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(54) **Method for inserting a tension anchor into the ground**

(57) Method for inserting a tension anchor (5) into the ground (2) for anchoring a building structure (1), in which the tension anchor comprises a head part (5a) with outlet openings and a coupled tube part (5c). By introducing a hardening substance through the tube part to the head part (5a), the hardening substance flowing through an outlet opening in the head part, a volume is formed there around the head part. Before the hardening substance has hardened, according to the method of the invention, a tension body (7) is introduced through the tube part to the head part. After the tension body has been introduced, the tube part is uncoupled from the head part and withdrawn from the ground. After the introduced substance has hardened, a fixed connection is created between the distal end of the tension body and the head part. The proximal end of the tension body is subsequently tensioned and fastened to the building structure.

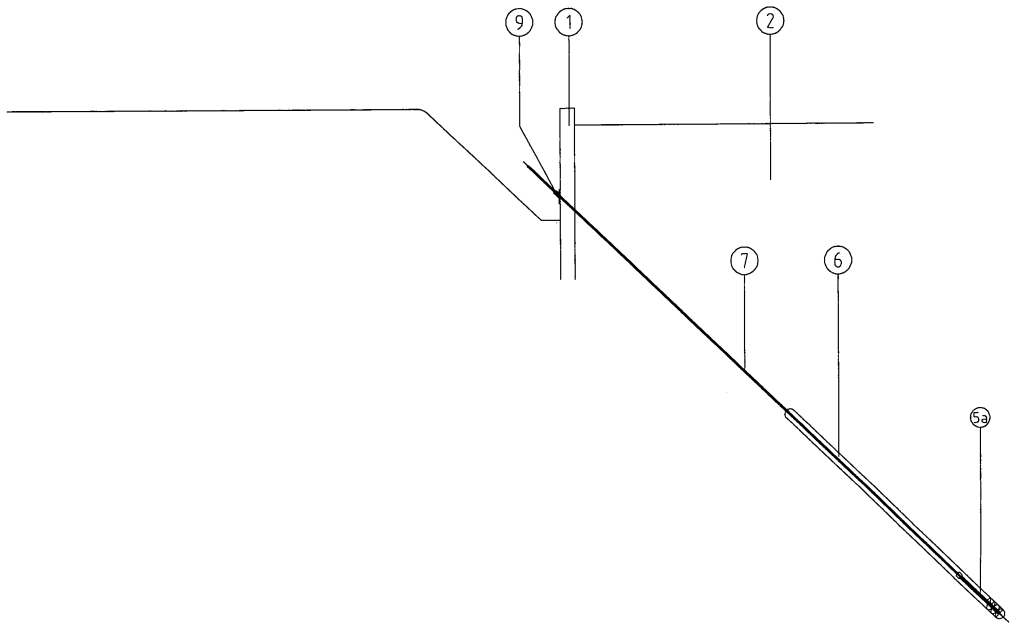

Fig. 7

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Description

[0001] The present invention relates to a method for inserting a tension anchor into the ground for anchoring a building structure according to the preamble of claim 1. Tension anchors are often used during building work in order to anchor various types of building structures, such as quay walls, bank sheet-piling, earth-retaining construction walls in construction pits, tunnels, bridges, etc.

[0002] Such a method is known from patent NL-192836 in the name of Gebr. Van Leeuwen Harmelen B.V. In this patent, a screw anchor is described which consists of a head part and extension tubes. The head part is tubular and is provided with a screw blade on the outside at the end. The screw anchor can be inserted into the ground by carrying out a rotary movement on the screw anchor. As soon as the screw anchor has been inserted into the ground to a sufficiently deep level, a hardener is introduced under pressure into the hollow space of the tubular tension anchor. At the level of the screw blade, outlet openings are provided in the outer circumference of the head part. The hardener flows through the outlet openings out of the hollow space of the tension anchor and is injected into the ground around the screw blade.

[0003] Despite the fact that the method is advantageous in many respects, there are still some drawbacks attached to it. One drawback of this method is that the tension anchor has to be made to fit in order to be attached to the building structure. To this end, the extension tubes have to be shortened and fixed, which is often a time-consuming procedure.

[0004] Another drawback is the fact that the use of the tension anchors is expensive. The tension anchors used are of a high quality as high-quality steel is used to obtain a high tensile strength. An extension tube is for example a machined smooth tube. A machining operation is required, for example, in order to be able to couple the various extension tubes to one another. The smooth exterior of the extension tube is advantageous when the screw anchor is inserted into the ground. Due to the materials used and the required machining operations, the screw anchor comprises expensive components.

[0005] It is an object of the present invention to overcome at least one of the abovementioned drawbacks, at least partially, and/or to provide a usable alternative. In particular, it is an object of the invention to provide a quick, cost-saving and efficient method.

[0006] This object is achieved by a method for inserting a tension anchor into the ground for anchoring a building structure, as defined in claim 1.

[0007] The tension anchor which is inserted into the ground with the aid of an insertion device comprises according to the invention a head part and at least one tube part. The head part comprises at least one outlet opening. First, the head part is inserted into the ground and then the tube part is coupled to the head part. When the tension anchor has reached a certain depth, a hardening substance is introduced through the tube part to the head part. The hardening substance flows through the outlet opening in the head part and there forms a volume around the head part which, once hardened, contributes to an increase in the permissible tensile force on the tension anchor. With the method according to the invention, at least one tensioning body is introduced through the tube part to the head part before the hardening substance has hardened. When one or more tensioning bodies have been introduced, the tube part is detached from the head part and withdrawn from the ground. When the substance which was fed in has hardened, a fixed connection is created between the distal end of the tensioning body and the head part. The proximal end of the tensioning body is subsequently tensioned and secured to the building structure.

[0008] It is advantageous in this case that the tube part which was withdrawn can be re-used. As the tube part is produced from high-quality material and has been subjected to several machining operations, re-using the tube part with the method according to the invention represents a significant cost saving. The tube part is, as it were, a kind of auxiliary equipment which can readily be loaded with a pressure force in order to introduce the head part of the tension anchor into the ground.

[0009] Furthermore, it is advantageous that the method according to the invention makes it significantly simpler to secure the tension anchor on the building structure. Preferably, strands are used as tensioning bodies. A strand may be, for example, a bundle of intertwined steel wires, but may also be a bundle of fibres of a non-metal material. The strands may be relatively flexible compared to the tube parts and may be secured using traditional means for tensioning and securing cables.

[0010] It is simple, for example, to accommodate the tensioning body in a block-shaped accessory having a hole and a wedge in order then to tension the tensioning body by lever action using this accessory. Following tensioning with the accessory, the tensioning body can be secured to the building structure in an anchor block. It is also possible to provide a screw thread on the proximal end of the tensioning body with which the tensioning body can be secured to the building structure using a coupling nut and an anchor block. Countless other ways of tensioning and securing a tensioning body are known.

[0011] In a preferred embodiment according to the invention, a screw anchor is introduced as a tension anchor. The head part of a screw anchor is provided with a screw blade. By means of a rotary movement, the screw anchor is inserted into the ground. As a result of the presence of the screw blade, having a diameter of for example at least 100 millimetres, the screw anchor can withstand larger tensile forces than tension anchors without a screw blade. The use of screw anchors has advantageously made it possible to achieve a desired anchoring using fewer tension anchors. This not only results in a time saving, but also in a cost saving.

[0012] In a further preferred embodiment, the head part of the tension anchor is coupled to the other tube parts by means of a bayonet fastening. Reference is made to the patent EP-0.878.584 in the name of Gebr. Van Leeuwen Harmelen B.V. for such a bayonet fastening. The patent EP-0.878.584 is deemed to be incorporated in this patent application by way of reference. Advantageously, the bayonet fastening provides a secure, strong and reliable coupling, which can easily be released by an angular rotation, following which the tube parts can be quickly removed.

[0013] In a particular embodiment of the method according to the invention, the hardening substance is already injected before the tension anchor has reached the desired depth. Advantageously, a larger hardened volume is obtained in this manner than if the injection is started after the tension anchor has reached this desired depth. The composition of the ground is critical in determining the moment at which injection of the hardening substance is started. For example, the presence of a layer of sand in the ground offers a good opportunity to start injecting the hardening substance when the head part of the tension anchor has reached the layer of sand. If, for example, a layer of peat is present in the ground, injection of the hardening substance can be started once the head part of the tension anchor has passed the layer of peat. Starting the injection of a hardening substance any earlier would mean a waste of hardening substance, since the layer of peat cannot contribute to the strength of the anchoring. An excessively large volume would also be disadvantageous if, for example, foundation poles have to be rammed into the ground which then hit the large hardened volume. Advantageously, the method according to the invention, in a controllable manner, provides an improved anchoring as a result of the enlarged hardened volume.

[0014] Further preferred embodiments are defined in the further subclaims.

[0015] The invention will be explained in more detail with reference to the attached drawings which show a practical embodiment of the invention, but which should not be seen as being limiting. In these drawings:

Fig. 1 shows a first step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 2 shows a second step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 3 shows a third step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 4 shows a fourth step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 5 shows a fifth step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 6 shows a sixth step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 7 shows a seventh step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 8 shows an eighth step of the method for inserting a tension anchor into the ground according to the invention;

Fig. 9 shows cross sections of tension anchors of different diameters, in which tensioning bodies are disposed inside the internal diameter of the tension anchor.

[0016] Figs. 1-8 show the consecutive steps of the method according to the invention. Fig. 1 shows a sheet pile wall 1, which is placed in the ground 2. In a first step, various accessories are put in place. Opposite the sheet pile wall 1, there is a digging machine 3 which has been converted so as to be able to insert screw anchors 5 into the ground. To this end, an insertion device 4 is located on an arm 3a of the digging machine 3. A part of a screw anchor can be arranged on the insertion device 4 and subsequently inserted into the ground 2 by means of a rotating movement.

[0017] Fig. 2 shows a second step for inserting a screw anchor 5 into the ground 2. The screw anchor 5 consists of multiple parts. The screw anchor 5 has a head part 5a which is connected to the other tube parts 5c by means of a bayonet fastening 5b. The tube parts 5c are connected to one another by means of screw thread connections 5d. Although not illustrated in the figures, the tube parts are preferably coupled to one another by means of a conical screw thread and the external surface of the tube parts is smooth at the transition. The screw thread connection is located inside the outside diameter of the exterior of the tube part 5c. This is advantageous when the tube parts 5c are inserted into the ground as no earth accumulates around the transitions of the tube parts, which would lead to additional resistance when the latter are inserted into the ground. Due to the fact that the screw thread is conical, the alignment of the ends of the tube parts 5c relative to one another during fastening is improved and the screw thread connection is relatively easy to release.

[0018] Screw blade windings having an outer diameter of approximately 400 mm are provided on the head part 5a. As a result, it is possible to drill the screw anchor 5 into the ground using a rotary movement. This rotary movement is provided by the insertion device 4 which is attached to the digging machine 3. Due to the large diameter of the screw blade windings, the screw anchor offers a large resistance when a tensile force is exerted on the tension anchor.

[0019] Fig. 3 shows a third step of the method according to the invention, in which the screw anchor 5 is inserted into the ground at the desired depth. The desired depth is determined by the composition of the ground. In

order to be able to absorb sufficient tensile force, the screw anchor 5 is usually drilled into the ground 2 to such an extent that the head part 5a, which forms the distal end of the screw anchor, is located in a stable layer of sand. In order to reach the desired depth, several tube parts 5c are coupled to the screw anchor 5. In the third step from Fig. 3, grout is introduced as hardening substance. At the depth in the ground reached in step 2 of Fig. 2, grout is introduced as hardening substance through the tube parts 5c to the head part 5a during the insertion of the screw anchor. By starting the introduction of grout only at a certain depth, wasting large amounts of grout is prevented.

[0020] Fig. 3 shows an enlarged detail III of the head part 5a. Outlet openings 5d are provided in the head part 5a in such a manner that the grout there flows out of the outlet openings at a pressure of, for example, 20 bar, and spreads around the screw anchor 5. When the grout has hardened, a grout body 6 will have formed in the ground. However, according to the method of the invention, a few measures are taken before the grout has hardened. These measures are shown in the following figures.

[0021] Fig. 4 shows a fourth step of the method according to the invention. During this step, tensioning bodies are conducted through the tube parts 5c towards the head part 5a in the screw anchor 5. In this case steel cables are used as tensioning bodies, as these advantageously have a rough outer surface. The rough outer surface results from the fact that the steel cable comprises a bundle of wound steel wires. This rough outer surface provides a good contact surface with the grout. A further advantage of a steel cable is that it is relatively flexible compared to a tubular tensioning body and can thus be tensioned and secured in a simple manner. However, it is also possible to use different materials instead of a steel cable as tensioning body, such as reinforcing iron, guy ropes, ropes, chains, etc. Depending on the internal diameter of the screw anchor 5, one or more steel cables or rods may be introduced.

[0022] Fig. 5 shows a fifth step of the method according to the invention, in which, before the grout hardens to form a grout body 6, the bayonet fastening 5b between the head part 5a and the other tube parts 5c is released. As the enlarged detail V shows, the bayonet fastening 5b can be released in a simple manner by rotating in a direction opposite to the direction of rotation required to drill the screw anchor 5 into the ground 2. Following a small angular rotation, the tube parts 5c can be withdrawn from the ground 2. Advantageously, the tube parts 5c can be re-used.

[0023] Fig. 6 shows the sixth step of the method according to the invention, in which the tube parts 5c are withdrawn. The hollow space resulting from the removal of the tube parts 5c is filled by simultaneously injecting grout while the tube parts 5c are being withdrawn. This grout is injected at a pressure lower than, for example, 5 bar.

[0024] Fig. 7 shows a seventh step of the method according to the invention, in which the grout, after some time, has hardened to form the grout body 6. During this step, an anchor block 9 is provided at the location of the sheet pile wall 1. The tensioning bodies 7 which have in the meantime formed a solid connection with the head part 5a as a result of the hardening of the grout are attached to the anchor block 9.

[0025] Fig. 8 shows an eighth step of the method according to the invention, in which the strands 7 which are attached to the anchor block 9 are tensioned using auxiliary equipment 8. By tensioning the tensioning bodies 7, a tensile force will be exerted on the sheet pile wall 1, thus preventing the sheet pile wall 1 from collapsing under, for example, the pressure from the ground 2.

[0026] Fig. 9 shows cross sections of tension anchors of different diameters. Cross sections of tensioning bodies 7 are shown inside the internal diameter of the tension anchor. Tension anchors having a small internal diameter of 40 millimetres provide space for three tensioning bodies 7 with a diameter of 15 millimetres. As Fig. 9 shows, with larger tension anchors having a diameter of 110 millimetres as many as 25 tensioning bodies with a diameter of 15 millimetres can be introduced.

[0027] Many variants are possible in addition to the embodiment shown. Thus, the release of the head part may also be effected by a controlled explosion, breaking, loosening a screw thread connection, etc. The head part and the tube part of the tension anchor may also be pushed over one another telescopically or only rest against one another, with the tube part pushing the head part and the head part remaining behind upon withdrawal of the tube part.

[0028] Thus, according to the invention, a method is provided for inserting a tension anchor into the ground for anchoring building structures which is efficient so that a cost-saving can be achieved with respect to material and labour.

Claims

1. Method for inserting a tension anchor (5) into the ground (2) for anchoring a building structure (1) comprising the following steps:

   - inserting a tension anchor into the ground (2) using an insertion device, the tension anchor comprising a head part (5a) with at least one outlet opening provided in the circumferential wall and at least one tube part (5c) coupled to the head part (5a);
   - introducing a hardening substance through the tube part (5c) to the head part (5a), the hardening substance flowing through an outlet opening in the head part (5a) in order there to form a volume around the head part (5a);
   - **characterized in that** the method furthermore comprises the following steps:

- extending at least one tensioning body (7) through the tube part (5c) to the head part (5a) before the substance introduced into the tension anchor (5) has hardened;
- uncoupling the tube part (5c) from the head part (5a) and withdrawing the tube part (5c) from the ground (2);
- tensioning the tensioning body (7) following the hardening of the introduced substance; and
- fastening the tensioning body (7) to the building structure (1).

2. Method according to claim 1, in which the tensioning body (7) extending through the tube part (5c) to the head part (5a) is flexible.

3. Method according to claim 1 or 2, in which the tensioning body (7) extending through the tube part (5c) to the head part (5a) is a strand.

4. Method according to one of the preceding claims, in which a screw anchor (5) comprising a head part (5a) with a screw blade is inserted into the ground as tension anchor.

5. Method according to one of the preceding claims, in which a bayonet fastening (5b) between the head part (5a) and the tube part (5c) is released before a tube part (5c) is withdrawn.

6. Method according to one of the preceding claims, in which the tube parts (5c) are connected to one another by a screw thread connection which is located inside the outside diameter of the exterior of the tube part (5c), in such a manner that connected tube parts are smooth at the connection.

7. Method according to one of the preceding claims, in which the introduction of a hardening substance (6) starts after the distal end of the tension anchor (5) has reached a depth which depth corresponds to at least half the depth of the depth which is ultimately desired.

8. Method according to one of the preceding claims, in which the introduction of a hardening substance (6) starts once the distal end of the tension anchor (5) is situated in a layer of sand.

9. Insertion device for inserting a screw anchor into the ground, comprising a tube part and a head part, as in the method according to one of the preceding claims, in which the insertion device comprises a rotating head for inserting the screw anchor into the ground by rotation, an injection head for introducing hardening substance into the tube part and the head part simultaneously with the rotary introduction of the screw anchor, and means for providing at least one tensioning body through the tube part to the head part of the screw anchor.

10. Anchoring comprising a hardened substance (6) in and around a head part (5a) of a tension anchor, **characterized in that** a tensioning body (7) forms a fixed connection with the head part (5a) by bonding with the hardened substance.

11. Anchoring according to claim 10, in which the head part (5a) comprises a screw blade (5d).

12. Anchoring according to claim 10 or 11, in which the tensioning body is flexible.

13. Anchoring according to one of claims 10-12, in which the tensioning body (7) is a strand connecting the head part (5a) to a building structure.

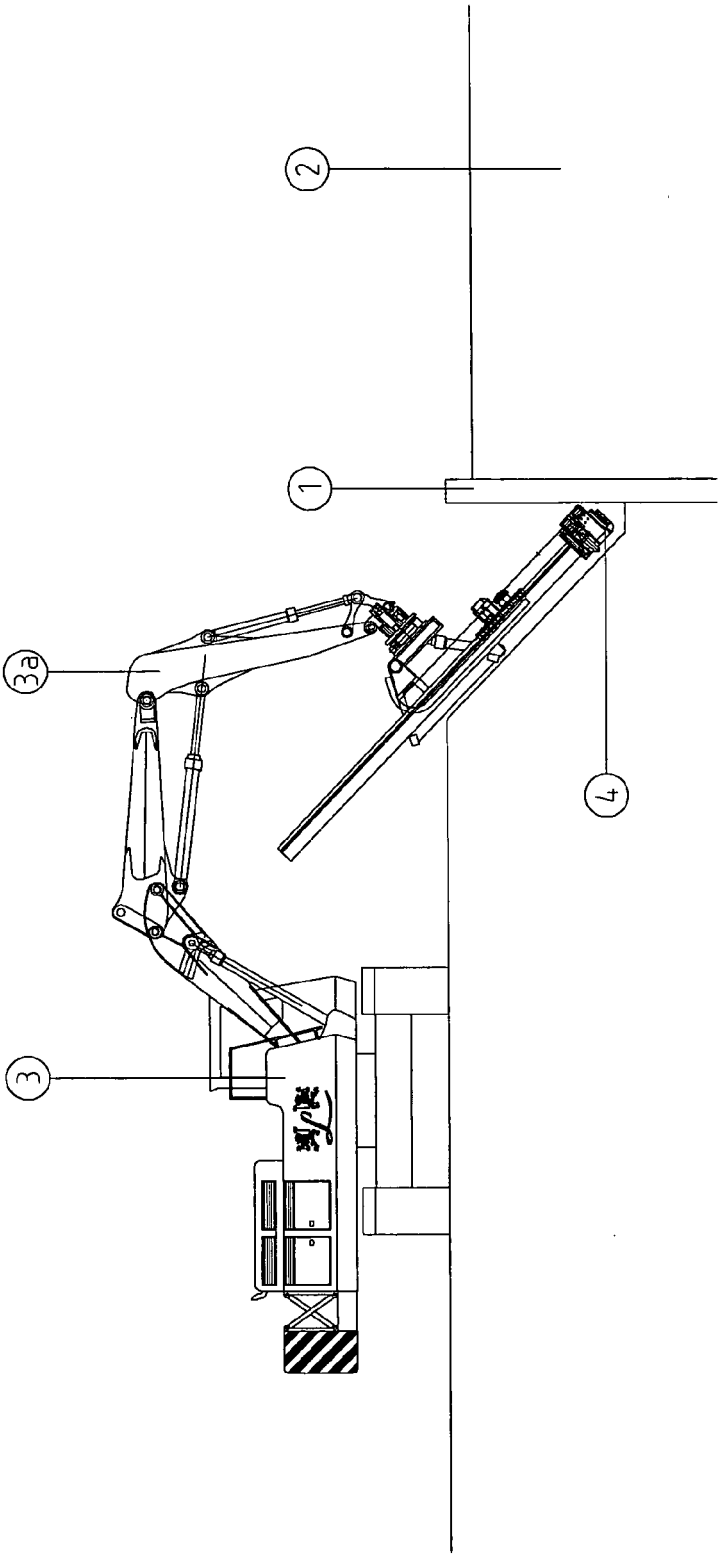

Fig. 1

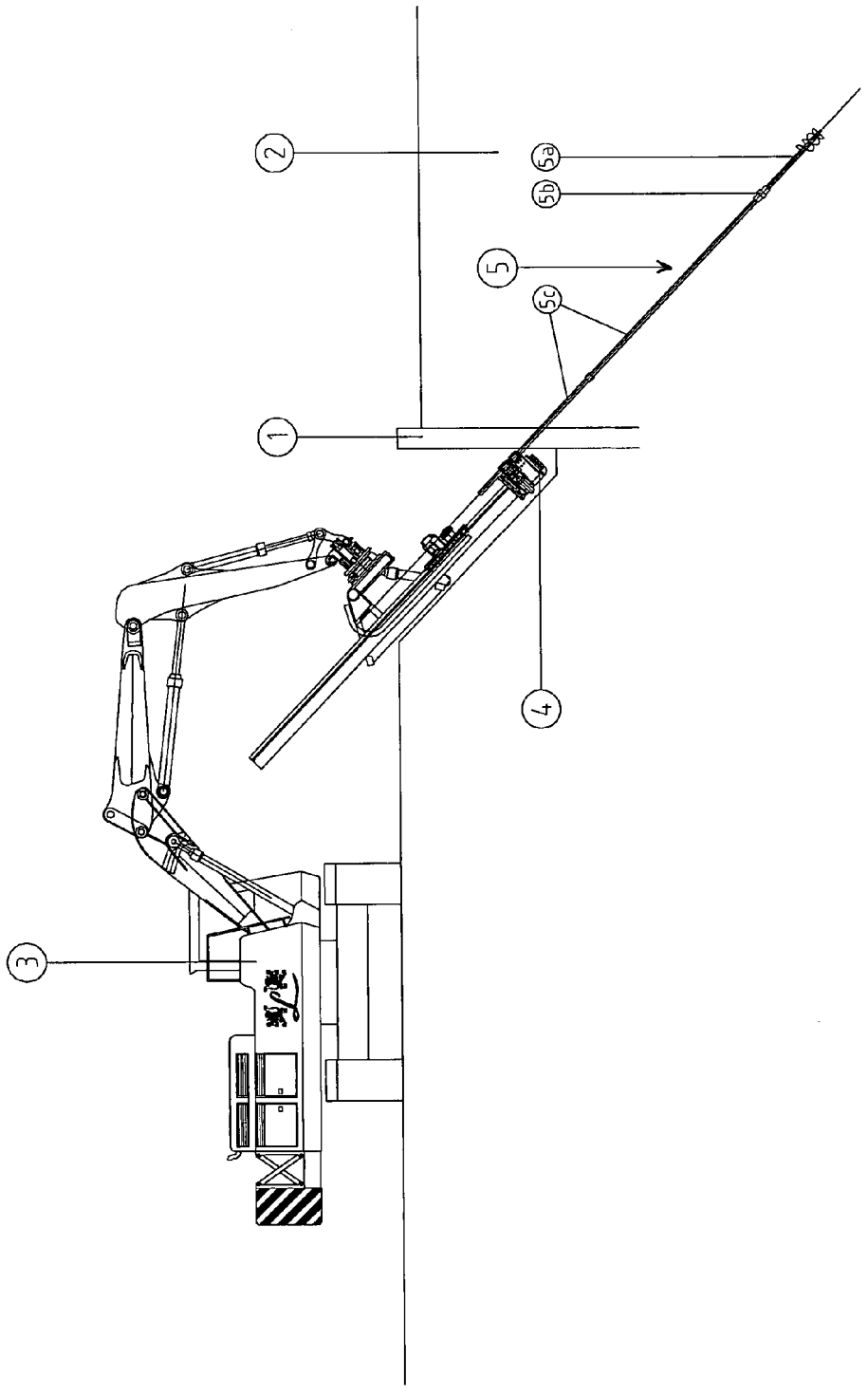

Fig. 2

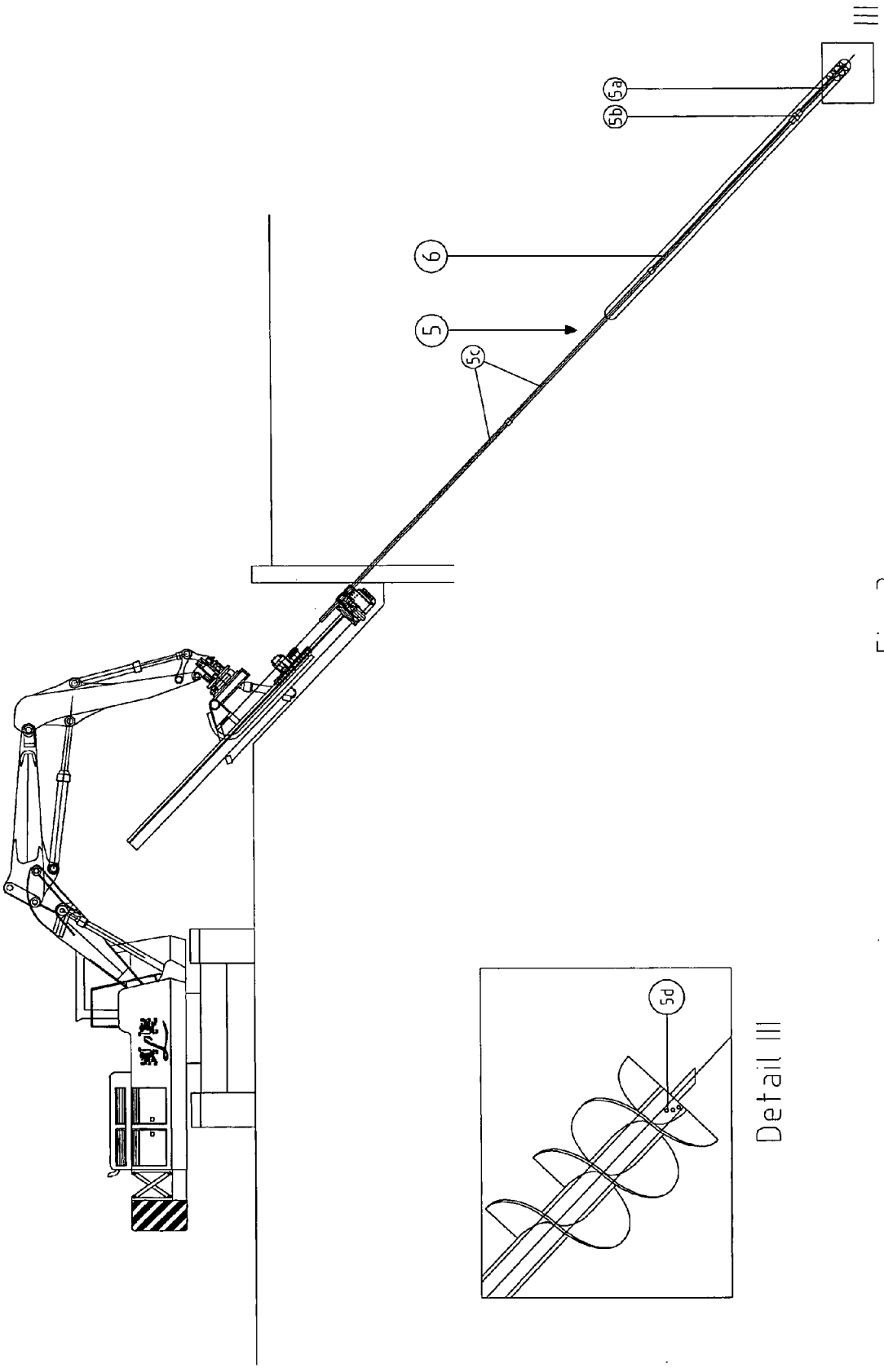

Fig. 3

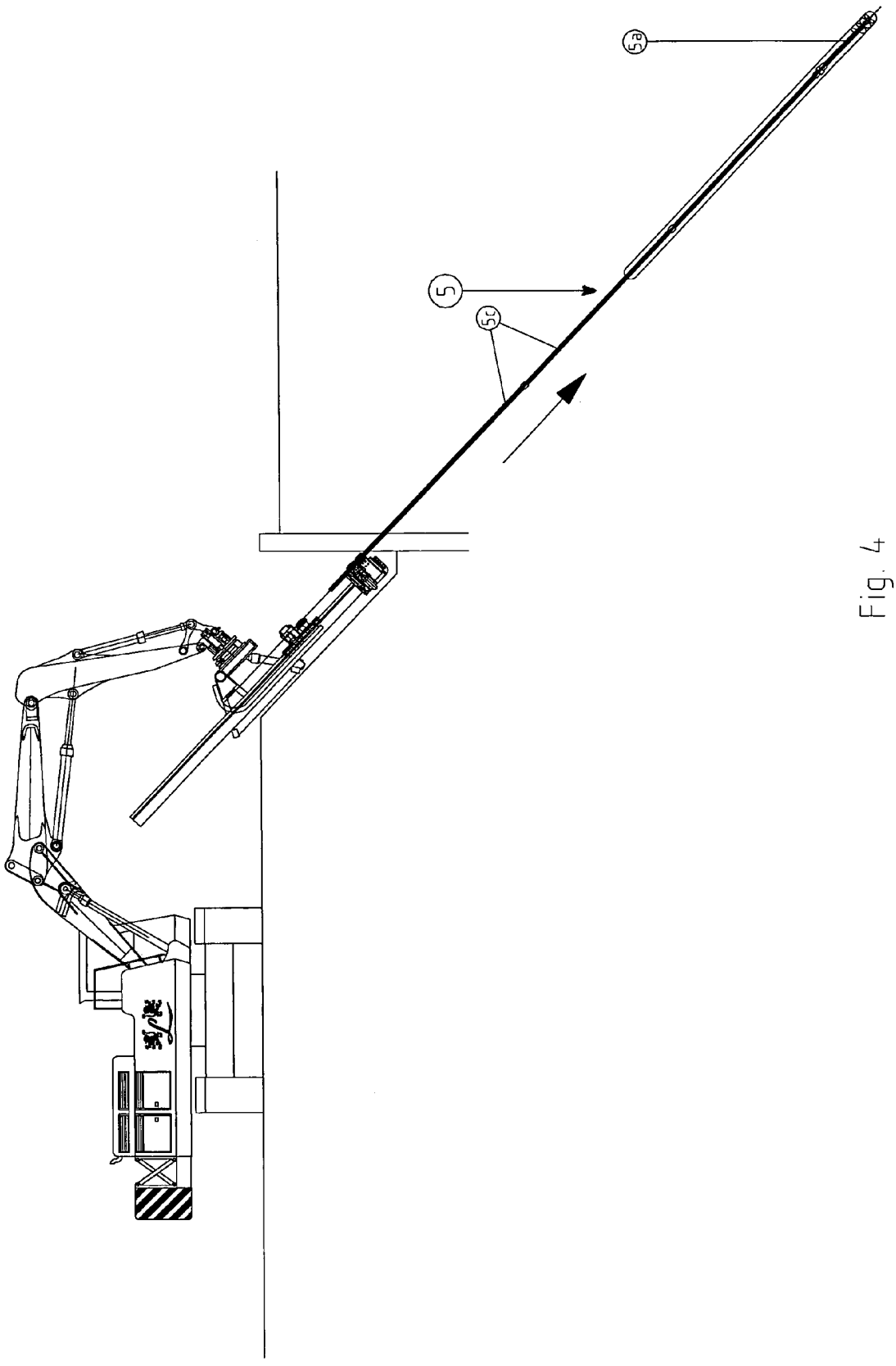

Fig. 4

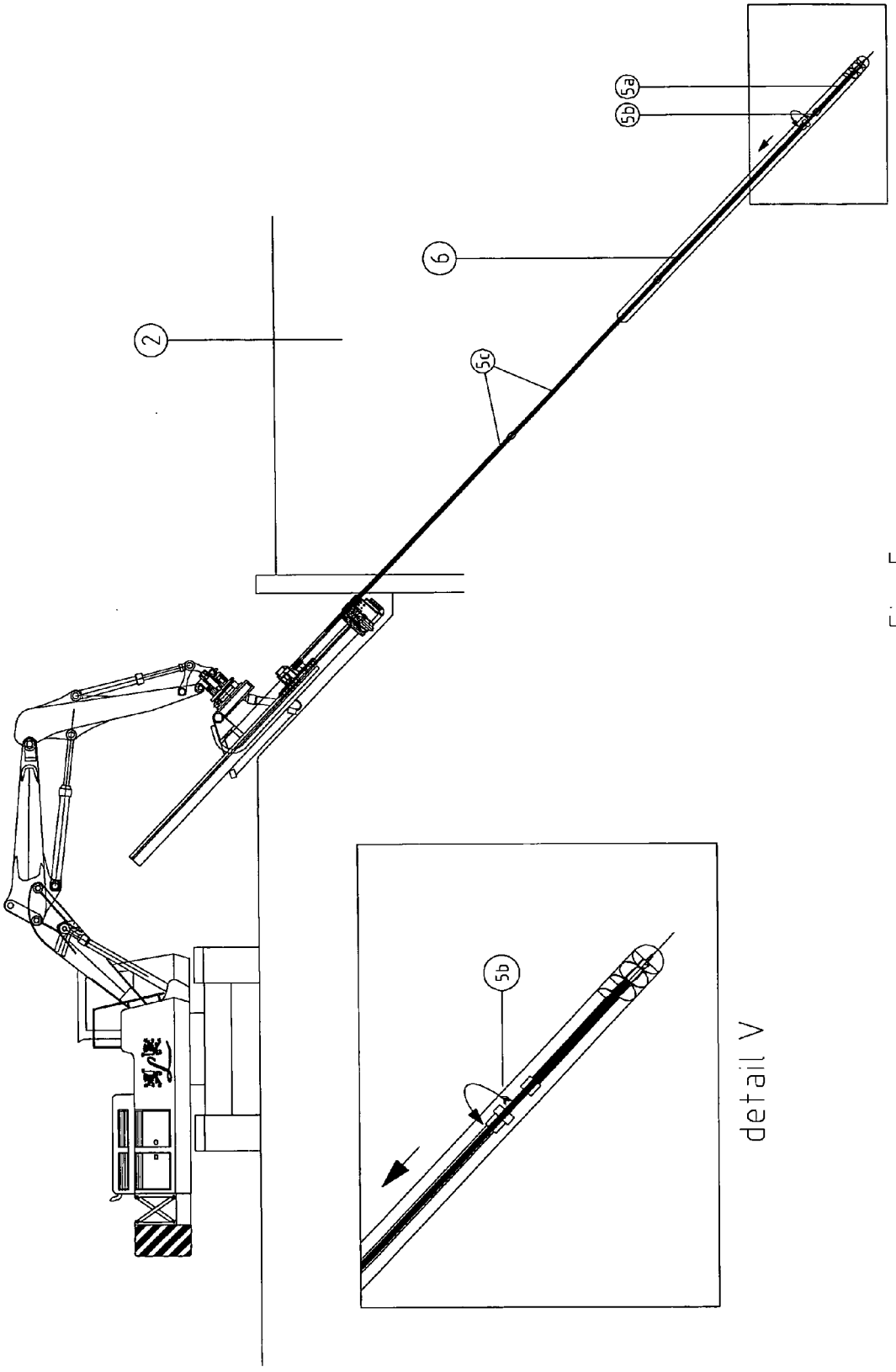

Fig. 5

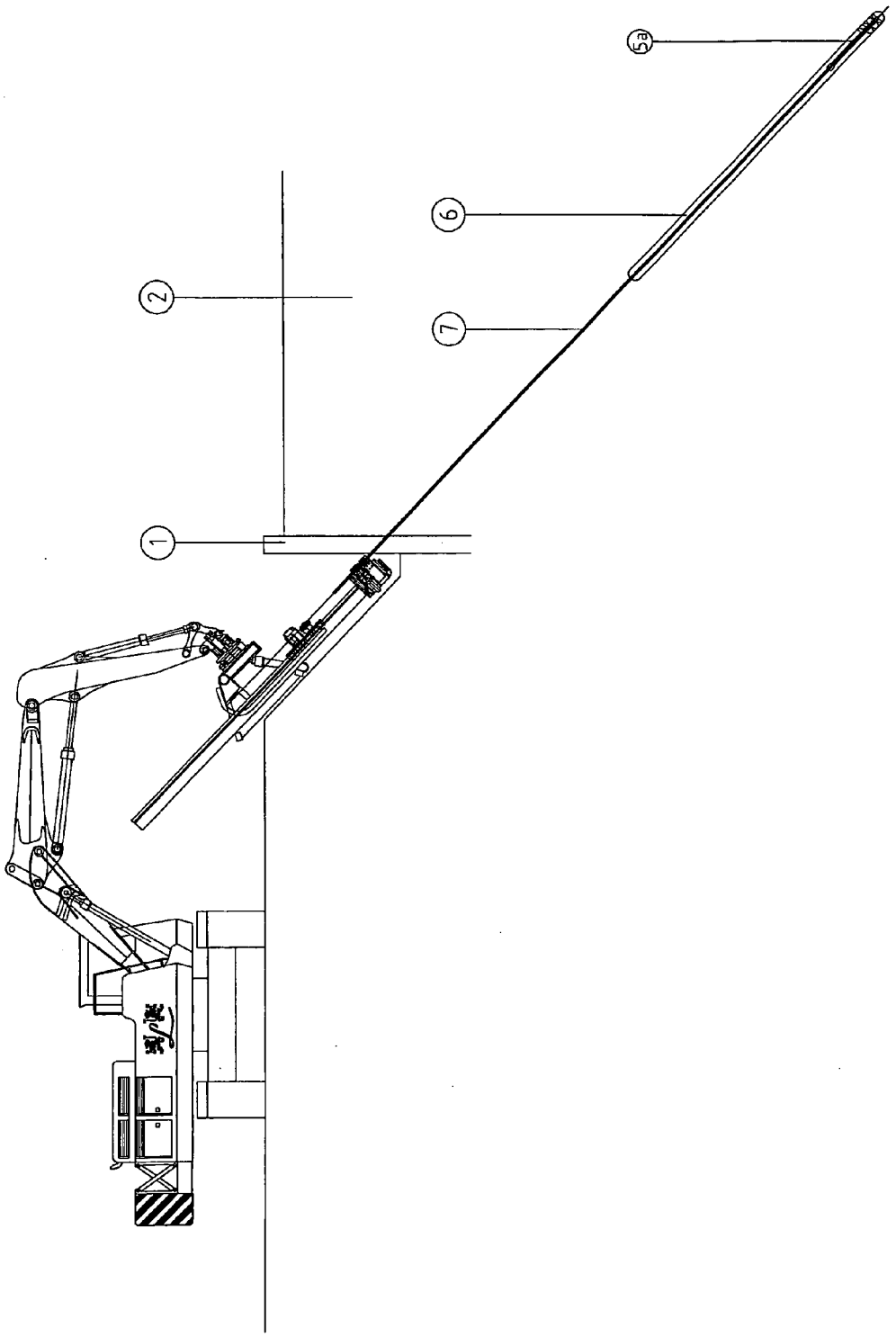

Fig. 6

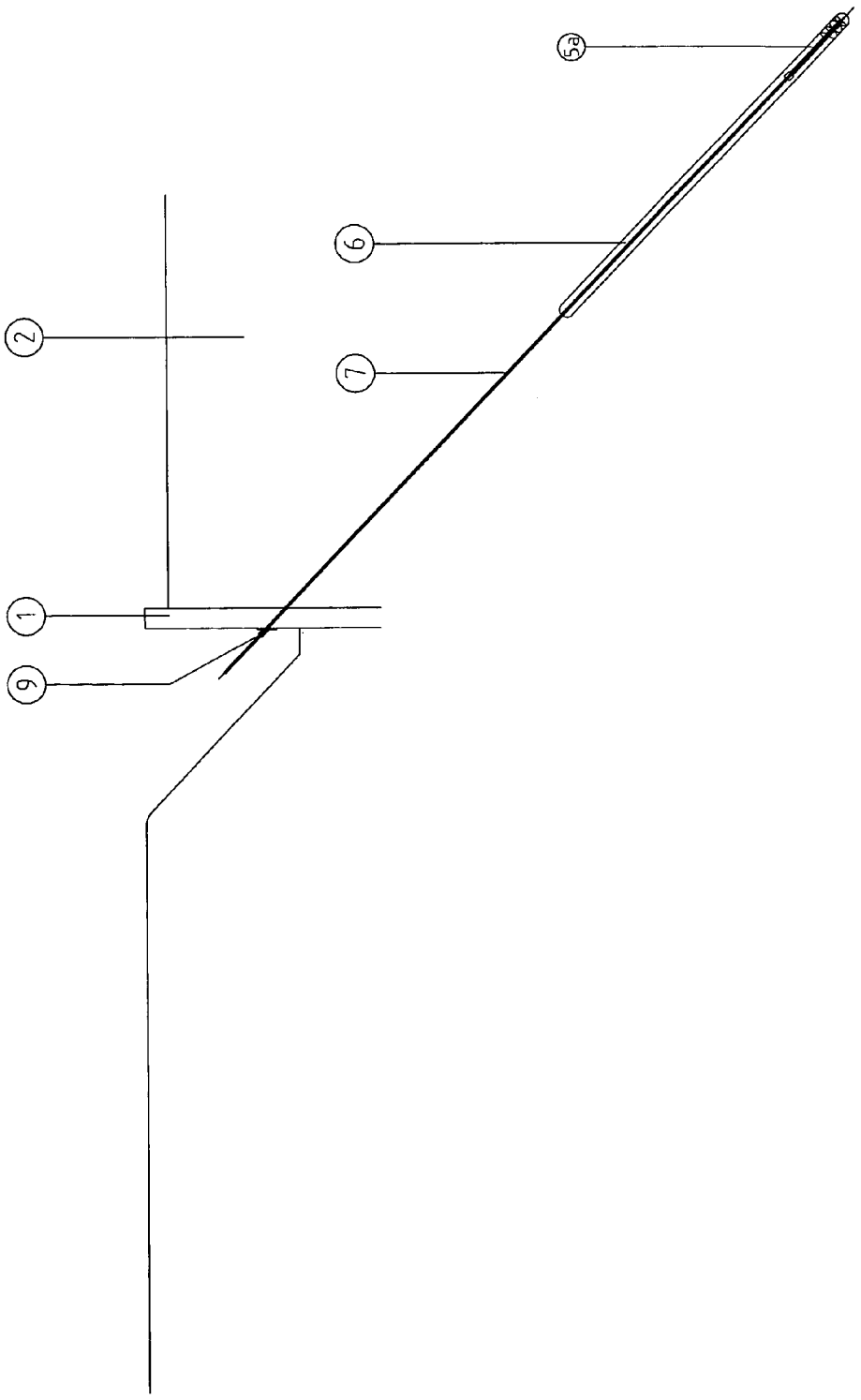

Fig. 7

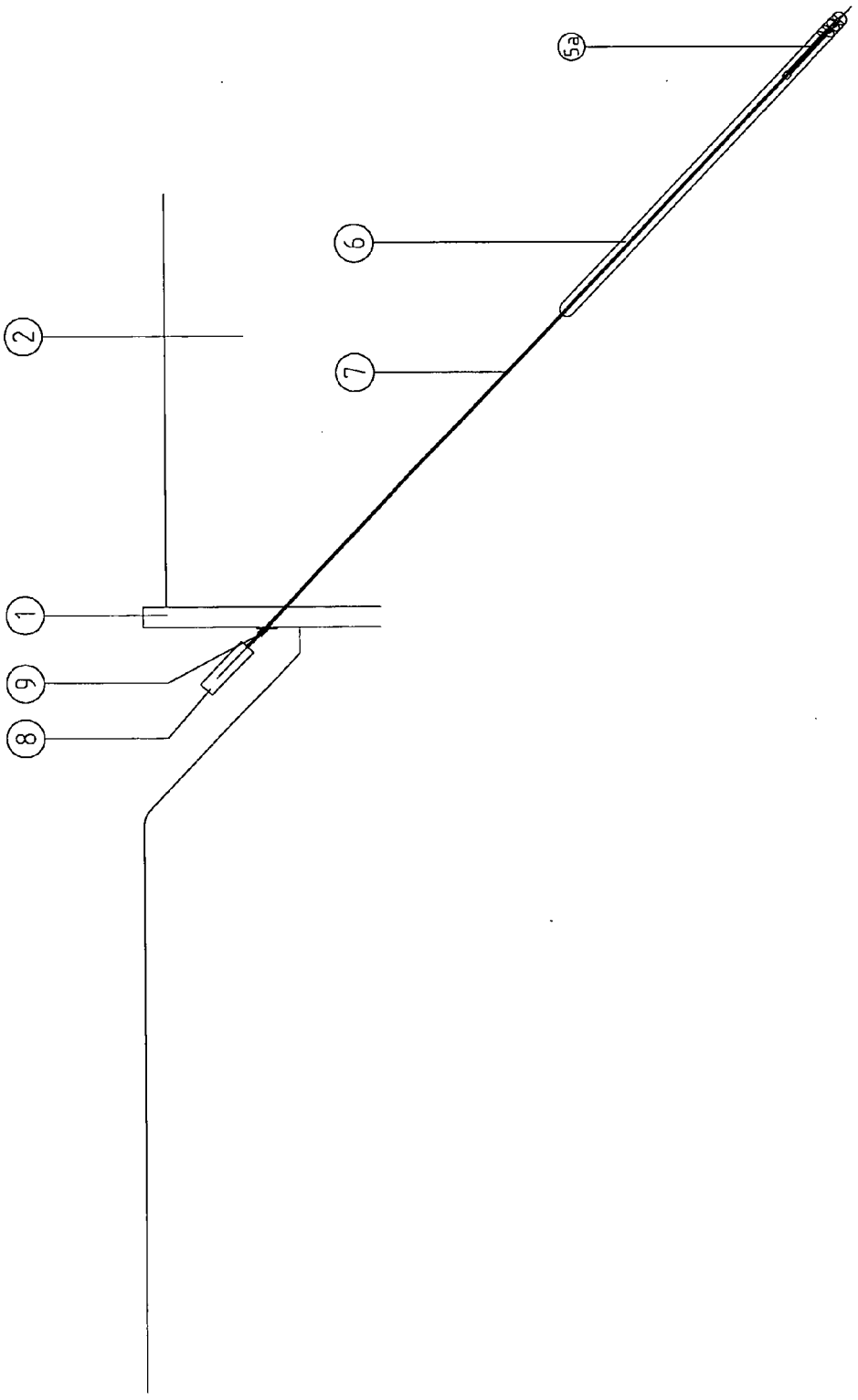

Fig. 8

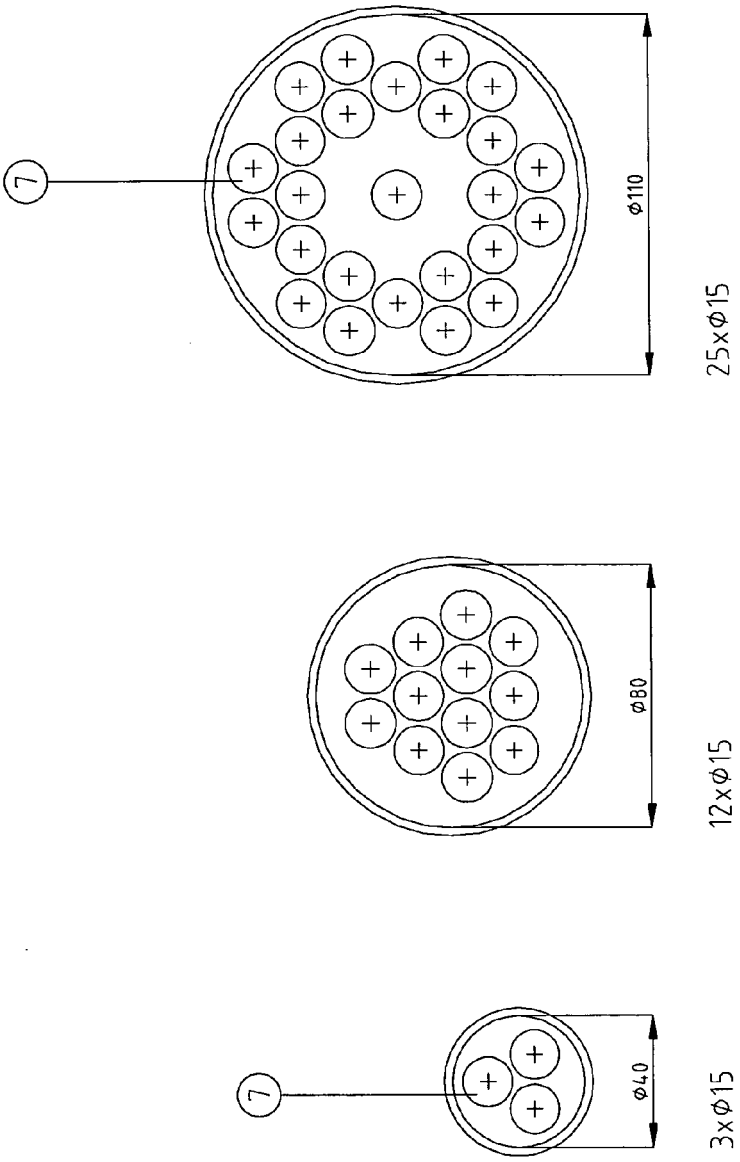

Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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