile-driving device according to one of claims 7 - 11, in which the withdrawal element comprises at least one through hole for the insertion of a reinforcing element. 10
13. Pile-driving device according to one of claims 7 - 12, in which the withdrawal element comprises a feed-through channel for feeding through setting substance. 15
14. Pile-driving device according to one of claims 7 - 13, in which the pile-driving hammer (1) is furthermore equipped as a withdrawal element. 20
15. Pile-driving device according to one of claims 7 - 14, comprising a supply line for the introduction of setting substance, the supply line comprising on the distal end a sock (6) which is to be filled with the setting substance. 25
16. Pile-driving device according to claim 15, in which the sock (6) is rolled over the distal end of the supply line. 30
17. Pile-driving device according to one of claims 7 - 16, comprising a base plate, the base plate comprising a collar with a diameter that is larger than the largest diameter of a pipe segment (3). 35
18. Pile-driving device according to claim 17, in which the detachable part (2c) of the base plate comprises an external diameter (2d) that is larger than the largest diameter of a pipe segment (3), in such a way that during withdrawal of the detachable part from the ground the telescopically connected pipe segments (3.1, 3.2) are withdrawn along with it. 40
19. Pile-driving device, in particular for use in a method according to one of claims 1 - 6, comprising at least one pipe segment (3.1), in which the pipe segment (3.1) on the proximal end comprises a bayonet opening (3a) for withdrawing the pipe segment (3.1) from the ground, in such a way that the bayonet opening (3a) can be connected to a radially projecting connecting element of the withdrawal element. 45
20. Pile-driving device according to claim 19, in which the bayonet opening (3a) comprises at least one slit extending in the axial direction of the pipe segment and having a lead-in part (3b) for guiding a connect-

ing element, which lead-in part slants relative to the slit up to a circumferential edge.

21. Telescopic foundation pipe system comprising pipe segments in which at least one pipe segment (3.1) comprises a bayonet opening (3a) for withdrawing the pipe segment (3.1) from the ground.
22. Telescopic foundation pipe system according to claim 21, in which the bayonet opening comprises at least one slit extending in the axial direction of the pipe segment, and having a lead-in part (3b) for guiding connecting elements, which lead-in part slants relative to the slit up to a circumferential edge.



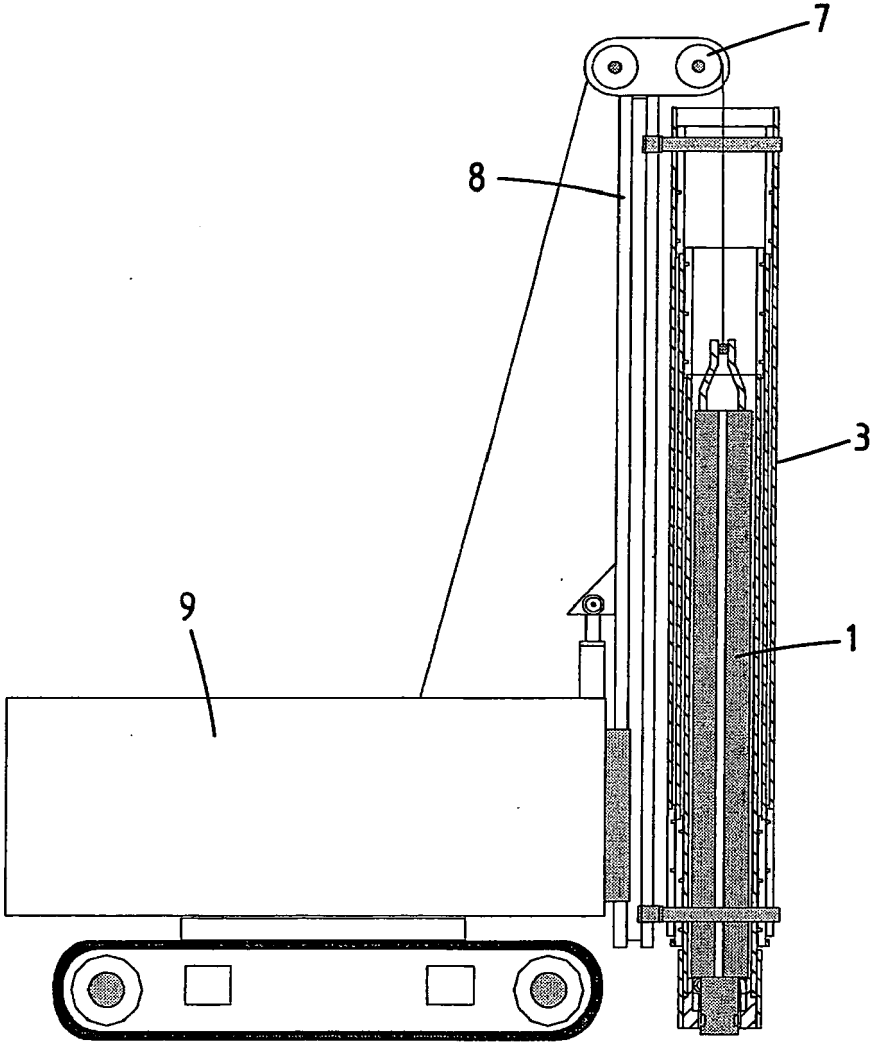


Fig.1

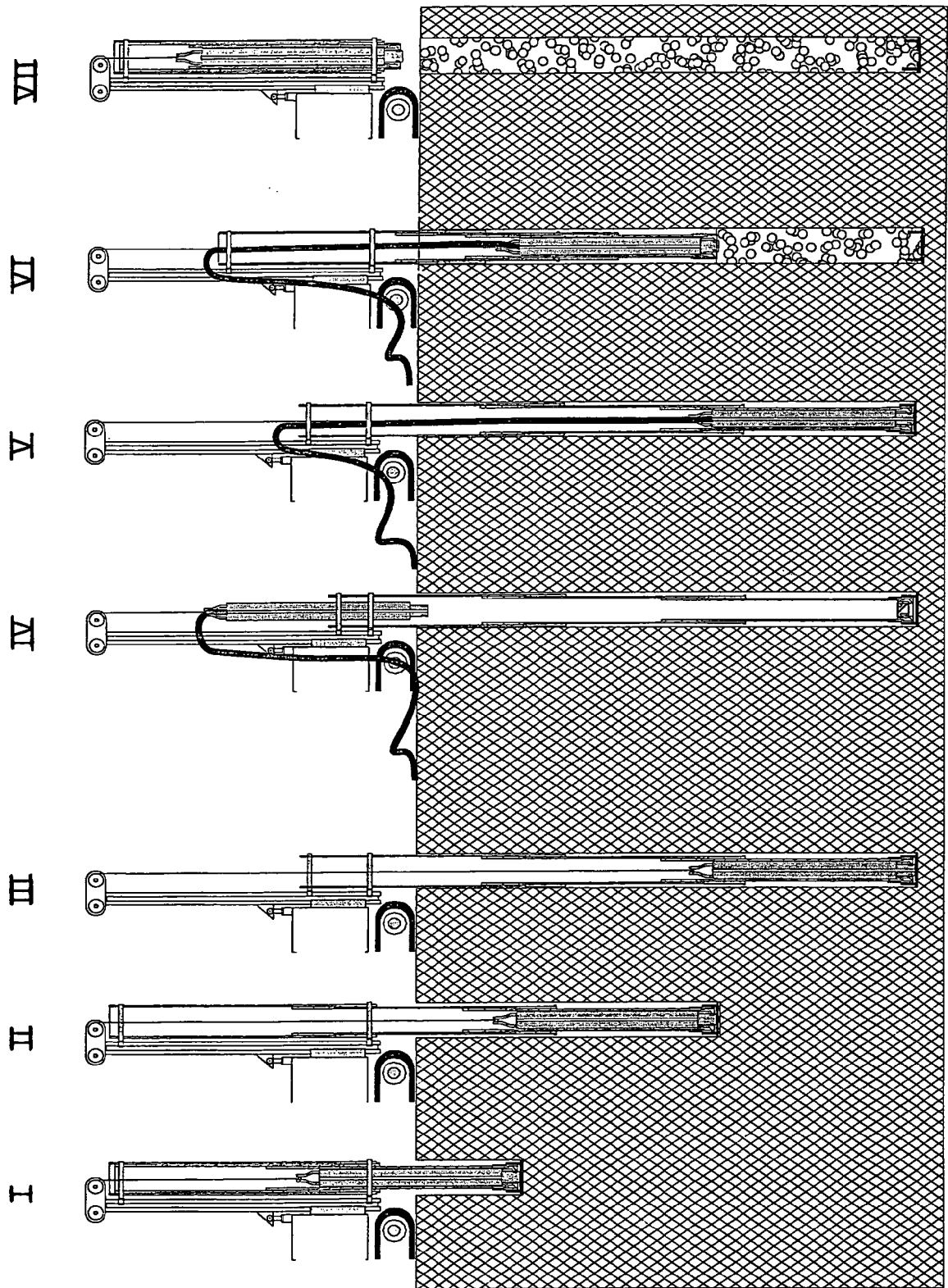


Fig.2

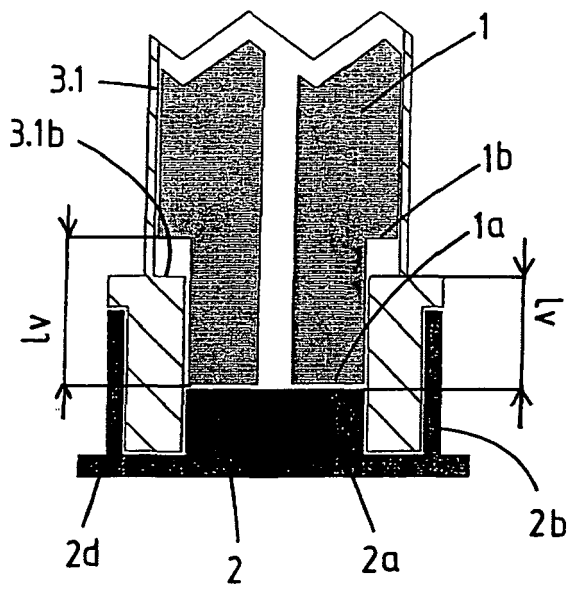


Fig.3

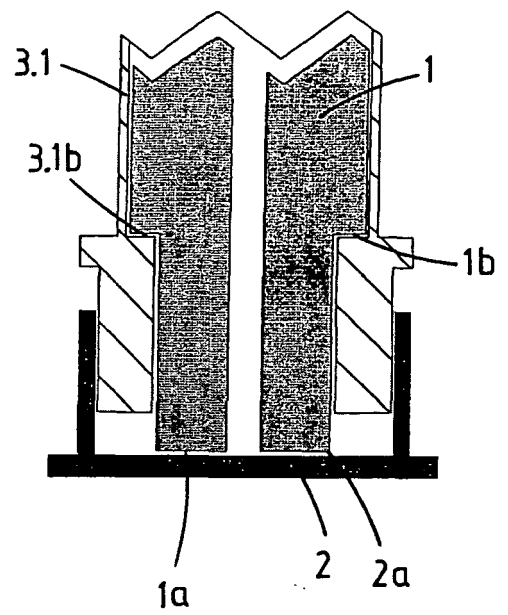


Fig.4

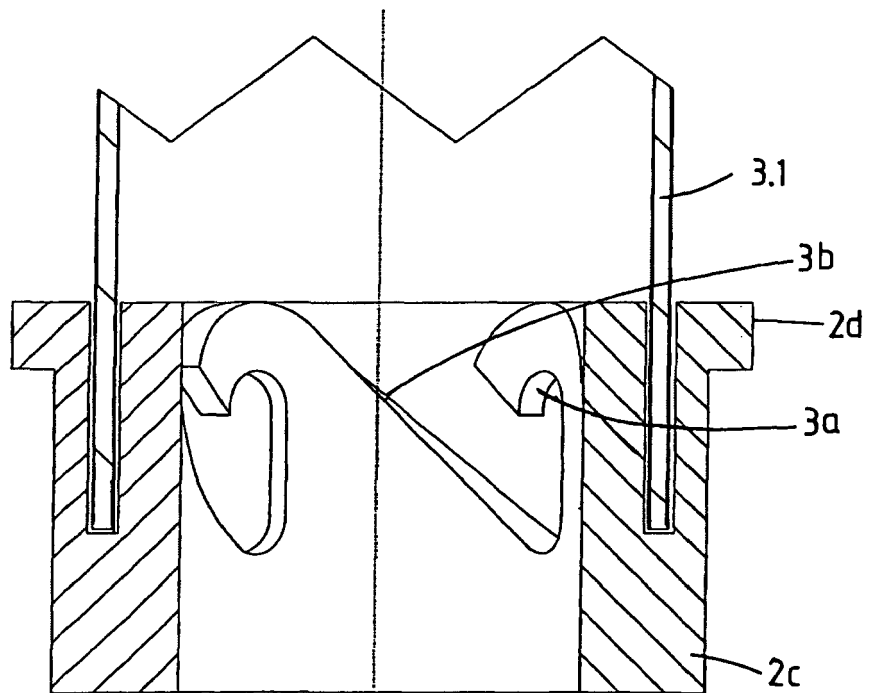


Fig.6

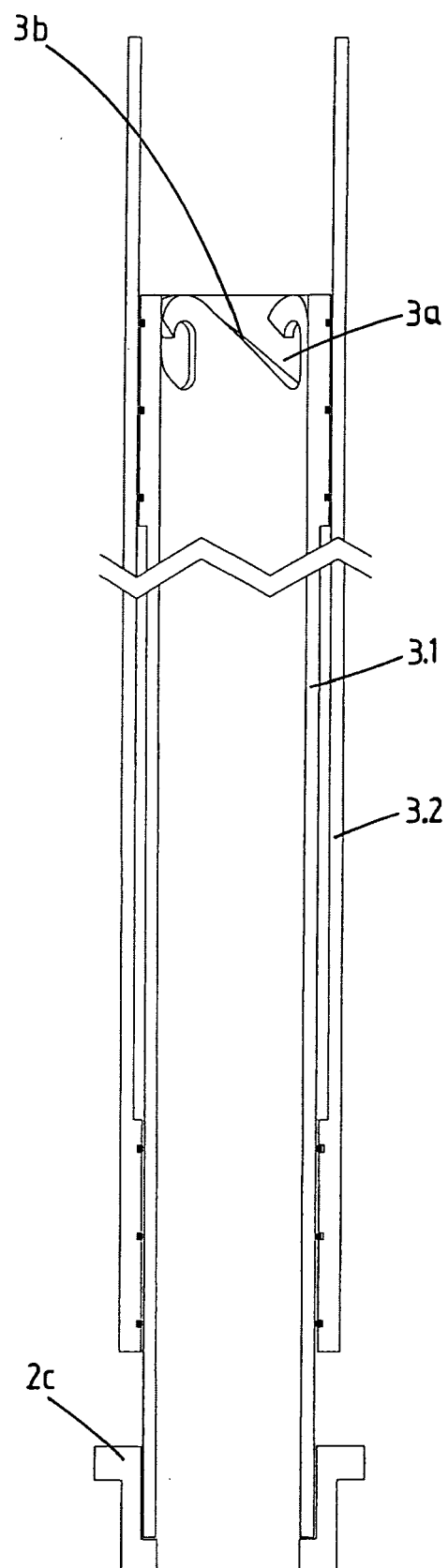


Fig.5

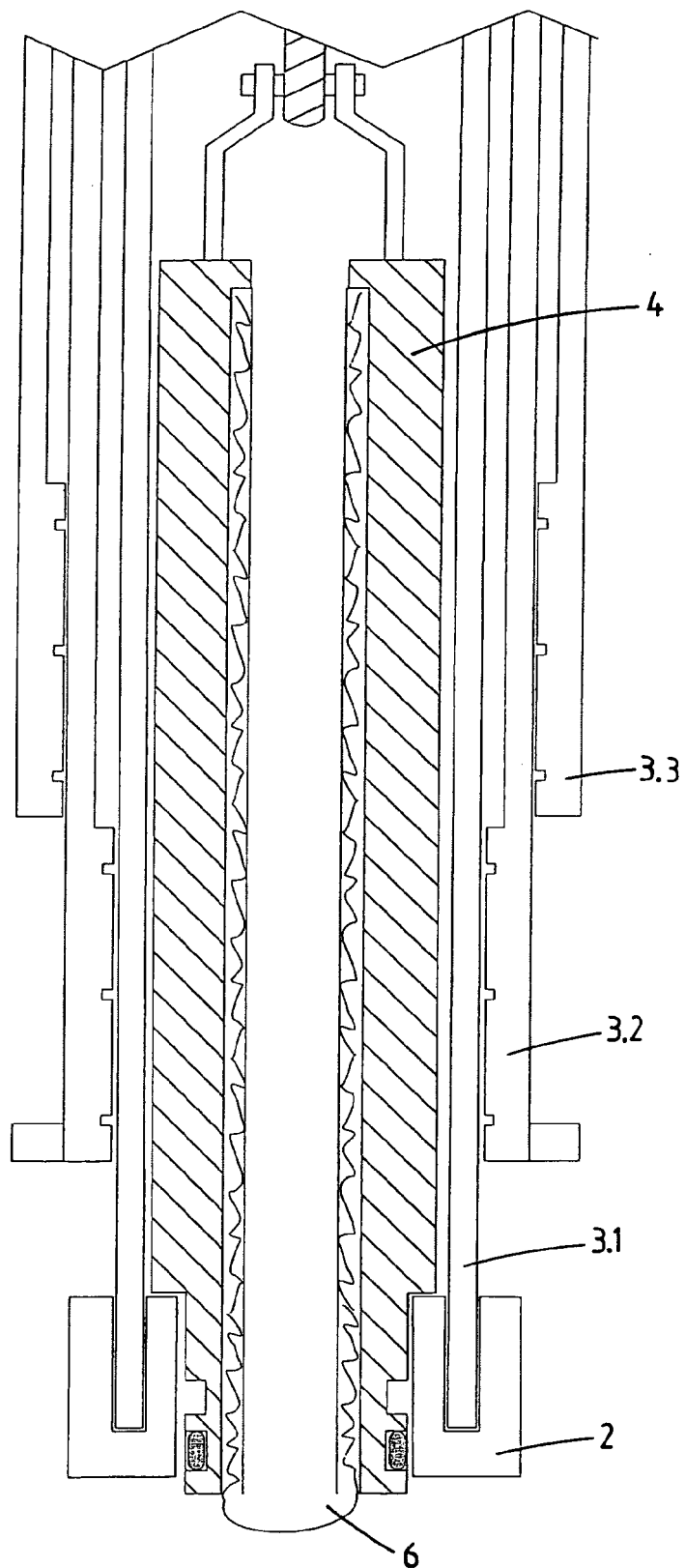


Fig.7

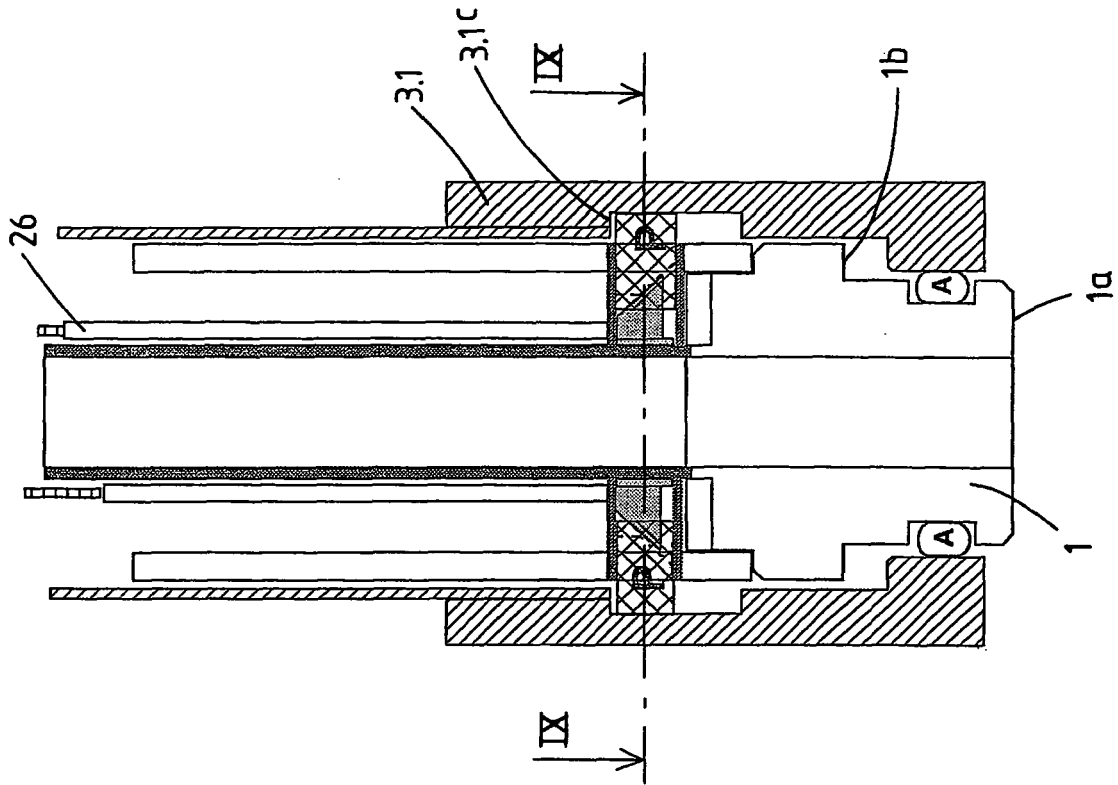
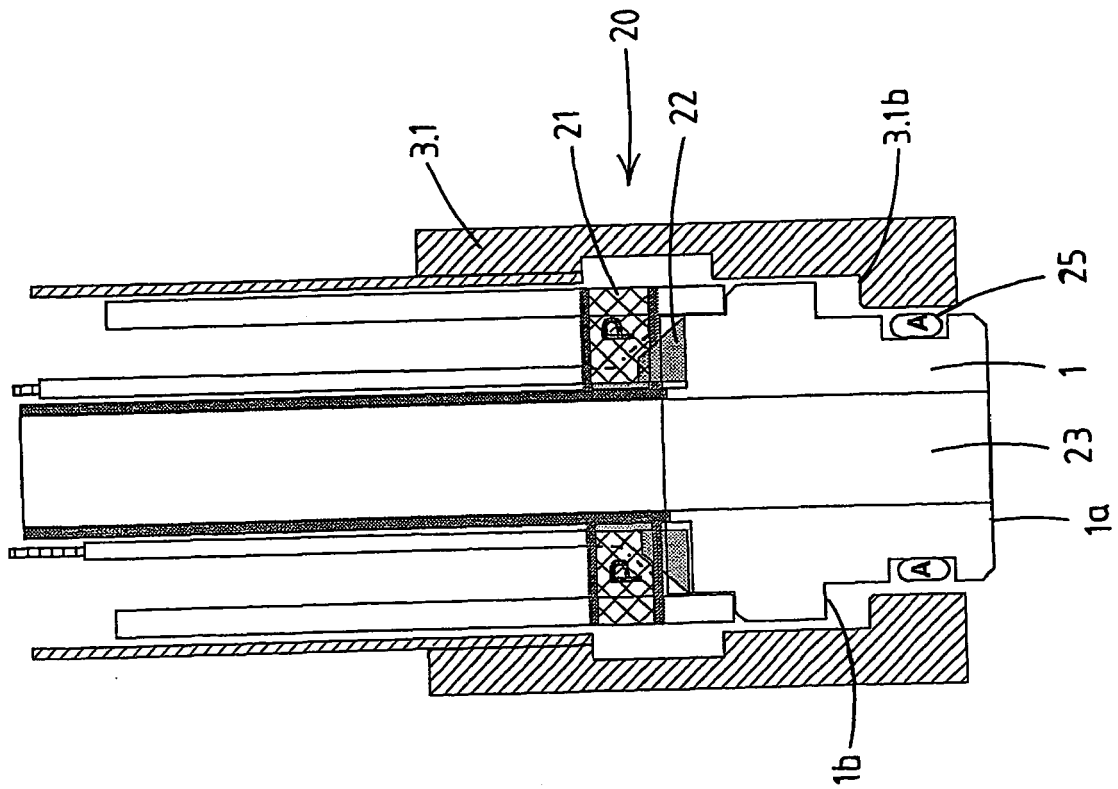


Fig.8



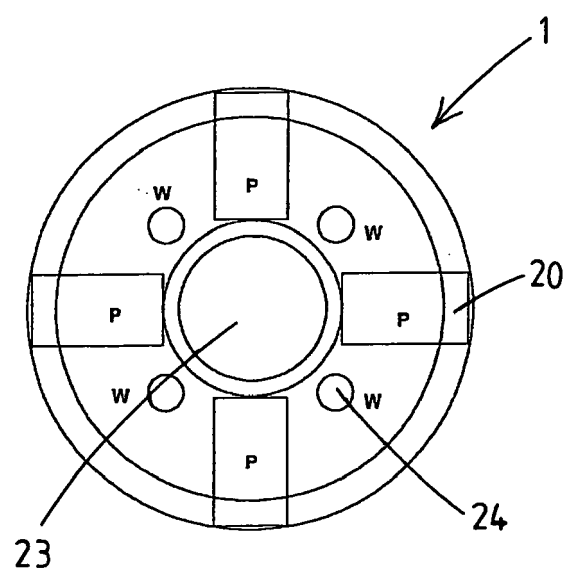


Fig.9

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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