



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11)

**EP 0 980 461 B1**

(12)

## EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention  
of the grant of the patent:  
**23.08.2006 Bulletin 2006/34**

(21) Application number: **98923228.5**

(22) Date of filing: **08.05.1998**

(51) Int Cl.:  
**E21B 15/04** <sup>(2006.01)</sup> **E21B 7/02** <sup>(2006.01)</sup>  
**E21B 7/04** <sup>(2006.01)</sup> **E21B 7/06** <sup>(2006.01)</sup>  
**E21B 19/086** <sup>(2006.01)</sup>

(86) International application number:  
**PCT/NZ1998/000055**

(87) International publication number:  
**WO 1998/050667 (12.11.1998 Gazette 1998/45)**

(54) **DIRECTIONAL DRILLING APPARATUS**

RICHTUNGSBOHRGERÄT

FOREUSE DIRECTIONNELLE

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**

(30) Priority: **08.05.1997 NZ 31476997**  
**28.05.1997 NZ 31493897**  
**27.03.1998 NZ 33008098**

(43) Date of publication of application:  
**23.02.2000 Bulletin 2000/08**

(73) Proprietor: **Flexidrill Limited**  
**Takapuna, Auckland (NZ)**

(72) Inventor: **WEST, Gregory Donald**  
**Takapuna,**  
**Auckland (NZ)**

(74) Representative: **Beresford, Keith Denis Lewis et al**  
**BERESFORD & Co.**  
**16 High Holborn**  
**London WC1V 6BX (GB)**

(56) References cited:  
**EP-A- 0 223 575** **EP-A- 0 792 995**  
**WO-A-96/21793** **DE-A1- 19 732 532**  
**US-A- 3 780 816** **US-A- 4 553 612**  
**US-A- 4 679 637** **US-A- 4 858 700**  
**US-A- 5 148 880** **US-A- 5 226 488**  
**US-A- 5 449 046** **US-A- 5 469 155**  
**US-A- 5 709 276**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

**EP 0 980 461 B1**

## Description

### TECHNICAL FIELD

5 [0001] This invention relates to directional drilling apparatus, in particular but not solely to directional drilling apparatus which can be used in confined spaces or utilised in locations close to obstacles such as fences, houses, buildings, etc.

### BACKGROUND OF THE INVENTION

10 [0002] It is known to provide directional drilling devices which provide directional drilling by means of a drilling head which has an angled cutting or drilling device thereon, the angled device being monitorable in respect to its orientation about the axis of the drill. Change in direction of the drill is achieved by ceasing or preventing rotation of the drill bit when said angle device is in a desired orientation and then pushing forward the drill such that the angled device causes the drill to deviate from its current course. Drilling can then be recommenced with the drill head being pushed forward in the  
15 desired new direction.

[0003] Directional drilling (also referred to as boring, thrusting and horizontal drilling) is a technology which allows services such as power cables, ducts, water pipes, gas lines, drainage pipes, etc, to be placed underground without the need to cut open the ground surface as is required in cut and cover methods. The drill gains its directional ability through the use of an angled steering blade on the drill head. Immediately behind the drill head is a transmitter (sonde) which  
20 relays information to an above ground operator, such information may include how deep the drill head is, the direction in which the drill is heading and the orientation of the drill head such as the angle it is pointing up or down.

[0004] Such devices are normally bulky and incorporate means to rotate and push forward or advance the drill head to as well means rotate it. It is also known to provide means to extend the drill such as a set of rods which are screwed into each other to provide additional length to the drill. The power requirement of such a device is somewhat high and  
25 as these devices incorporate the source of power the devices are large. This limits the use of the device in that it is common for drilling to be required substantially horizontally or parallel to the surface of the ground from a distance beneath the surface of the ground. Thus since the above-mentioned device must rest on ground level the drill must be angled in from the surface of the ground such that it levels off at the required depth. The drills as aforementioned are of course flexible to some degree however flexibility is limited therefore the angle at which the drill enters the ground dictates  
30 that the drilling unit itself must be positioned at some distance back from the point at which the level drilling commences. Obviously this is inconvenient and may in some cases limit drilling. It may in other cases mean that neighbouring land must be encroached upon and as the ultimate length of the drill usable by such a device is limited the length of useful drilling may be somewhat limited.

[0005] EP-A-0223575 describes a drilling unit mountable to a boom for limited pivoting movement relative to the boom.

35 [0006] US patent 5226488 describes a directional drilling apparatus in which a drill is mounted on a turret on a vehicle chassis, so that the drill may be rotated in azimuth and tilted downwardly to launch the drill obliquely into the ground.

[0007] US patent 5709276 describes a directional drilling apparatus for launching a directional drill obliquely into the ground in a number of different azimuth directions using a single launch pit.

[0008] German patent publication DE 19732532 describes a directional drilling apparatus in which a directional drill  
40 is launched obliquely into the ground from a vehicle, the drill being advanced with rotation in order to proceed along a straight path, and being an advanced without rotation but with vibration of the drill string in order to alter the drilling direction.

### BRIEF SUMMARY OF THE INVENTION

45 [0009] In a first aspect the present invention consists in a directional drilling unit as defined in claim 1.

[0010] Preferably means are provided to monitor the location of said directional drill head, and said means are provided to monitor the orientation (and hence advancement direction when not rotating) of the directional drill head.

[0011] Preferably said prime mover or power source is a digger or excavator.

[0012] Preferably said directional drilling unit is powered by said prime mover, most preferably by power transferred  
50 by hydraulic means.

[0013] In another aspect the present invention may broadly be said to consist in directional drilling apparatus as defined in claim 9.

[0014] Preferably said powering of said directional drilling apparatus is from a prime mover such as a digger or excavator.

55 [0015] Preferably said directional drilling apparatus are articulated from said prime mover.

[0016] Preferably said means are provided to monitor the orientation and hence advancement direction when not rotating of the directional drill head.

[0017] In embodiments of the present invention actuating means are provided to enable the sideways cant of the

drilling apparatus to be adjusted by a user.

[0018] In alternative embodiments of the present invention, actuating means are mounted on or adjacent said means to rotate said extendable drill, said actuating means oriented such that when actuated a thrust is provided in the forward direction, that is in a direction towards the drill head; and second actuating means are provided, said second actuating means being attachable to said extendable drill and capable of providing a forward thrust to said extendable drill;

characterised in that the drill head is advanced in the following manner, first and second actuating means are placed in a non-actuated state; the actuating means are then placed in a state of actuation; thereafter said second actuating means are placed in a state of actuation, thereafter said actuating means returned to a state of non-actuation.

[0019] Preferably said actuation means comprises a pair of actuating devices substantially parallel to each other.

[0020] Preferably said actuation means and said second actuation means comprise a hydraulic ram.

[0021] Preferably said second actuation means includes means to selectively hold said drill and thereby thrust forward.

[0022] To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

## BRIEF DESCRIPTION OF DRAWINGS

[0023] Preferred exemplary forms of the present invention will now be described with reference to the accompanying drawings in which;

Figure 1 shows directional drilling apparatus according to a preferred form of the present invention, the directional drilling device is articulated from a prime mover or other source of power 2, such articulation may be achieved by means of a linkage arrangement 3, suitable linkage arrangements will be obvious to those skilled in the art to which the invention relates, the present invention provides for the advancement of a drill rod 7 in a desired direction, the advantage of the present invention over the prior art ("prior art" will be described shortly) is that the useful length 5 of the drill rod 7 is greater than that of the prior art as it is easier to commence drilling at the level required, the provision of a relatively small hole or "launch pit" 4 allows the apparatus 1 to be placed at or near the desired drilling depth;

Figure 2 shows a prior art arrangement in which the drill rod 7 is advanced by a unit 10 such a unit incorporates a source of power and means to rotate and change direction of the drill rod 7 together, such a unit is obviously bulky and the angle 11 which the drill must enter the ground limits the useful length 5 of the drill rod 7;

Figure 3 shows a drill head 20 such a drill head incorporated into the present invention such drill heads are known in the art to which the invention relates, and the prime function of such a drill head is that when it is rotated in the correct direction it advances in a substantially straight manner, however as the drill head 20 has an angled cutting blade 21 at the cutting surface thereof, if the rotation of the drill head 20 is stopped and the drill head itself pushed forward in the direction labelled 22 the drill head 20 changes direction along that indicated by 23, rotation of the drill head thereafter be commenced said drill advancing upon its new direction, such known drill heads incorporate means by which an operator or user can ascertain the orientation of the angled blade 21, the orientation can of course be varied by rotating the drill head 20. Once the drill head 20 is in the desired orientation it can be advanced thus changing the direction of the drill;

Figure 4 shows a directional drilling unit according to a preferred form of the present invention. The unit incorporates means 30 to rotate the extendable drill and drill head 7 and 20, and the unit also incorporates means to advance said extendable drill and drill head such that the direction of directional drill head can be varied; the means to rotate said drill rod 7 may comprise means to grip the outside of said drill rod 7 and rotate it. The means to advance said drill rod 7 may comprise articulated means to push forward the drill preferably using any means to grip the outside of the drill rod 7 provided by the means to rotate the drill 30;

Figure 5 shows a specially preferred form of the present invention in which actuators are provided to increase the stability of the drilling unit 1 in use, this preferred form of the apparatus is attached to the prime mover or digger by means of a quick fit bucket fastening 54, a bearing 57 is provided to allow for  $360^\circ \pm 80$  rotation of the drilling unit 1, an actuator 56 is provided to allow for the sideways cant of the drilling unit 1; the stabilisers 50, 51 and 52 are extendable. When the actuators, for examples hydraulic actuators, are extended, the stabilisers 50, 51 and 52 extend and bear against the internal surfaces of the hole or launch pit 4, or they may extend against a digger blade, a wall or other suitable surface or device. Thus additional stability is provided enabling greater accuracy in drilling. In forms of the invention, the stabilisers may simply comprise flat plates, however they may be textured to provide additional grip, or, in preferred forms of the invention they may have a series, for example, three spikes to increase the "bite" of the stabilisers;

Figure 6 shows an end elevation of a directional drilling unit 1 according to a preferred form of the present invention;  
 Figure 7 shows another end elevation of the directional drilling unit 1 according to a preferred form of the present invention;

Figure 8 shows a top view of directional a drilling unit 1 according to a preferred form of the present invention;

Figure 9 shows a side elevation of a directional drilling unit 1 of a preferred form of the present invention;

Figure 10 shows a perspective view of directional drilling apparatus according to a preferred form of the present invention, said directional drilling apparatus comprising a drilling unit 1 attached to a prime mover 2 by means of an articulated arm;

Figure 11 shows a partial perspective view of the directional drilling apparatus according to a preferred form of the present invention showing the drill rod 7 entering the ground; and

Figure 12 shows a diagrammatic view of the thrust sequence of actuating devices 200 and 201 and second actuation device 300 according to a preferred form of the present invention. Those skilled in the art to which the invention relates will realise that a variety of actuating devices such as hydraulic or air rams can be utilised

## DETAILED DESCRIPTION

**[0024]** Preferred forms of the present invention provide a directional drilling unit 1 said directional drilling unit is articulated by an arm 3 from a prime mover or other source of power 2. The source of power or prime mover 2 is preferably but not necessarily easily moveable.

**[0025]** In preferred forms of the present invention, the prime mover 2 provides power and perhaps control of the directional drilling unit 1 and in preferred forms the power is provided by means of a hydraulic circuit or connection. Such connections will be obvious to those skilled in the art to which the invention relates.

**[0026]** The unit itself comprises means 30 to rotate the drill rod 7. Such means may comprise a hydraulic motor and may incorporate jaws or clamping devices which hold the outer surface of the drill rod 7.

**[0027]** The directional drilling ability of a drill is achieved through the use of an angled steering blade on the drill head. A transmitter relays information to the operator above ground. Information transmitted may consist of a variety of types such as how deep the drill head is, the direction in which it is heading, the orientation, ie angle up or down of the drill head. This information is used by the operator to steer or control the drill. For example if the operator requires the drill to steer to the right to avoid an existing underground service the aboveground locator operator would instruct the drill operator to rotate the drill head to 3 o'clock and push (thrust) the drill head forward which will cause the drill to flex and head to the right. Once the drill head is heading in the desired direction and the drill head is required to track in a straight direction the drill operator spins or rotates (a combination of pushing and rotating) the required distance until another change of direction is required. The use of a combination of spinning and pushing or thrusting and rotating makes it possible to steer under, over or around obstacles and arrive at the desired end point with a great deal of accuracy. The level of accuracy is of course dependant upon the ground conditions encountered.

**[0028]** Once the drill head is at its end point, for example drilling may have occurred from one side of the road to the other, the drill head would ordinarily be removed and a cutter and/or packer attached to the drill or drill pipe or string with the service, for example power cable, duct, water pipe, gas line or drainage pipe attached. The drill or drill rods would then be pulled out of the ground while the drill is rotating, thus giving the cutter and/or packer a cutting action in allowing a hole of sufficient diameter to be formed for the pipe or cable duct line or service to be installed.

**[0029]** Preferred forms of the present invention can be used in particular in residential areas where the distance required to be drilled is often no more than 100 metres. Access to the site is often difficult and it is quite often the case that there is no lead-in room. That is, it is often not possible to move a great distance back from the initial entry point in order to provide access to the required depth of the drill.

**[0030]** Drills according to these preferred forms of the invention can be of a compact size and this can increase the number of sites which can be used. In particular drills according to preferred forms of the present invention can be launched both up and down hill. At least some preferred forms of the present invention can be set up to drill at right angles to a road thereby limiting the disruption to traffic.

**[0031]** One example of the present invention generates 8000 pounds (35585 N) of thrust and approximately 10,500 pounds (46706 N) of pull-back from an 18 horse power (13.4 kW) source.

**[0032]** Preferred forms of the present invention have a drive mechanism which utilises no thrust chains, cogs or pulleys. This limits the amount of maintenance required.

**[0033]** Preferred hydraulic pump forms of the invention utilise a fluid supply which comprises a main pressure water source such as a garden hose.

**[0034]** As mentioned previously at least preferred forms of the present invention can be launched above or below ground pointing up or down. Up to  $\pm 80$  degrees of launch angle are possible.

**[0035]** In preferred forms of the present invention the unitary drilling apparatus itself can swivel through  $360^\circ \pm 80$  when utilised with an excavator or prime mover with an ability to rotate through  $360^\circ \pm 80$  and the ability to offset the

boom of said excavator provides a great deal of flexibility.

**[0036]** In preferred forms of the present invention the drilling unit is attached or attachable to a prime mover or excavator or digger. This means that a user requires less specialised equipment and can lower costs.

**[0037]** As described earlier, in order to control the direction of the drill rod 7 the orientation of the cutting blade 21 must be ascertained and then the drill advanced without rotation. In the preferred form of the present invention this advancement is provided by means 30 to advance the drill and drill head. Such means may comprise an hydraulic ram or may utilise chains and suitable gear wheels to provide for the forward articulation of the drill.

**[0038]** The monitoring of the orientation of the cutting blade 21 may be achieved by radio transmission or a communication means which may be provided through a hollow centre of the drill rod 7.

**[0039]** In preferred forms of the present invention, the drill rod 7 is made up of links of either solid bar or preferably tube. Said tube of course has an aperture therethrough, and in preferred forms of the invention the aperture may be used to provide either a cutting fluid or simply water to the drill head 20. Such provision of water facilitates the washing away of material at the drill head.

**[0040]** In preferred forms of the invention the drill rod 7 is made up of links of drill which are screwed one into the other by means of a threaded portion.

**[0041]** Prior art directional drilling apparatus utilise links of drill rod 7 of 3½ and sometimes 4 metres in length. Preferred forms of the present invention utilise drill rod 7 which are made up of links of bar or tube which are less than 3½ metres in length.

**[0042]** When in use the present invention provides for the addition of additional links to the drill rod 7 by means of releasing the device gripping the outer surface of the drill, retracting the means to rotate the drill 30, placing an additional length of drill rod 7 into the unit, attaching said additional length of drill to the preceding length of drill, and then reclamping the device to grip the outer surface of drill rod 7 at a rearward portion of the additional drill link.

**[0043]** Preferred forms of the present invention, in particular the form illustrated in Figure 5, allow for the quick fitting of the drilling unit 1 to the prime mover. Also present, in this preferred form of the invention is a bearing 57. This bearing allows a  $360^\circ \pm 80$  rotation of the drilling apparatus 1. Those skilled in the art to which the invention relates will realise that a variety of different bearings will be suitable.

**[0044]** An actuator 56 allows for the sideways cant of the drilling apparatus 1. The actuator may be hydraulically powered.

**[0045]** Preferred forms of the present invention utilising a floating ram system as shown in Figure 12 provide a system whereby the actuating devices 200 and 201 are first extended, moving the device into position two as shown in Figure 12; then the second actuating device 300 is extended to its actuated position or condition, bringing the device into the position three as shown in Figure 12; the actuating devices and second actuating devices are then retracted, reverting the device into the position one as shown in Figure 12. In position one a new drill rod 7 can be added and the process described above repeated.

**[0046]** As the drill rods are withdrawn out of the ground and the pipe, cable or other utility is being pulled into the ground the reverse of the above sequence of operation is performed.

**[0047]** Devices incorporating this preferred form of the present invention enable the length of the drill rod links 7 to be reduced in some cases for example to 2.1 metres and use a 1m drill rod. The weight of the device can be reduced perhaps by 30%, that is maybe down to 210 kilos giving an improved power to weight ratio. The drive train is believed to be more reliable than those utilising gears, cogs or cables.

**[0048]** Comparing the performance of such a system with previous technology it has been found that 8,000 pounds (35585 N) of thrust and 10,500 pounds (46706 N) of pull-back can be generated from an 18 horse power (13.4 kW) engine using the abovementioned preferred form of the present invention whereas using known drive train techniques only 7,200 pounds (32026 N) of thrust and 8,000 pounds (35585 N) of pull-back are generated from an engine rated at 55.4 horse power (41.27 kW) for example.

**[0049]** In the form of the invention as illustrated in Figure 5, 10 and 11 stabilisers 50, 51 and 52 are advanced by means of actuators for example hydraulic actuators and bear against the internal surfaces of the hole or launch pit 4. The stabilisers have the effect of locking the drilling apparatus 1 into the hole 4 thus increasing the accuracy of the drilling. The stabilisers 50, 51 and 52 are preferably remotely controllable by an operator.

**[0050]** As can be shown in the figures the present invention provides a unitary directional drilling device which can be placed into a small hole 4 or above ground. Thus the use of the length of drill is maximised.

## Claims

1. A directional drilling unit (1) adapted for attachment to a mechanical arm (3), the drilling unit comprising:

a directional drill head (20);

an extendable drill (7);

means (30) to rotate said extendable drill and drill head;

means (200, 201, 300) to advance said extendable drill axially such that said drill moves in the direction of said directional drill head; **characterised by** further comprising mounting means (57) attachable to an end of a mechanical arm (3), said mounting means including a bearing (57) providing 360 degree rotation of the drilling unit (1) relative to the arm (3) about an axis perpendicular to the drill (7); and

stabilising means (50, 51, 52) extendable from the drilling unit (1) and adapted to bear against the interior of an opening, or against another solid surface, for stabilising the drilling unit.

2. A directional drilling unit according to claim 1, wherein the stabilising means comprises a pair of opposing extendable plates (50, 51) at the forward end of the drilling unit, and an extendable plate (52) at the rear end of the drilling unit.

3. A directional drilling unit according to claim 1 or claim 2, wherein the mounting means further comprising actuating means (56) for controlling the sideways cant of the directional drilling unit.

4. A directional drilling unit according any of claims 1 to 3, wherein the means for advancing said extendable drill comprise:

first actuating means (200, 201) mounted to the drilling unit; and

second actuating means (300) mounted on the first actuating means (200, 201) and attachable to said extendable drill.

5. A directional drilling unit according to claim 4, wherein said first actuation means and said second actuation means each comprise a hydraulic ram.

6. A directional drilling unit according to any preceding claim, wherein the drilling unit is less than 3.5 metres long.

7. A directional drilling unit according to claim 6, wherein the drill (7) comprises a number of drill sections, and each drill section is less than 3.5 metres long.

8. A directional drilling unit according to claim 7, wherein each drill section is about 1 metre long.

9. Directional drilling apparatus comprising a prime mover having a mechanical arm (3) mounted at one of its ends to the prime mover, and a drilling unit (1) mounted at the free end of the arm (3) by a mounting means (57), the drilling unit (1) comprising:

a directional drill head (20);

an extendable drill (7);

means (30) to rotate said extendable drill and drill head;

means (200, 201, 300) to advance said extendable drill axially such that said drill moves in the direction of said directional drill head; **characterised in that**

said mounting means includes a bearing (57) providing 360 degree rotation of the drilling unit (1) relative to the arm (3) about an axis perpendicular to the drill (7); and

said drilling unit comprises stabilising means (50, 51, 52) extendable from the drilling unit (1) and adapted to bear against the interior of an opening, or against another solid surface, thus stabilising the drilling unit.

10. Directional drilling apparatus according to claim 9, wherein the stabilising means comprises a pair of opposing extendable plates (50, 51) at the forward end of the drilling unit (1), and an extendable plate (52) at the rear end of the drilling unit.

11. Directional drilling apparatus according to claim 9 or claim 10, wherein the prime mover is a digger or mechanical excavator.

12. Directional drilling apparatus according to any of claims 9 to 12, wherein the prime mover is adapted to supply power to the drilling unit.

13. Directional drilling apparatus according to claim 12, wherein the means (30) to rotate said extendable drill and drill head is a hydraulic motor, and the means (200, 201, 300) to advance said extendable drill comprises a hydraulic

ram, and the power supplied from the prime mover is hydraulic power.

14. Directional drilling apparatus according to any of claims 9 to 13, wherein the means for advancing said extendable drill comprise:

first actuating means (200, 201) mounted to the drilling unit; and  
second actuating means (300) mounted on the first actuating means (200, 201) and attachable to said extendable drill.

15. Directional drilling apparatus according to claim 14, wherein said first actuation means and said second actuation means each comprise a hydraulic ram.

16. Directional drilling apparatus according to claim 14 or claim 15, wherein said second actuation means includes means to selectively hold said drill.

17. A directional drilling apparatus according to any of claims 9 to 16, wherein the drilling unit (1) is detachably mounted to the free end of the arm (3).

18. A method of directional drilling using a directional drilling apparatus according to any of claims 9 to 16 comprising the steps of:

controlling said mechanical arm (3) to place said directional drilling unit (1) at a drilling start position and to orient said unit in a drilling start direction;  
extending stabilising means (50, 51, 52) from said directional drilling unit; and  
selectively rotating and advancing said directional drill head to perform a directional drilling operation.

19. A method according to claim 18, wherein the directional drilling unit is placed within a launch pit as the drilling start position, and wherein the stabilising means (50, 51, 52) are extended to engage walls of the launch pit.

## Patentansprüche

1. Richtungsbohrgerät (1), das zur Befestigung an einem mechanischen Arm (3) ausgebildet ist, wobei das Richtungsbohrgerät umfasst:

einen Richtungsbohrkopf (20);  
einen verlängerbaren Bohrer (7);  
Mittel (30) zum Drehen des verlängerbaren Bohrers und des Bohrkopfes;  
Mittel (200, 201, 300) zum axialen Vorantreiben des verlängerbaren Bohrers, so dass sich der Bohrer in die Richtung des Richtungsbohrkopfes bewegt; **dadurch gekennzeichnet, dass** es ferner umfasst:

Anbringungsmittel (57), das an einem Ende eines mechanischen Arms (3) befestigbar ist, wobei das Anbringungsmittel ein Lager (57) umfasst, das 360 Grad Drehung des Bohrgeräts (1) relativ zu dem Arm (3) um eine zu dem Bohrer (7) senkrechte Achse vorsieht; und  
Stabilisierungsmittel (50, 51, 52), die von dem Bohrgerät (1) ausfahrbar sind und dazu ausgebildet sind, gegen das Innere einer Öffnung oder eine andere feste Oberfläche zu drücken, um das Bohrgerät zu stabilisieren.

2. Richtungsbohrgerät nach Anspruch 1, worin die Stabilisierungsmittel ein Paar gegenüberliegender ausfahrbarer Platten (50, 51) an dem vorderen Ende des Bohrgeräts und eine ausfahrbare Platte (52) an dem hinteren Ende des Bohrgeräts umfassen.

3. Richtungsbohrgerät nach Anspruch 1 oder Anspruch 2, worin das Anbringungsmittel ferner ein Betätigungsmittel (56) zum Steuern der Seitenneigung des Richtungsbohrgeräts umfasst.

4. Richtungsbohrgerät nach einem der Ansprüche 1 bis 3, worin das Mittel zum Vorantreiben des verlängerbaren Bohrers umfasst:

erste Betätigungsmittel (200, 201), die an dem Bohrgerät angebracht sind; und  
zweites Betätigungsmittel (300), das an den ersten Betätigungsmitteln (200, 201) angebracht ist und an dem  
verlängerbaren Bohrer befestigbar ist.

- 5 5. Richtungsbohrgerät nach Anspruch 4, worin die ersten Betätigungsmittel und das zweite Betätigungsmittel jeweils einen hydraulischen Kolben umfassen.
6. Richtungsbohrgerät nach einem der voranstehenden Ansprüche, worin das Bohrgerät weniger als 3,5 Meter lang ist.
- 10 7. Richtungsbohrgerät nach Anspruch 6, worin der Bohrer (7) eine Zahl von Bohrabschnitten umfasst und jeder Bohrabschnitt weniger als 3,5 Meter lang ist.
8. Richtungsbohrgerät nach Anspruch 7, worin jeder Bohrabschnitt etwa 1 Meter lang ist.
- 15 9. Richtungsbohrgerät, umfassend eine Antriebsmaschine mit einem mechanischen Arm (3), der an einem seiner Enden an der Antriebsmaschine angebracht ist, und ein Bohrgerät (1), das an dem freien Ende des Arms (3) mittels eines Anbringungsmittels (57) angebracht ist, wobei das Bohrgerät (1) umfasst:  
einen Richtungsbohrkopf (20);  
einen verlängerbaren Bohrer (7);  
Mittel (30) zum Drehen des verlängerbaren Bohrers und des Bohrkopfs;  
Mittel (200, 201, 300) zum axialen Vorantreiben des verlängerbaren Bohrers, so dass sich der Bohrer in die Richtung des Richtungsbohrkopfs bewegt; **dadurch gekennzeichnet, dass**  
das Anbringungsmittel ein Lager (57) umfasst, das 360 Grad Drehung des Bohrgeräts (1) relativ zu dem Arm  
25 (3) um eine zu dem Bohrer (7) senkrechte Achse vorsieht; und  
das Bohrgerät Stabilisierungsmittel (50, 51, 52) umfasst, die von dem Bohrgerät (1) ausfahrbar sind und dazu ausgebildet sind, dass sie gegen das Innere einer Öffnung oder gegen eine andere feste Oberfläche drücken, um so das Bohrgerät zu stabilisieren.
- 30 10. Richtungsbohrgerät nach Anspruch 9, worin die Stabilisierungsmittel ein Paar gegenüberstehender ausfahrbarer Platten (50, 51) an dem vorderen Ende des Bohrgeräts (1) und eine ausfahrbare Platte (52) an dem hinteren Ende des Bohrgeräts umfassen.
11. Richtungsbohrgerät nach Anspruch 9 oder Anspruch 10, worin die Antriebsmaschine ein Bagger oder ein mechanischer Trockenbagger ist.
- 35 12. Richtungsbohrgerät nach einem der Ansprüche 9 bis 11, worin die Antriebsmaschine dazu ausgebildet ist, dem Bohrgerät Leistung zuzuführen.
- 40 13. Richtungsbohrgerät nach Anspruch 12, worin das Mittel (30) zum Drehen des verlängerbaren Bohrers und Bohrkopfs ein hydraulischer Motor ist und die Mittel (200, 201, 300) zum Vorantreiben des verlängerbaren Bohrers eine hydraulische Ramme umfassen und die von der Antriebsmaschine zugeführte Leistung hydraulische Leistung ist.
- 45 14. Richtungsbohrgerät nach einem der Ansprüche 9 bis 13, worin die Mittel zum Vorantreiben des verlängerbaren Bohrers umfassen:  
erste Betätigungsmittel (200, 201), die an dem Bohrgerät angebracht sind; und  
ein zweites Betätigungsmittel (300), das an den ersten Betätigungsmitteln (200, 201) angebracht ist und das an dem verlängerbaren Bohrer befestigbar ist.
- 50 15. Richtungsbohrgerät nach Anspruch 14, worin die ersten Betätigungsmittel und das zweite Betätigungsmittel jeweils einen hydraulischen Kolben umfassen.
16. Richtungsbohrgerät nach Anspruch 14 oder Anspruch 15, worin das zweite Betätigungsmittel Mittel umfasst, den Bohrer wahlweise zu halten.
- 55 17. Richtungsbohrgerät nach einem der Ansprüche 9 bis 16, worin das Bohrgerät (1) abnehmbar an dem freien Ende des Arms (3) angebracht ist.



18. Verfahren zum Richtungsbohren unter Verwendung eines Richtungsbohrgeräts nach einem der Ansprüche 9 bis 16, umfassend die Schritte:

Steuern des mechanischen Arms (3), um das Richtungsbohrgerät (1) in einer Bohr-Startstellung anzuordnen und das Bohrgerät in eine Bohr-Startrichtung zu orientieren;  
Ausfahren von Stabilisierungsmitteln (50, 51, 52) von dem Richtungsbohrgerät; und wahlweise Drehen und Vorantreiben des Richtungsbohrkopfs, um einen Richtungsbohrvorgang auszuführen.

19. Verfahren nach Anspruch 18, worin das Richtungsbohrgerät in einer Startgrube als die Bohr-Startstellung angeordnet ist und worin die Stabilisierungsmittel (50, 51, 52) ausgefahren werden, um in Wände der Startgrube einzugreifen.

## Revendications

1. Unité de forage directionnelle (1) conçue pour une fixation à un bras mécanique (3), l'unité de forage comprenant :

une tête de forage directionnelle (20),  
un foret pouvant s'allonger (7),  
un moyen (30) pour faire tourner ledit foret pouvant s'allonger et ladite tête de forage,  
un moyen (200, 201, 300) pour avancer ledit foret pouvant s'allonger axialement de sorte que ledit foret se déplace dans la direction de ladite tête de forage directionnelle, **caractérisée en ce qu'elle** comprend en outre un moyen de montage (57) pouvant être fixé à une extrémité d'un bras mécanique (3), ledit moyen de montage comprenant un élément de support (57) permettant une rotation de 360 degrés de l'unité de forage (1) par rapport au bras (3) autour d'un axe perpendiculaire au foret (7), et  
un moyen de stabilisation (50, 51, 52) pouvant s'allonger depuis l'unité de forage (1) et conçu pour porter contre l'intérieur d'une ouverture, ou contre une autre surface solide, en vue de stabiliser l'unité de forage.

2. Unité de forage directionnelle selon la revendication 1, dans laquelle le moyen de stabilisation comprend une paire de plaques opposées pouvant s'étendre (50, 51) à l'extrémité avant de l'unité de forage, et une plaque pouvant s'étendre (52) à l'extrémité arrière de l'unité de forage.

3. Unité de forage directionnelle selon la revendication 1 ou la revendication 2, dans laquelle le moyen de montage comprend en outre un moyen d'actionnement (56) destiné à commander l'inclinaison latérale de l'unité de forage directionnelle.

4. Unité de forage directionnelle selon l'une quelconque des revendications 1 à 3, dans laquelle le moyen destiné à faire avancer ledit foret pouvant s'allonger comprend :

un premier moyen d'actionnement (200, 201) monté sur l'unité de forage, et  
un second moyen d'actionnement (300) monté sur le premier moyen d'actionnement (200, 201) et pouvant être fixé audit foret pouvant s'allonger.

5. Unité de forage directionnelle selon la revendication 4, dans laquelle ledit premier moyen d'actionnement et ledit second moyen d'actionnement comprennent chacun un vérin hydraulique.

6. Unité de forage directionnelle selon l'une quelconque des revendications précédentes, dans laquelle l'unité de forage présente une longueur inférieure à 3,5 mètres.

7. Unité de forage directionnelle selon la revendication 6, dans laquelle le foret (7) comprend un certain nombre de sections de foret, et chaque section de foret mesure moins de 3,5 mètres en longueur.

8. Unité de forage directionnelle selon la revendication 7, dans laquelle chaque section de foret mesure environ 1 mètre de long.

9. Dispositif de forage directionnel comprenant une machine motrice comportant un bras mécanique (3) installé au niveau de l'une de ses extrémités sur la machine motrice, et une unité de forage (1) montée à l'extrémité libre du bras (3) par un moyen de montage (57), l'unité de forage (1) comprenant :

une tête de forage directionnelle (20),  
 un foret pouvant s'allonger (7),  
 un moyen (30) pour faire tourner ledit foret pouvant s'allonger et ladite tête de forage,  
 un moyen (200, 201, 300) pour faire avancer ledit foret pouvant s'allonger axialement de telle sorte que ledit  
 foret se déplace dans la direction de ladite tête de forage directionnelle, **caractérisé en ce que**  
 ledit moyen de montage comprend un élément de support (57) permettant une rotation de 360 degrés de l'unité  
 de forage (1) par rapport au bras (3) autour d'un axe perpendiculaire au foret (7), et  
 ladite unité de forage comprend un moyen de stabilisation (50, 51, 52) pouvant s'étendre depuis l'unité de  
 forage (1) et conçu pour reposer contre l'intérieur d'une ouverture, ou contre une autre surface solide, en  
 stabilisant donc l'unité de forage.

10. Dispositif de forage directionnel selon la revendication 9, dans lequel le moyen de stabilisation comprend une paire  
 de plaques pouvant s'étendre opposées (50, 51) à l'extrémité avant de l'unité de forage (1), et une plaque pouvant  
 s'étendre (52) à l'extrémité arrière de l'unité de forage.

11. Dispositif de forage directionnel selon la revendication 9 ou la revendication 10, dans lequel la machine motrice est  
 une pelleteuse ou un excavateur mécanique.

12. Dispositif de forage directionnel selon l'une quelconque des revendications 9 à 12, dans lequel la machine motrice  
 est conçue pour fournir de l'énergie à l'unité de forage.

13. Dispositif de forage directionnel selon la revendication 12, dans lequel le moyen (30) pour faire tourner ledit foret  
 pouvant s'allonger et ladite tête de forage est un moteur hydraulique, et le moyen (200, 201, 300) pour faire avancer  
 ledit foret pouvant s'allonger comprend un vérin hydraulique, et la puissance fournie depuis la machine motrice est  
 une puissance hydraulique.

14. Dispositif de forage directionnel selon l'une quelconque des revendications 9 à 13, dans lequel le moyen destiné à  
 faire avancer ledit foret pouvant s'allonger comprend :

un premier moyen d'actionnement (200, 201) monté sur l'unité de forage, et  
 un second moyen d'actionnement (300) monté sur le premier moyen d'actionnement (200, 201) et pouvant être  
 fixé audit foret pouvant s'allonger.

15. Dispositif de forage directionnel selon la revendication 14, dans lequel ledit premier moyen d'actionnement et ledit  
 second moyen d'actionnement comprennent chacun un vérin hydraulique.

16. Dispositif de forage directionnel selon la revendication 14 ou la revendication 15, dans lequel ledit second moyen  
 d'actionnement comprend un moyen pour maintenir sélectivement ledit foret.

17. Dispositif de forage directionnel selon l'une quelconque des revendications 9 à 16, dans lequel l'unité de forage (1)  
 est montée de façon amovible sur l'extrémité libre du bras (3).

18. Procédé de forage directionnel utilisant un dispositif de forage directionnel selon l'une quelconque des revendications  
 9 à 16, comprenant les étapes consistant à :

commander ledit bras mécanique (3) pour placer ladite unité de forage directionnelle (1) à une position de début  
 de forage et pour orienter ladite unité dans une direction de début de forage,  
 étendre le moyen de stabilisation (50, 51, 52) à partir de ladite unité de forage directionnelle, et  
 faire tourner et faire avancer sélectivement ladite tête de forage directionnelle afin de réaliser une opération de  
 forage directionnelle.

19. Procédé selon la revendication 18, dans lequel l'unité de forage directionnelle est placée à l'intérieur d'un puits de  
 lancement en tant que position de début de forage, et dans lequel le moyen de stabilisation (50, 51, 52) est étendu  
 pour être en contact avec les parois du puits de lancement.

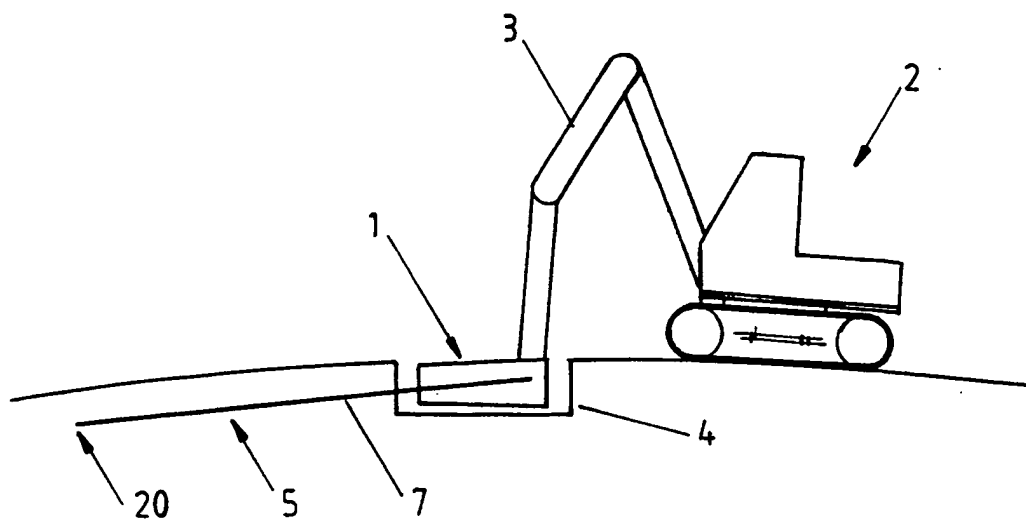


FIG. 1

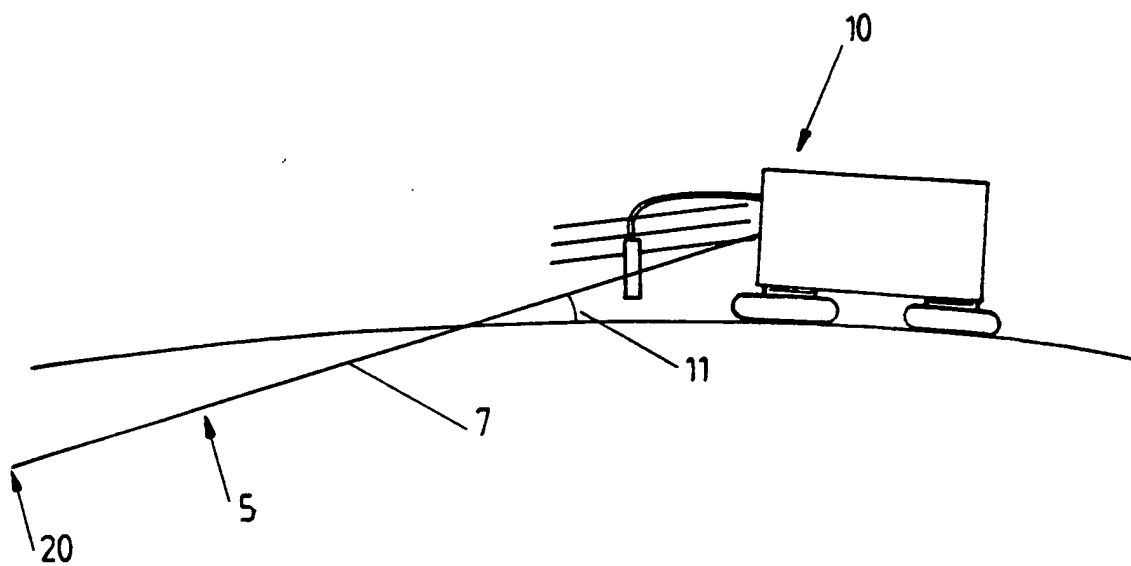


FIG. 2 (PRIOR ART)

FIG. 3

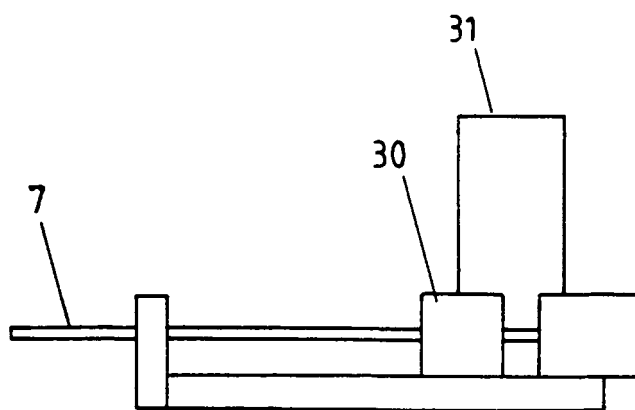
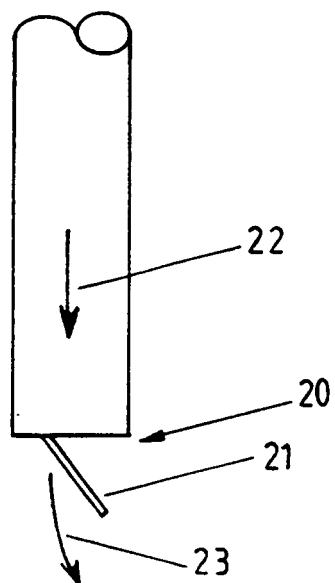


FIG. 4

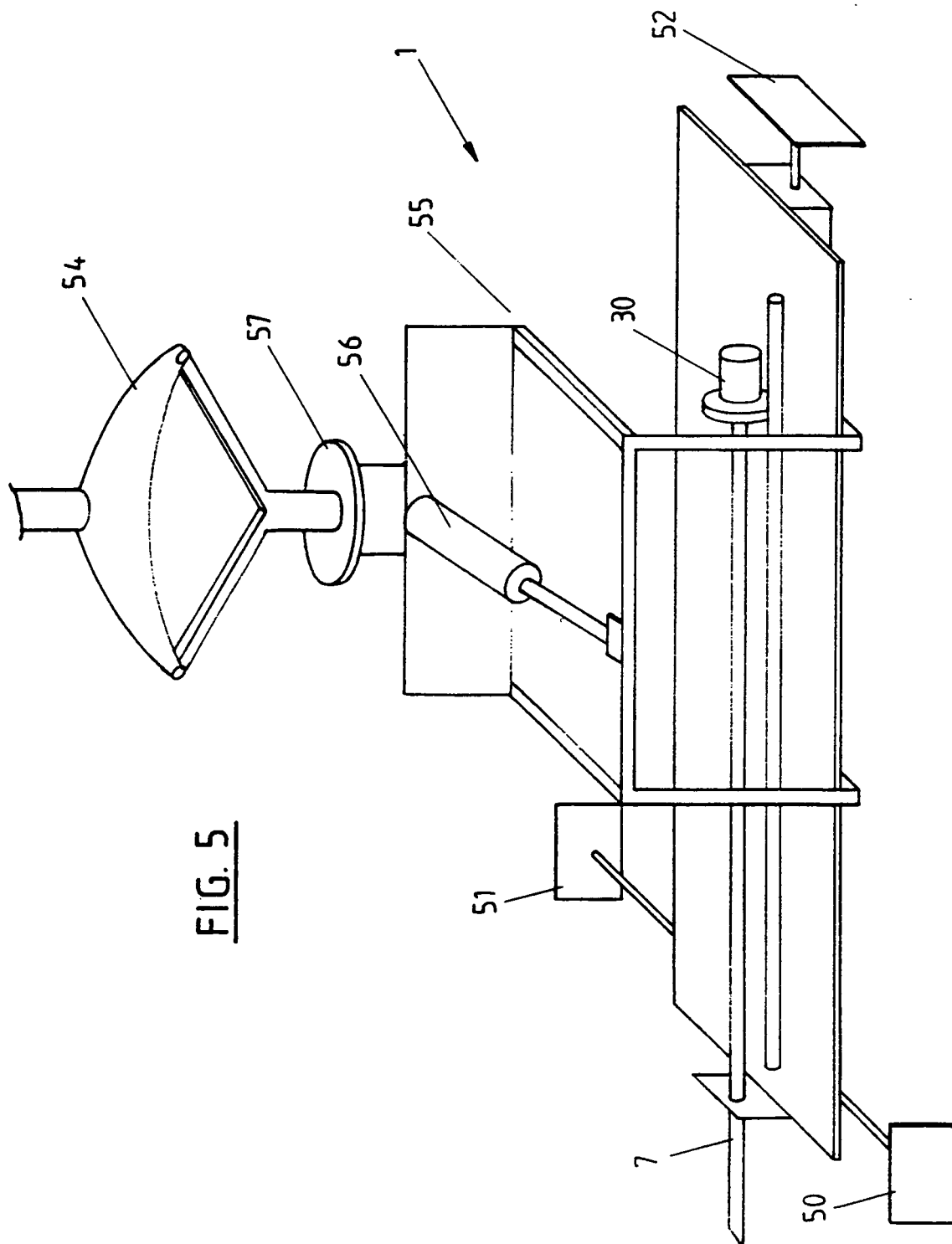


FIG. 5

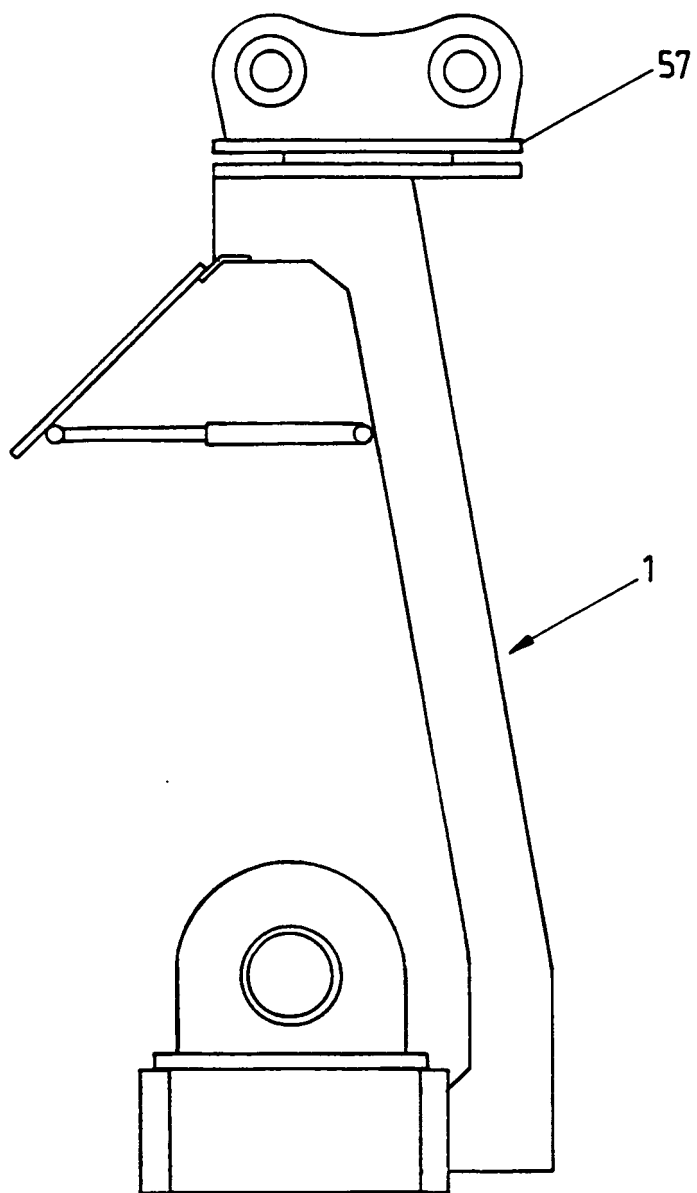


FIG. 6

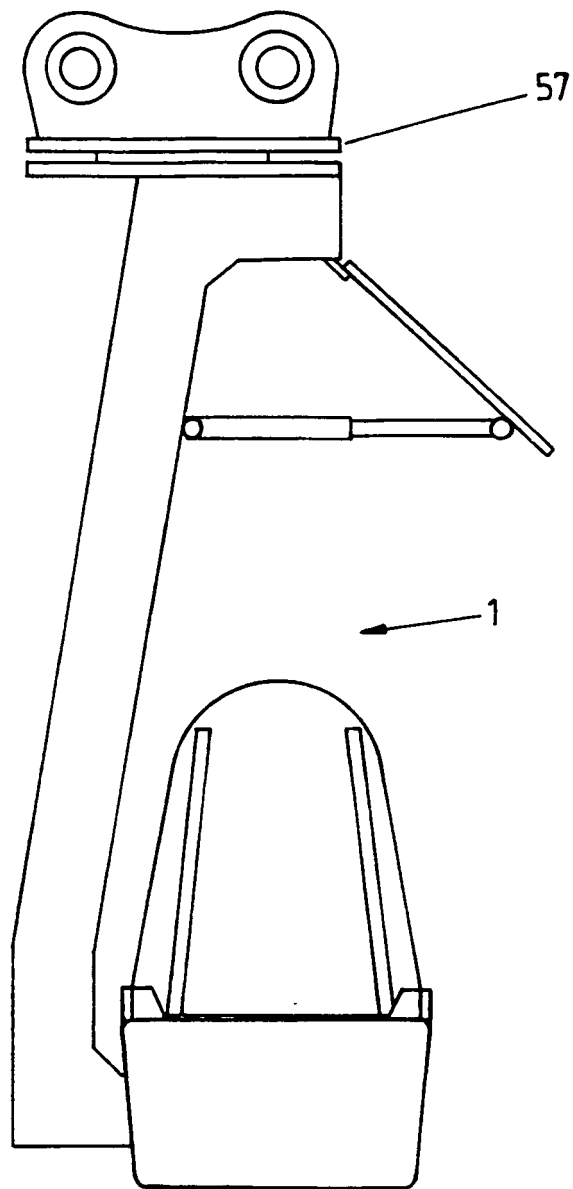
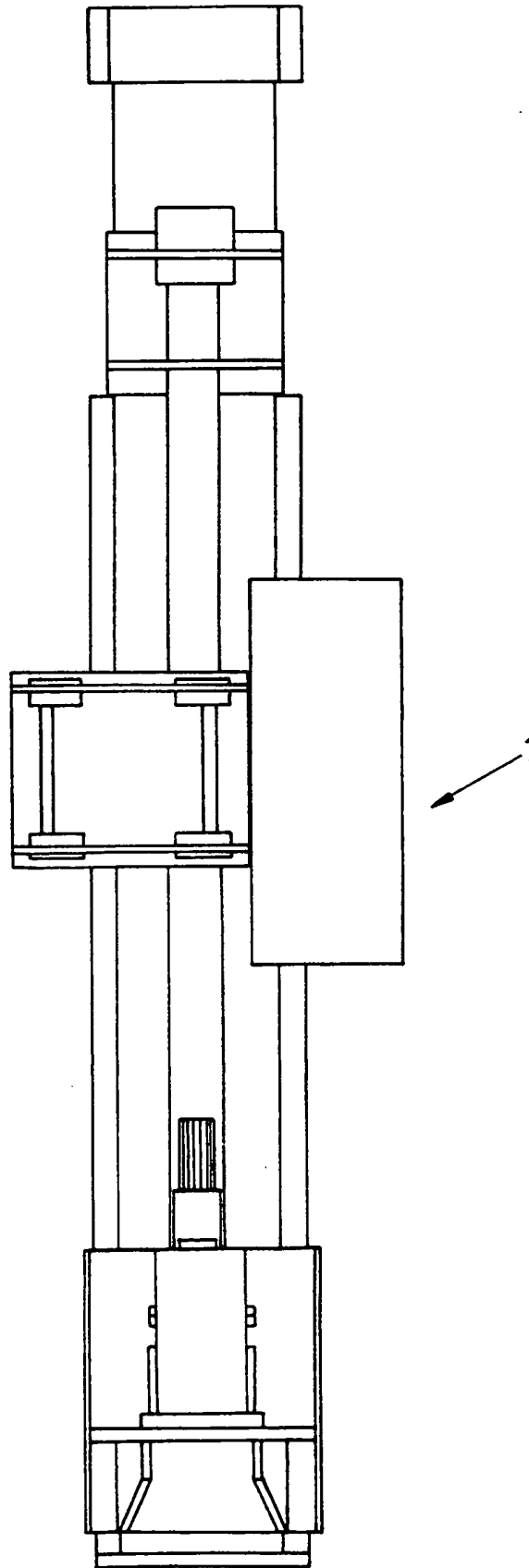
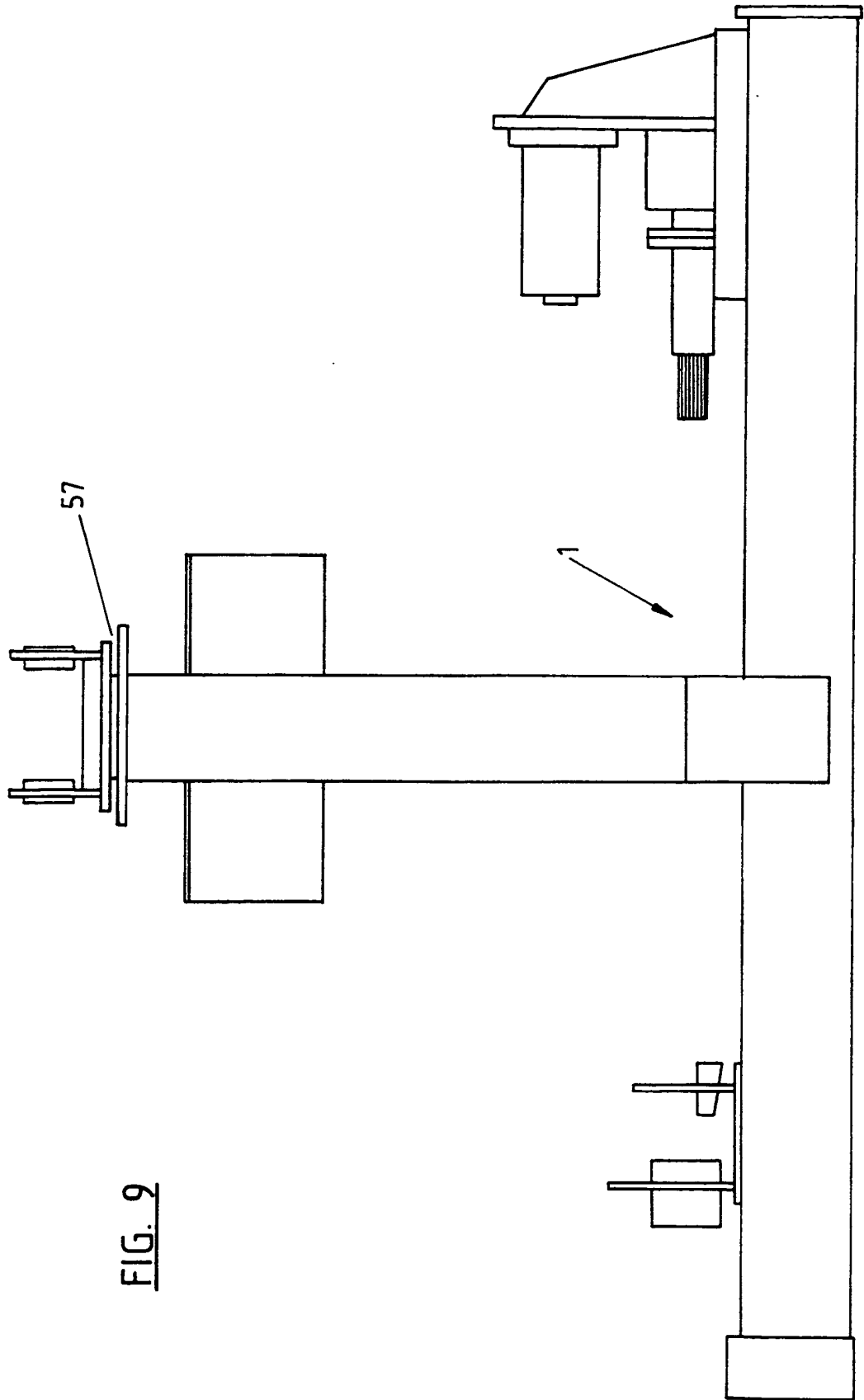


FIG. 7

FIG. 8







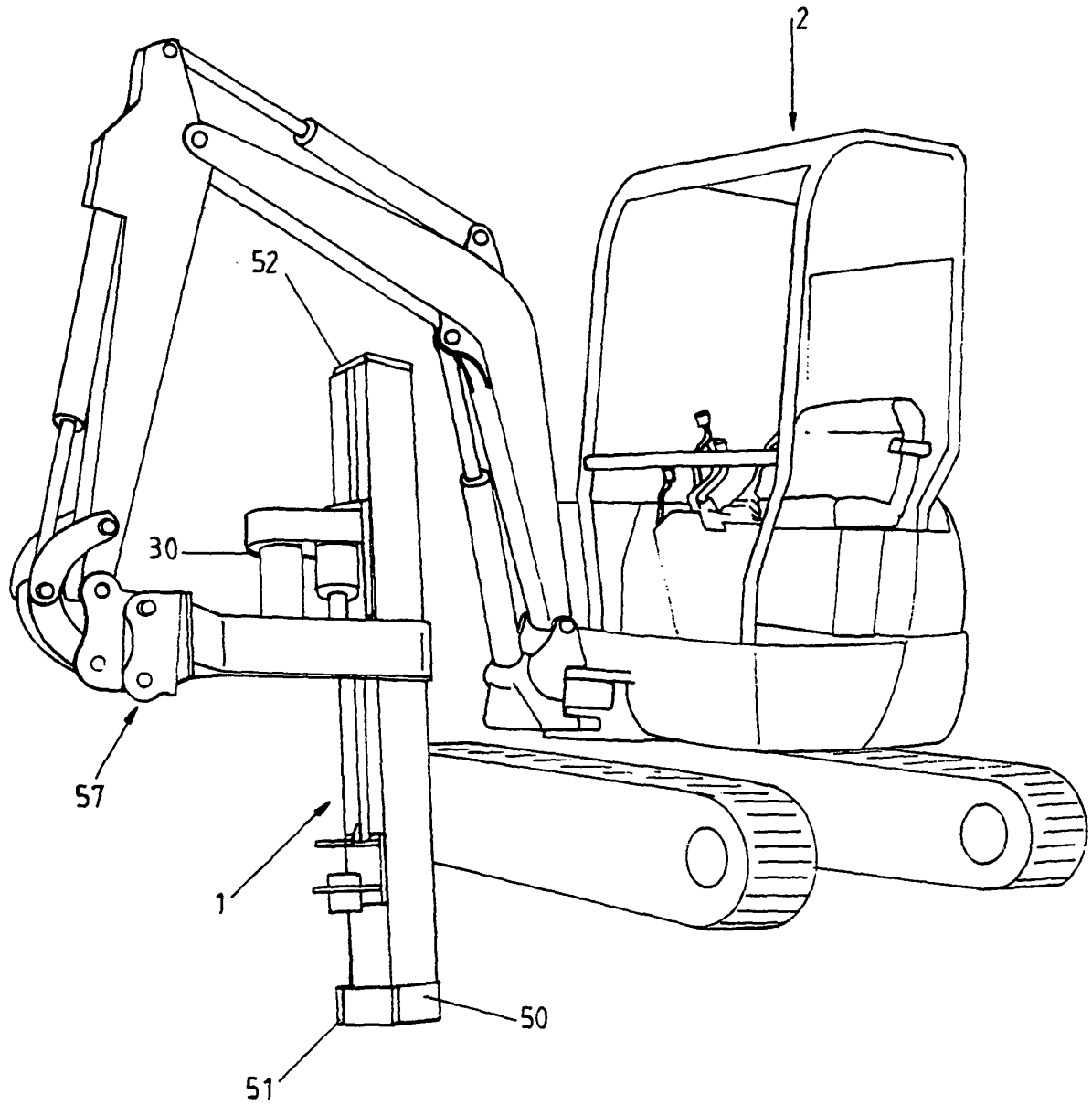


FIG. 10

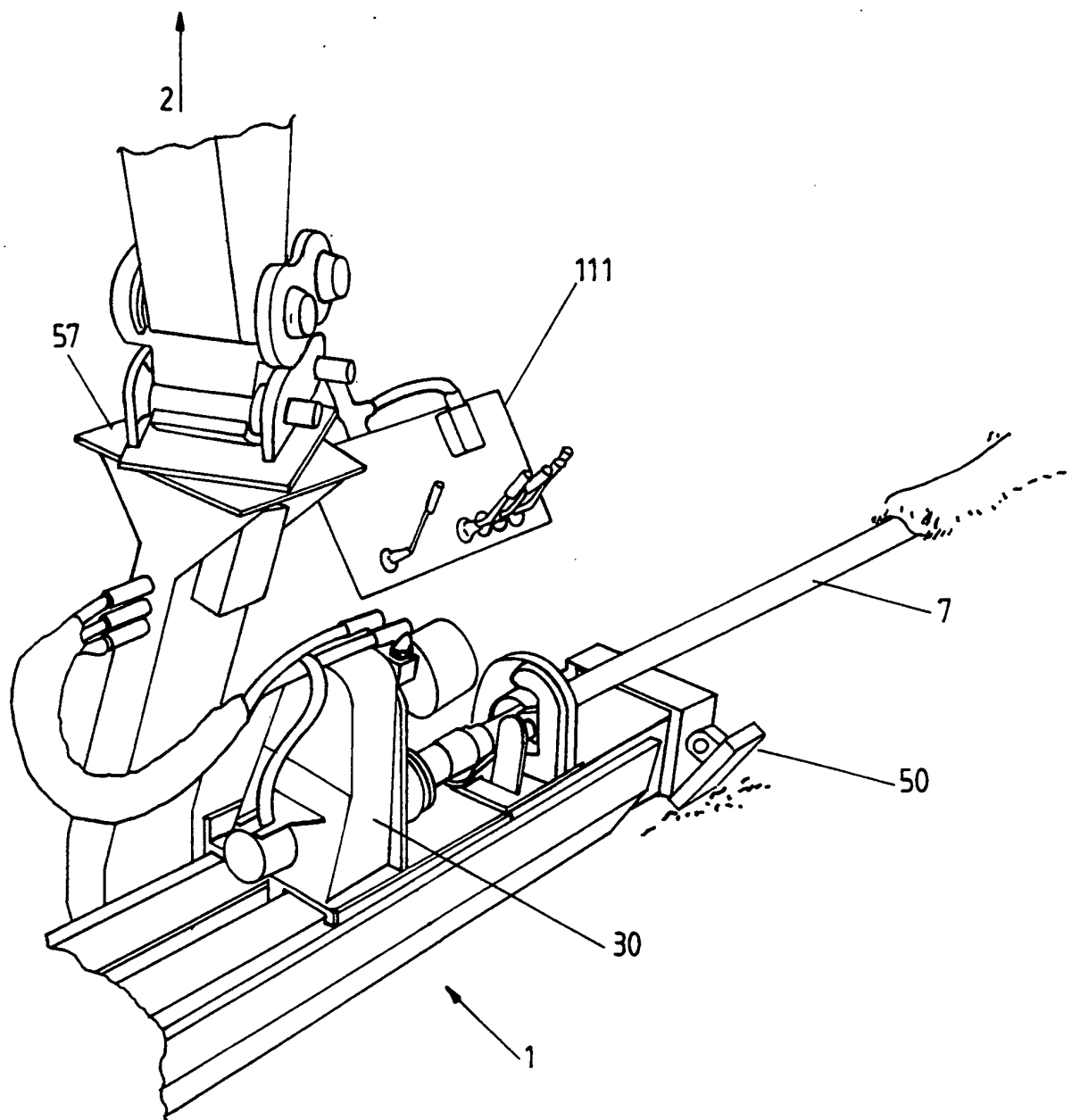


FIG. 11

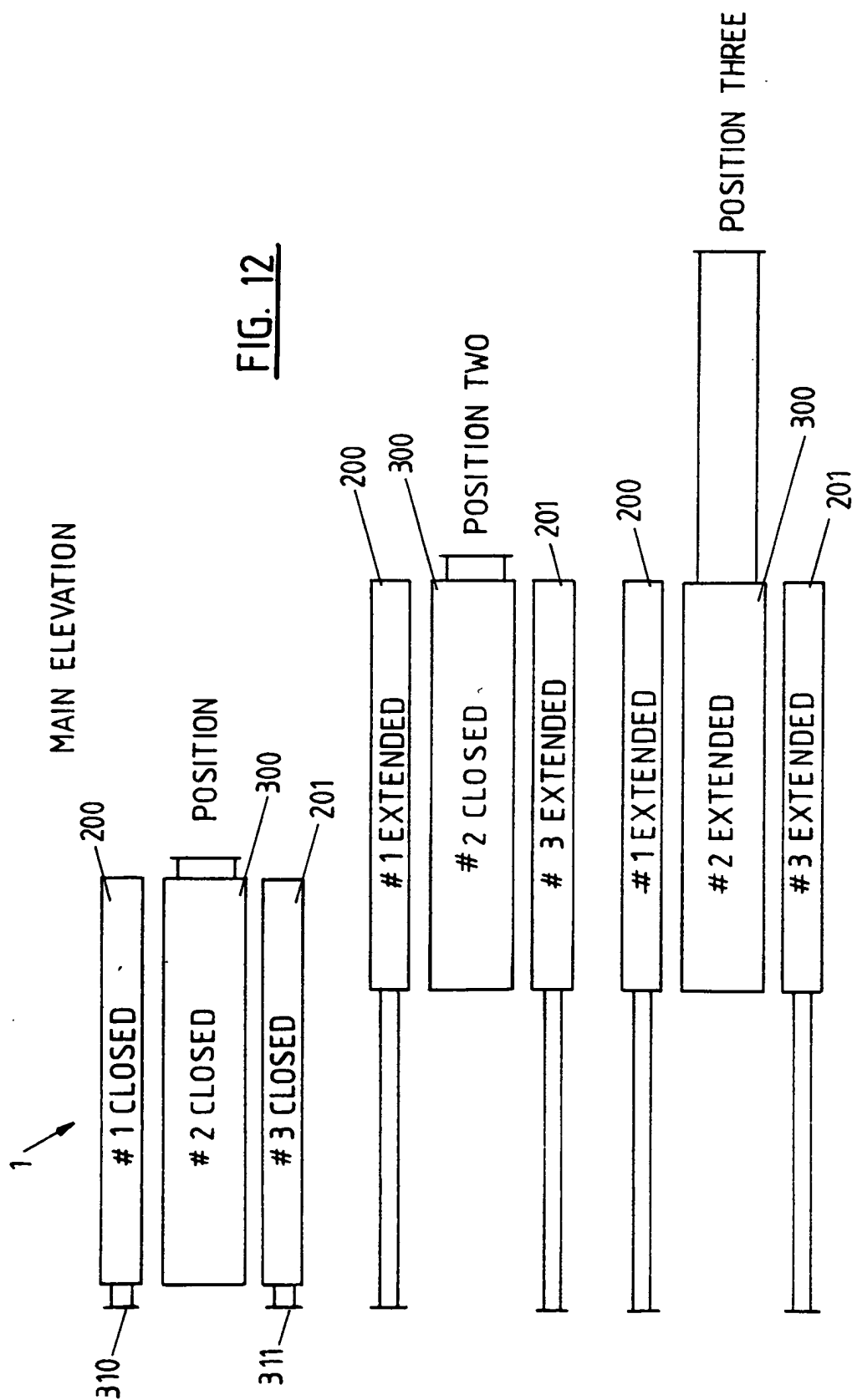


FIG. 12