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(72) Inventors:

- **Berndsen, Erik Gerhard**
6611 KT Overasselt (NL)
- **Kuiten, Adrianus Hendrikus Johannes Maria**
5627 VZ Eindhoven (NL)

(74) Representative: **van Westenbrugge, Andries**
Nederlandsch Octrooibureau
Postbus 29720
2502 LS Den Haag (NL)

(57) A method for carrying out work in ground makes use of, in combination, a slim element which can be assembled from a number of sections connected in series, and also a handling device provided with a mobile frame, and a drive-in device supported on the frame, for driving the slim element into the ground. The method comprises the steps of:

- driving the slim element into the ground at a first position,

- removing the slim element from the ground at said first position, while maintaining its assembled state,
- guiding the part of the slim element projecting above the force-in device,
- moving the handling device to a second position at a distance from the first position,
- driving the slim element into the ground at the second position.

Fig 2

Description

[0001] The invention relates to the field of carrying out work, such as soil-drilling tests, in ground. The object of such work can vary, and is connected with various specialities in the field of soil mechanics. An example is the examination of a site for the presence of explosives such as unexploded bombs and the like. Such an examination is often necessary if a certain area in which it is suspected that such explosives are present is being developed. Clearing up explosives is dangerous because the position of bombs and the like is not known.

[0002] Whilst every effort is made using advanced techniques, such as by means of magnetometers, to detect where any explosives may be present, the range of such instruments is limited, so that many soil-drilling tests are needed. Furthermore, the instruments must be introduced into the ground with the necessary care, in order to ensure that they do not accidentally run into an explosive, thus setting off an explosion. In this technique a hole, into which the magnetometer is lowered, is usually drilled. The hole is then drilled further, depending on the range of the magnetometer, after which a measurement is then performed again. As a result of this, the examination of a site is very time-consuming.

[0003] A further example known from practice relates to the performance of soil-drilling tests in connection with determining the load-bearing capacity of the ground, for example for building a road, or for industrial sites, dwellings and the like. In the last instance a reliable foundation can be designed on the basis of the data obtained by means of soil-drilling tests. The structure of the ground can also be determined by means of soil-drilling tests. Soil-drilling tests can be used in particular in ground with relatively soft, compressible strata.

[0004] For performing soil-drilling tests, a slim element, which can consist of a steel tube with a conical or cone-shaped tip, is used. The resistance met with by the cone while the slim element is being forced in is measured. During this process, the data relating to the mechanical resistance and often also relating to the shaft friction are established. Sometimes the conductivity of the ground and possibly of the groundwater is also measured. A good picture of the soil characteristics can be obtained from these data.

[0005] A force that is sufficiently great to force the slim element into the ground must be delivered by means of the pressure element. A hydraulic press and the like, for example, can be used for that purpose. Depending on the nature of the ground, the slim element can be of quite great length, for example up to 20 metres. However, handling a slim element of great length is difficult, and for that reason such a slim element is assembled from a number of sections of limited length. As soon as a first section has been forced into the ground, a second section can be fixed on it, after which the assembly is forced further into the ground, and so on. These actions must be performed in reverse order when the slim element is

being removed from the ground, after the measuring has been completed. The same series of actions must then be performed at the next position, and so on. It has been found in practice that assembling and disassembling the slim element each time means a considerable hold-up in the work. Particularly when determining the nature of the ground in connection with the designing of foundations, short distances are often chosen between those positions. This leads to fairly high costs and quite a long time spent on the site examination.

[0006] The object of the invention is therefore to provide a method of the type described in the preamble, in which such a troublesome delay can be avoided. That object is achieved by means of a method for carrying out work in ground, comprising the steps of:

- driving the slim element into the ground at a first position,
- removing the slim element from the ground at said first position, while maintaining its assembled state,
- guiding the part of the slim element projecting above the force-in device,
- moving the handling device to a second position at a distance from the first position,
- driving the slim element into the ground at the second position.

[0007] The method according to the invention is carried out by means of, in combination, a slim element which can be assembled from a number of sections connected in series, and also a handling device provided with a mobile frame, and a drive-in device, supported on the frame, for forcing the slim element into the ground. However, this soil-drilling test device, which is known per se, is operated in a manner which differs from the conventional one. In the case of the method according to the invention, the slim element is in fact assembled only once, and is then maintained in its assembled state in such a way that it can be used directly for a subsequent soil-drilling test at another place. This means a considerable time saving, particularly where there are a large number of soil-drilling tests to be carried out at a short distance from each other, such as is the case, for example, when the ground is soft.

[0008] For carrying out the first soil-drilling test it is assembled in the conventional manner, so that the method according to the invention in that first phase also comprises the steps of:

- forcing a first section into the ground,
- connecting a second section to the top of the first section,
- forcing the assembled first and second sections further into the ground,
- connecting further sections, while forcing the assembled sections further into the ground in each case, until the slim element has been assembled completely.

[0009] For the rest, when the series of soil-drilling tests has been completed, the slim element will be disassembled into the separate sections when it is being removed at the last position. Here again, however, the disassembly of the slim element need only be performed once, which also again results in time being saved.

[0010] The drive-in device is supported on the frame, and in certain cases can be immovably fixed on the frame. The drive-in device can then, for example, force the slim element into the ground through a suitable opening in the frame. According to a preferred embodiment of the method according to the invention, this method, however, comprises the steps of:

- placing the drive-in device on the ground at the first position,
- driving the slim element into the ground at the first position,
- removing the slim element from the ground at the first position,
- removing the force-in device from the first position,
- placing the drive-in device on the ground at the second position.

[0011] The drive-in device placed on the ground has a stable position, such that the slim element can be forced in a suitable manner into the ground without the frame being overloaded in the process.

[0012] The invention furthermore relates to the combination of a handling device comprising a mobile frame and a force-in device supported on the frame, and also at least two sections which can be assembled in series to form a slim element. Such a combination is also known. As explained above, the sections are fixed on each other one by one in each case to form the slim element, and are disassembled from each other again one by one after each soil-drilling test. In the combination according to the invention, such a laborious procedure is avoided in that the drive-in device is provided with a guide which has a length identical to the length of at least two assembled sections.

[0013] The guide with a relatively great length makes it possible to handle the slim element as one unit not only for removing it after a first soil-drilling test, but also for subsequently moving the placing device and then driving the slim element into the ground at another position. This means that it is not necessary to take the slim element apart and reassemble it at different positions.

[0014] The drive-in device preferably has a housing containing drive-in elements which can act upon the slim element, the guide being fixed on the housing of the drive-in device. Said drive-in elements can be designed in many different ways, which are known per se and will not be described in any further detail. Hydraulic drive-in elements are one example. The drive-in device disclosed in Dutch Patent 1.021.599 could also be used. This publication discloses a slim element which is clamped between the two facing parts of two chains, each link of a

chain bearing a thrust block with a contour that is shaped according to the outer surface of the slim element and acts upon said surface.

[0015] In order to provide further ease of handling of the slim element, a table is preferably provided at a distance above the housing, in such a way that a section can be placed between the table and the housing in each case during the assembly of the slim element. The guide can then be fixed on the table. This guide in turn can be designed in many different forms, on condition that these forms are suitable for guiding the long slim element in a suitable manner without bending or buckling occurring in it. An example is a guide in the form of a long hollow tube with an internal diameter that is greater than the greatest transverse measurement of the slim element. The guide can, however, be any substantially prismatic guide structure having an internal passage whose transverse measurements are greater than the transverse measurements of the slim element.

[0016] The guide structure must have such strength and rigidity that, despite the fairly great upwardly projecting length, it can support the slim element in a suitable manner. This means that the guide structure must be capable of withstanding the shocks and swings undergone by the frame while travelling over uneven terrain between the various positions where soil-drilling tests have to be carried out. On the other hand, it is undesirable to make the guide structure too heavy, since the mass inertia of the guide structure adversely affects the stability of the placing device.

[0017] It is therefore preferable to have a guide structure which is additionally supported against transverse loads and bending. The table is therefore preferably provided with brackets, between which brackets and a part of the guide structure that is situated higher up tension elements extend in each case. The tension elements, which can be held at a distance from the guide structure by means of brackets, considerably increase the bending stiffness without the weight having to be increased too much for that purpose. In order to increase the stability further, the tension elements can be guided over auxiliary brackets fixed on the guide structure.

[0018] It has already been mentioned above that the guide structure could be designed, for example, in the form of a tube. A light and reliable design of the guide structure is one with a lattice structure. Such a lattice structure can have, for example, a triangular or rectangular cross section.

[0019] The invention also relates to a handling device which can be used in combination in the abovementioned method. This handling device can comprise a mobile frame, a platform provided on the frame, which platform can rotate relative to the frame according to a substantially vertical axis, an arm which is provided on the platform and can rotate relative to the platform according to a substantially horizontal axis, as well as suspension means on the free end of the arm, from which suspension means the force-in device is suspended.

[0020] Such a handling device increases the possibilities for carrying out soil-drilling tests. The various degrees of freedom that are obtained by means of the rotatable platform and the arms fixed rotatably on it make it possible to always place the force-in device in the desired position. Moreover, the force-in device can be held securely and stably in the desired position by means of the frame and the arm.

[0021] In connection with handling the force-in device in the desired manner, the suspension means can comprise a pivoted connection between the arm and the housing of the force-in device. In addition, the suspension means can comprise an actuator, which is connected at one side to the arm and at the other side to the housing of the force-in device, in order to make the force-in device rotate relative to the arm about the pivoted connection.

[0022] US Patent Specification 5.592.993 discloses a device with a frame, a platform rotatably mounted on the frame, and an arm rotatably suspended on the frame, to which arm a drilling device is fixed. Said drilling device has a telescopic bearer, which guides the drill, drill motor and drill rod when carrying out the drilling operations. The bearer is placed on the ground in this process. Such a device is not suitable for forcing a slim element into the ground. Furthermore, this known device is not suitable for manoeuvring a slim element of great length.

[0023] The invention will now be explained in greater detail with reference to an exemplary embodiment shown in the figures.

Figure 1 shows a side view of the handling device according to the invention.

Figure 2 shows a side view of the handling device, in the lowered state.

Figure 3 shows a view in perspective of a part of the handling device.

Figure 4 shows a part of the slim element.

[0024] Figures 1 and 2 show the handling device indicated in its entirety by reference numeral 1, and also the slim element 2 manoeuvred by means of said handling device 1. As shown in Figure 4, the slim element 2 is composed of a number of standard sections 3 and the section 4 with a cone-shaped end 5 provided at the bottom end. The connections between the sections 3, 4 are known per se, and are therefore not shown in any further detail. By connecting together a suitable number of sections 3, 4, a slim element 2 of the desired length can be obtained, for example a length between 10 and 20 m, depending on the ground in which the soil-drilling test is to be carried out.

[0025] For carrying out soil-drilling tests, the section 4 with cone-shaped end 5 is usually lengthened in each case by fitting further sections 3 and stepwise forcing the slim element 2 thus being formed into the ground. Conversely, when the slim element 2 is being removed from the ground, a section 3 is usually in each case detached and removed, and so on. Such a procedure is laborious,

very time-consuming and very expensive, particularly if large numbers of soil-drilling tests have to be carried out in soft ground, for example in connection with calculating a foundation.

[0026] The purpose of the handling device 1 is to provide a more efficient way of carrying out soil-drilling tests in the ground. For this purpose, the handling device 1 has a guide indicated in its entirety by 6, which is suitable for guiding the slim element 2 up and down when it is being forced into and removed from the ground respectively. This guide 6 is composed of the lattice structure 7, which has a triangular cross section, as can be seen in the section of Figure 2. The lattice structure 7 can be composed of a number of lattice structure segments 8. The lattice structure 7 per se has a relatively low bending stiffness. In order to increase the bending stiffness of the guide 6, brackets 9 which form part of the table 10 are provided. Said table 10 is supported on the housing 12 by means of supports 11 of the force-in device 13. Furthermore, a platform 14 for the operating personnel is fixed on the housing 12. A stock 17 of sections 3 can also be present on the table 10, in connection with assembling and disassembling the slim element 2 respectively.

[0027] The brackets 9 project relative to the table 10 and the housing 12. Tension elements extend from the brackets 9, in the present example pulling cables 15, which are fixed at a higher level on the lattice structure 7 by means of auxiliary brackets 16. In addition, yet further pulling cables can be provided (not shown), extending from the brackets 9 as far as near the top of the lattice structure 7. By means of the combination of the lattice structure 7, brackets 9 and pulling cables 15, the guide 6 has obtained a relatively higher bending stiffness.

[0028] The whole assembly, consisting of the force-in device 13 with the guide 6 thereon, is fixed on the vehicle 18. Said vehicle 18 has a frame 19 provided with caterpillars 20. Platform 21 is mounted on the frame 19 so that it rotates about a vertical axis, which platform bears drives and a cab 22. An arm 23 is also supported on the platform 21 so as to pivot about pivot pin 24 with horizontal axis. By means of the piston/cylinder device 25, the arm 23 can move up and down about the pivot pin 24.

[0029] On the free end of the arm 23 is a pivot pin 26 on which the bearer 27 is fixed. Furthermore, that end of the arm is provided with an actuator 28, which at one side acts upon the arm and at the other side acts upon said bearer. The bearer 27 can be tilted by lengthening or shortening the actuator 28. By means of said actuator, the drive-in device 13 and guide 6 can also be tilted, for example in connection with transport after the guide has been removed. For this purpose, the drive-in device 13 is suspended from the bearer 27. The housing 12 of the drive-in device 13 has feet 29. The drive-in device 13 is provided with drive-in elements 30 known per se, which can be driven hydraulically, for example.

[0030] In use, the handling device 1 is positioned at the desired place, and in particular the drive-in device 13 is set down at the correct position, the feet 29 going onto

the surface of the ground. This can be achieved by manoeuvring the vehicle 18 and also by manoeuvring the arm 23 in a suitable manner. Subsequently, at a first position, the slim element 2 is assembled by assembling sections 3, 4 in each case. After the slim element 2 has been driven into the ground and desired results have been obtained, the slim element 2 can be moved upwards in its entirety, i.e. without detaching and removing the sections 3, 4 all separately again, the guide 6 ensuring that the relatively easily bending slim element is well supported. The vehicle 18 can then be driven to the next position, where the slim element 2 can be driven directly into the ground and can carry out measurements. There is no longer any stoppage for fitting a new section 3 each time, which results in time gained and a cost saving.

[0031] Although reference is made above to driving a slim element into the ground in connection with clearing up explosives or carrying out measurements, according to the invention a slim element can also be driven into the ground by means of the device for other purposes. An example is driving a slim element into the ground for introducing or injecting certain fluids. A particular example is the injection of bacterial solutions into soil for the purpose of combating soil pollution.

List of reference numerals

[0032]

1. Handling device
2. Slim element
3. Section
4. Section with cone-shaped end
5. Cone-shaped end of section
6. Guide
7. Lattice structure
8. Lattice structure segments
9. Bracket
10. Table
11. Support
12. Housing
13. Drive-in device
14. Platform
15. Tension cable
16. Auxiliary bracket
18. Vehicle
19. Frame
20. Caterpillar
21. Platform
22. Cab
23. Arm
24. Pivot pin of arm
25. Actuator of arm
26. Pivot pin
27. Bearer
28. Actuator
29. Foot
30. Drive-in element

Claims

1. Method for carrying out work in ground by means of, in combination, a slim element (2) which can be assembled from a number of sections (3, 4) connected in series, and also a handling device (1) provided with a mobile frame (19), and a drive-in device (13) supported on the frame, for driving the slim element (2) into the ground, comprising the steps of:

- driving the slim element (2) into the ground at a first position,
- removing the slim element (2) from the ground at said first position, while maintaining its assembled state,
- guiding the part of the slim element (2) projecting above the force-in device (13),
- moving the handling device (1) to a second position at a distance from the first position,
- driving the slim element (2) into the ground at the second position.

2. Method according to Claim 1, comprising the steps of:

- driving a first section (4) into the ground,
- connecting a second section (3) to the top of the first section (4),
- driving the assembled first and second sections (3, 4) further into the ground,
- connecting further sections (3, 4), while driving the assembled sections (3, 4) further into the ground in each case, until the slim element (2) has been assembled completely.

3. Method according to Claim 1 or 2, comprising the steps of:

- placing the drive-in device (13) on the ground at the first position,
- driving the slim element (2) into the ground at the first position,
- removing the slim element (2) from the ground at the first position,
- removing the force-in device (13) from the first position,
- placing the drive-in device (13) on the ground at the second position.

4. In combination, a handling device (1), comprising a mobile frame (19) and a drive-in device (13) supported on the frame, and also at least two sections (3, 4) which can be assembled in series to form a slim element (2), **characterized in that** the drive-in device (13) is provided with a guide (6) which has a length identical to the length of at least two assembled sections (3, 4).

5. Combination according to Claim 4, provided with a drive-in device (13) having a housing (12) containing drive-in elements (30) which can act upon the slim element (2), the guide (6) being fixed on the housing (12) of the force-in device (13). 5
6. Combination according to Claim 5, in which a table (10) is provided at a distance above the housing (12), in such a way that a section (3, 4) can be placed between the table (10) and the housing (12) in each case during the assembly of the slim element (2). 10
7. Combination according to Claim 6, in which the guide (6) is fixed on the table (10). 15
8. Combination according to Claim 7, in which the guide (6) comprises a substantially prismatic guide structure (7) having an internal passage whose transverse measurements are greater than the transverse measurements of the slim element (2). 20
9. Combination according to Claim 8, in which the table (10) is provided with brackets (9), between which brackets (9) and a part of the guide structure (6) that is situated higher up tension elements (15, 17) extend in each case. 25
10. Combination according to Claim 9, in which the tension elements (15) are guided over auxiliary brackets (16) fixed on the guide structure (7). 30
11. Combination according to one of Claims 8 - 10, in which the guide structure comprises a lattice structure (7). 35
12. Combination according to Claim 11, in which the lattice structure (7) has a triangular or rectangular cross section.
13. Handling device (1) for use in the combination according to one of Claims 4 - 12, comprising a mobile frame (19), a platform (21) provided on the frame, which platform can rotate relative to the frame (19) according to a substantially vertical axis, an arm (23) which is provided on the platform (21) and can rotate relative to the platform (21) according to a substantially horizontal axis, as well as suspension means (26) on the free end of the arm (23), from which suspension means a drive-in device (13) with a guide (6) is suspended. 40 45 50
14. Handling device (1) according to Claim 13, in which the suspension means comprise a pivoted connection (26) between the arm (23) and the housing (12) of the drive-in device (13). 55
15. Handling device (1) according to Claim 13 or 14, in which the suspension means comprise an actuator (28), which is connected at one side to the arm (23) and at the other side to the housing (12) of the drive-in device (13), in order to make the drive-in device (13) rotate relative to the arm about the pivoted connection (26).
16. Handling device (1) according to Claim 15, in which a bearer (27) is provided, which bearer is connected at one side to the arm (23) and at the other side to the housing (12) of the drive-in device (13).
17. Handling device (1) according to one of Claims 13 - 16, comprising a frame (19) provided with caterpillar tracks (20).

Fig 1

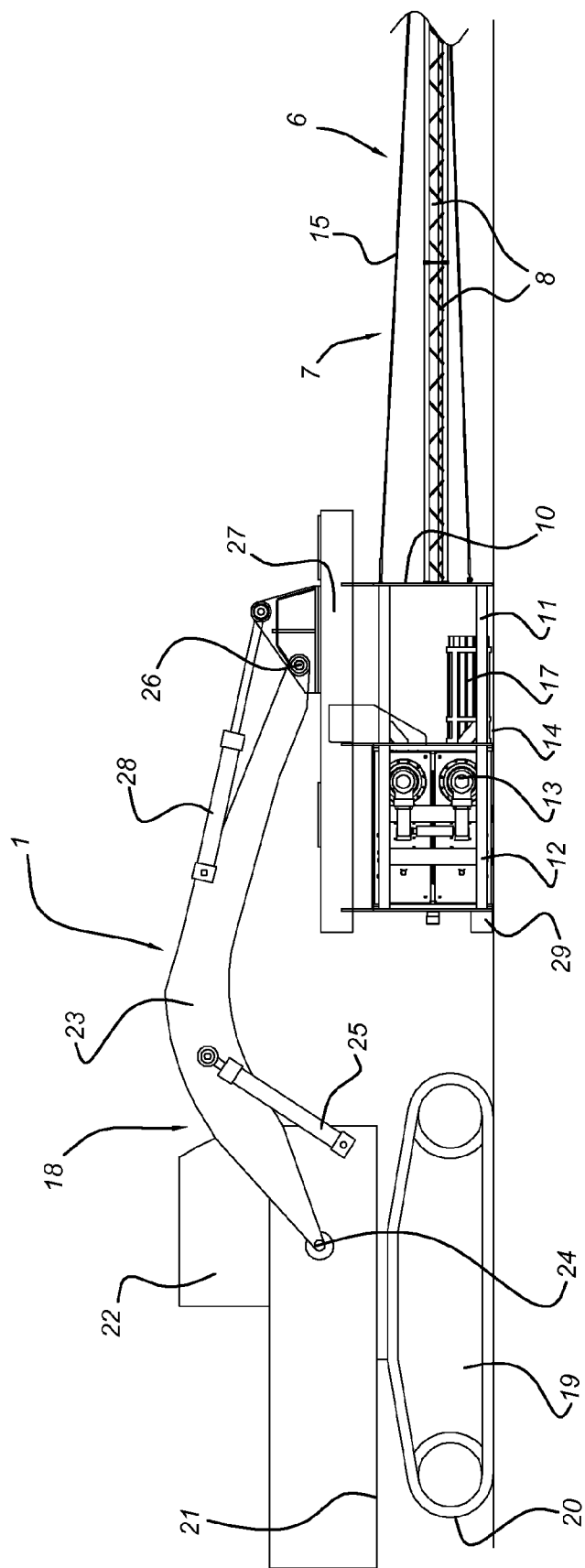


Fig 2

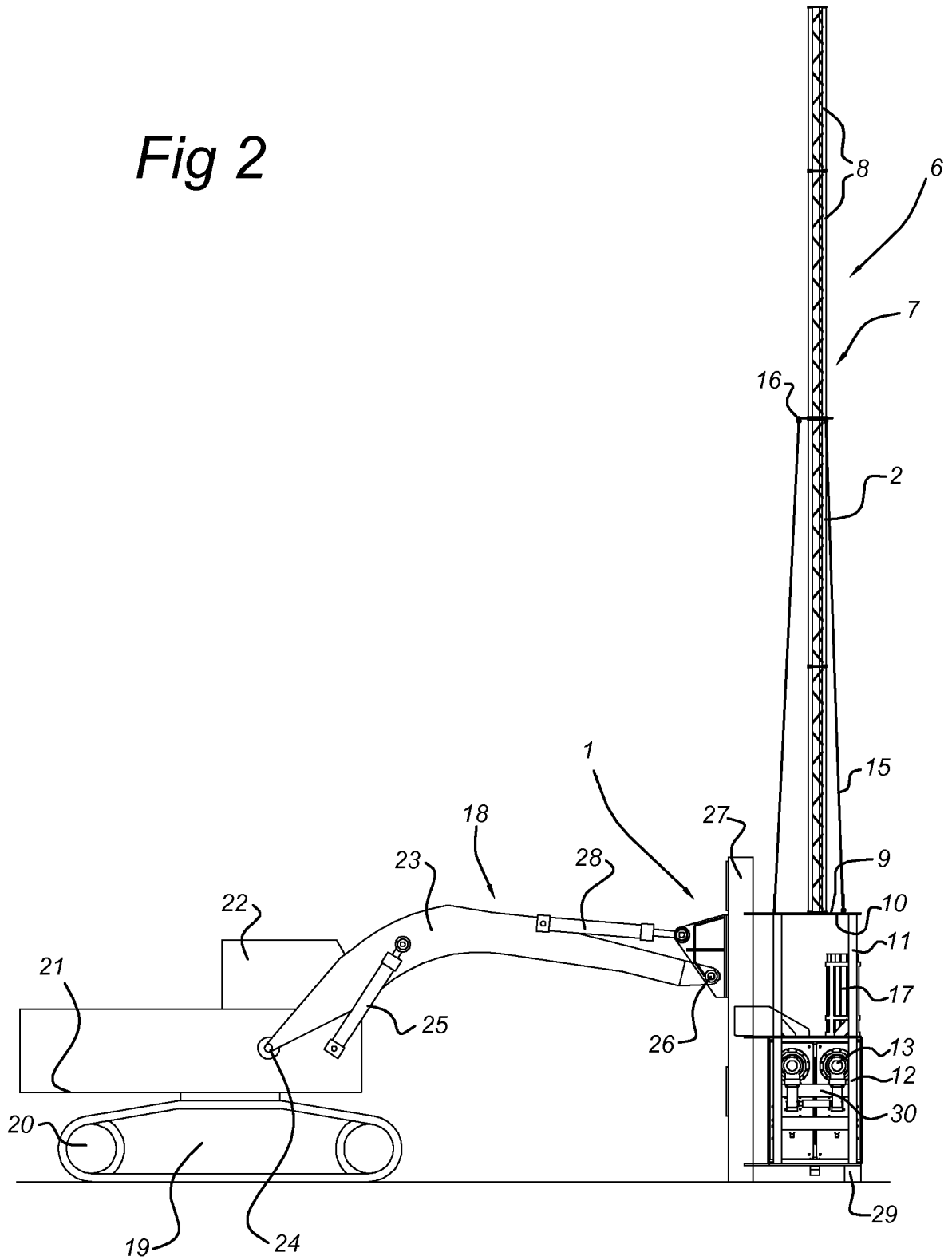


Fig 3

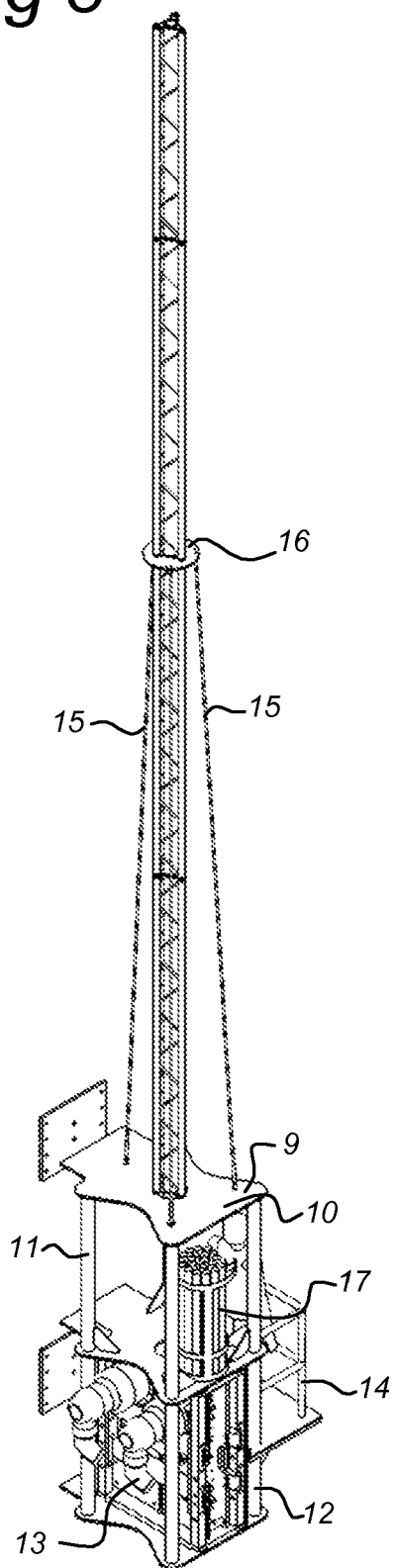
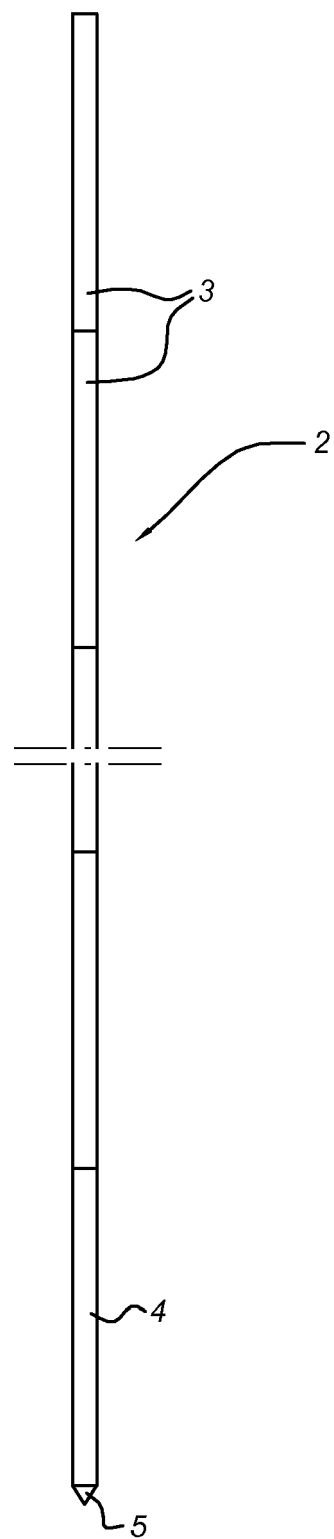


Fig 4





EUROPEAN SEARCH REPORT

Application Number
EP 08 15 6087

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 404 757 A (SOULARD PAUL J [FR]) 11 April 1995 (1995-04-11) * column 1, line 67 - column 6, line 54; figures 1-3 *	1,3	INV. E02D1/02
X	EP 0 900 884 A (RAMMSONDIERUNG SIGG AG [CH]) 10 March 1999 (1999-03-10) * paragraph [0016] - paragraph [0027]; figures 1-4 *	1-3	
X	GB 1 077 097 A (BAUGRUND BERLIN VEB) 26 July 1967 (1967-07-26) * the whole document *	1-3	
X	US 3 054 285 A (HENDRIKUS ROOSEN PETRUS) 18 September 1962 (1962-09-18) * column 2, line 15 - column 3, line 16; figures 2,3 *	4-12	
A	DE 16 34 483 A1 (MUELLER LUDWIG) 6 May 1970 (1970-05-06) * the whole document *	4-12	TECHNICAL FIELDS SEARCHED (IPC)
A	DE 16 34 649 A1 (BAUGRUND BERLIN VEB) 20 August 1970 (1970-08-20) * page 3, paragraph 3 - page 5, paragraph 1; figures 1,2 *	4-12	E02D
X	US 6 641 332 B1 (ALVARADO ROBERT D [US]) 4 November 2003 (2003-11-04) * column 1, line 21 - column 5, line 2; figures 11,1,3 *	13-17	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 November 2008	Examiner Geiger, Harald
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			

4
EPO FORM 1503 03.82 (P04C01)



Application Number

EP 08 15 6087

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 08 15 6087

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-3

Method for carrying out work in ground

2. claims: 4-12

System comprising handling device on mobile frame and a drive-in device and a slim element

3. claims: 13-17

Handling device with mobile frame, platform, arm and suspension means.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 15 6087

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-11-2008

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5404757	A	11-04-1995	NONE	
EP 0900884	A	10-03-1999	AT 252667 T DE 59710892 D1	15-11-2003 27-11-2003
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DE 1634649	A1	20-08-1970	NONE	
US 6641332	B1	04-11-2003	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DD 1021599 [0014]
- US 5592993 A [0022]