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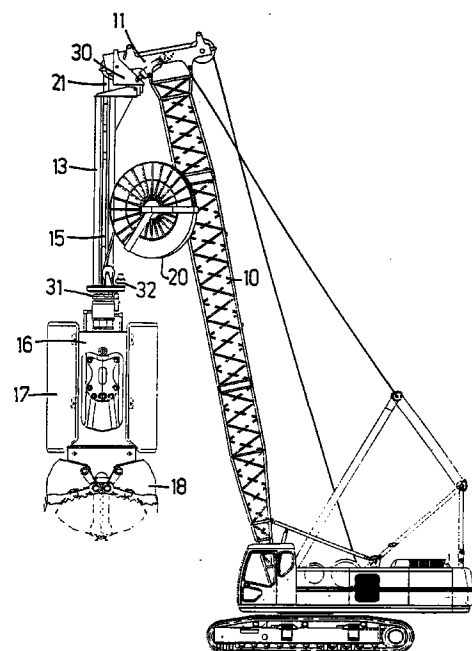
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### (54) Excavation equipment

(57) This invention relates to excavations for diaphragms, in particular to the type including : a hydraulic bucket (16), at least one wire line (21) to lift and lower the bucket (16) along a vertical excavation axis (x), a telescopic guide group (13 - 15) to guide the bucket along the excavation axis, and a rotation device (31) to rotate the bucket around the excavation axis. The rotation device (31) is interposed between the telescopic guide group (13 - 15) and the bucket (16) ; the wire line (21) is fixed to an element (15) arranged upstream of the rotation device (31). The equipment includes flexible conduits (19) for bucket activation and winding paddle wheels (20) to wind the conduits around a horizontal axis. The paddle wheels (20) are also mounted on a non rotating structural element (13) arranged upstream of the rotating device (31).



**FIG.4**

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## Description

### Background of the invention

This invention relates to the excavation field, for the construction of diaphragms, and refers, in particular, to a hydraulic bucket excavation equipment for the construction of such diaphragms.

### Objects of the invention

There are described diaphragms composed of a series of flanking panels arranged side by side, each panel is obtained in a generally rectangular-section excavation, extended in the direction of the diaphragm, where short sides are confined with the short sides of the adjacent panels. Excavations are generally carried out with buckets with two superposed valves, with penetration teeth and ground loading. The body of the bucket is equipped with guiding elements, fixed to the body, either rigidly or through positioning and regulation devices.

The bucket is suspended on a surface excavation equipment, bucket lowering and lifting into the hole is achieved through one or more manouver wire lines, either of the direct fire type or lifting block type. The body of the bucket is suspended from these wire lines. Excavation power required to activate the valves is obtained via one or more oleodynamic cylinders in the bucket body, supplied by two flexible conduits wrapped around respective constant tension power-driven winding paddle wheels.

To allow optimal valve closure, the teeth on the valves are arranged in asymmetric and complementary manner. The number of teeth is therefore different on both valves, making specific loads exerted on the teeth by the force of excavation.

To ensure the stability and success of the operation, it is essential that the surface of the diaphragm be free of discontinuity points: adjacent panels must be in contact, on the entire depth. It is therefore necessary that both the short sides and long sides of each panel be vertical. It is also necessary to avoid any helicoidal torsion of the single panels: although they are contiguous in height and have vertical axes, panels can be separated and diverge, below certain digging depths, as a result of the torsion exerted on the vertical axis. During excavation, it is therefore very important to ensure that panel sides remain vertical.

Vertical positioning errors are mainly due to the asymmetric position of the teeth of the valves, and to the irregular nature of the ground.

The asymmetric positioning of valve teeth is required to obtain the maximum, complete and balanced closure of the valves. Field experts recognize that valve teeth are out of phase by half a step with respect to those of the other valve to allow valve closure without any contact between the teeth. For obvious reasons related to

equilibrium during excavation, one of the valves is equipped with an additional tooth (with respect to the other valve). Teeth geometry is therefore symmetric vertically, on the valve rotation axis. On the other hand, the degree of intensity exerted on each valve on closure (ground excavation) is different.

The difference in torsion is mainly due to the above mentioned difference of the excavation teeth on both valves.

Reference is made to figures 1 to 3, that illustrate the bucket-type excavation equipment of the type used for diaphragm construction. The equipment is equipped with a telescopic guide group, mounted on connection head 11, at the top of arm 10 of the crane. The telescopic group can turn on the vertical excavation axis by way of rotation device 12, fixed to head 11. The telescopic group includes an upper element 13, fixed to the rotating section of rotating element 12, all intermediate element 14, that can slide telescopically inside the first, and a lower element 15, that can slide telescopically inside the second. The body of bucket 16, including lateral guides 17 and standard-type valves 18, is activated by a hydraulic system incorporated on the inside part of the body of the bucket 16, and powered by way of flexible conduits 19, is wound on paddle wheels 20, fixed to the lower section of third element 15. The paddle wheels are mounted in a rotatable way on the first upper telescopic first element 13, and are equipped with an elastic hydraulic recall system to ensure a predefined, substantially constant level of tension on the flexible conduits, 19. Manouver wire line 21 is fixed at 22 to all element 23 that is fixed to the bucket body, to ensure bucket lifting and lowering. These movements correspond to the retraction and extension of the telescopic group 13-15 respectively. During bucket downward movement (lowering), flexible conduits are wound by the paddle wheels. The winding is controlled in order that the conduits be subjected to the specified level of tension; during bucket lifting, bucket wheels rewind conduits automatically.

The telescopic group makes it possible to ensure that the panel is maintained in a vertical position during the first meters of excavation, or when the bucket body is not yet employed, with the lateral guides, in the excavation section of the panel.

During excavation, to compensate or at least limit deviations from the vertical axis, due to the asymmetric configuration of the teeth, during each of, or after a few excavation cycle(s), the bucket is removed from the hole, and the rotation device 12 is used to rotate the guide group and, consequently, the bucket body, by 180°, on vertical axis x.

It must be noted that this technique involves a few disadvantages. Firstly, it limits paddle wheel diameter, that, rotating fixed to the telescopic group, must not physically interfere with the crane arm during this manouver. For this reason, paddle wheels with relatively limited diameters should be used. This limitation has a

negative effect on flexible conduits, in terms of curving angles, passage section, accurate winding on the paddle wheel. Consequently, by reducing the diameter of the paddle wheel, one reduces the functionality, causing faster wear and reducing the lifetime duration of the flexible conduits.

Secondly, in at least one of the operation configurations, if not in both, a double torsion is generated by the manouver wire line copper components on the vertical axis. This double torsion is caused by the torsional instability of all the suspended parts, causing the above mentioned helix-type movement. The accuracy of the excavation is almost exclusively dependent on the operator's experience.

Lastly, wire line bucket-type excavation equipment of the type mentioned here can easily lead to wire line winding with subsequent sliding and premature wearing of the wire lines, in the event of excessive rotation, due to manouvering errors.

#### Summary of the invention

It is an object of this invention to carry out an improved type of bucket excavation equipment, limiting disadvantages and limits of the said technique, as described above. In particular, an object of this invention is to propose an equipment capable of carrying out precise excavations, with particular attention on eliminating, or, at least limiting torsional errors.

Another object of the present invention is to carry out an excavation equipment allowing use of larger diameter paddle wheels, and therefore flexible conduits capable of handling heavier oil loads and therefore more power for valve operation.

Another object of the present invention is to carry out an excavation equipment that is easier to manouver, in order that excavation accuracy is no longer entirely dependent on the operator's experience.

These and other objects and advantages, that will be further understood thereby, are attained according to the present invention, with an excavation equipment for diaphragm construction, of the type that includes : a hydraulic bucket, wire line means for bucket lifting and lowering the bucket along a substantially vertical excavation axis, a telescopic guide group to guide the bucket along the said excavation axis, a rotation device to rotate the bucket around said excavation axis, characterized by the fact that the said rotation device is interposed between the telescopic guide group and the bucket, and that the wire line means are fixed to an element arranged upstream of the rotation device.

The equipment includes flexible conduits for bucket activation and winding means for conduit winding around a substantially horizontal axis. Winding means will, preferably, be mounted on the non-rotating structural element arranged upstream of the rotating device.

#### Brief description of the drawings

There will now be described the structural and functional preferred, but not unique, embodiment of the excavation equipment object of the present invention, reference being made to the accompanying drawings, wherein like numerals are used to designate like parts, and in which :

FIG.1 : side elevation diagrammatic view of the excavation equipment of know type.

FIG. 2 : side elevation, according to arrow A of FIG.1, of parts suspended on the crane ;

FIG. 3 : shows an enlarged representation of teeth position on bucket valves ;

FIG.4 : side elevation of the excavation equipment, object of the present invention, and

FIG.5 : sectional view, enlarged scale, of the hydraulic rotation assembly included with the excavation equipment, according to FIG.4.

#### Detailed description of the invention

Referring to FIG.4, which shows the excavation equipment object of the present invention, for simplicity, parts already described in previous claims, referring to FIGURES 1 to 3, will be described only to such an extent as is necessary for understanding of the invention.

The excavation equipment illustrated in FIG.4 includes coupling head 11 arranged at the top of arm 10 of the crane. A telescopic guide group composed of coaxial telescopic elements, preferably three in number, is mounted, preferably by way of a horizontal hinge 30, on head 11. The coaxial telescopic elements should, preferably, be : a first upper and external element 13, coupled on the top section of head 11, a second, intermediate element (not illustrated in FIG.4 for simplicity) and a third lower and internal element, 15.

The excavation force required for valve activation is obtained by way of one or more oleodynamic cylinders contained in the bucket body, and supplied by two flexible conduits, 19, wound on respective winding paddle wheels 20, motorized through constant tension (only one visible in FIG.4). Lowering and lifting of bucket 16 into the excavation is obtained by way of one or more manouver wire lines 21.

According to the present invention, body 16 of the bucket is mounted in a rotatable way on a substantially parallel axis, to the excavation axis, on the lower end of lower telescopic element 15, by interposing a hydraulic rotation device 31 through which only the bucket, and not the telescopic array, can turn on the vertical excavation axis x. Also according to the present invention, the attachment point of wire line 21 if fixed to an element arranged upstream from rotation device 31, in the preferred embodiment, the wire line is fixed to lower element 15 of the telescopic group, preferably close to its

upper end.

Also according to the present invention, winding paddle wheels 20 are mounted on a structural element arranged upstream from the rotation device, that does not, consequently, rotate with the bucket, in the preferred embodiment, paddle wheels are hinged on the upper element 13 of the telescopic guide group. This type of configuration makes it possible to adapt paddle wheel dimensions to specific functional requirements, without technical or geometric limitations. As will be apparent in comparing FIG.4 and 2, according to the present invention (FIG.4), paddle wheels can be positioned as required, on the telescopic array without protruding on the front of the telescopic group. This makes it possible to create diaphragms that can be based on possible existing vertical walls. This possibility is eliminated if a traditional type of equipment is used, illustrated in FIGS. 1 and 2, wherein at least one of the possible operating positions the paddle wheels protrude on the front of the more extended section of the equipment, and could interfere with an existing vertical wall.

Another advantage of the preferred embodiment of the equipment object of the present invention is based on the fact that flexible conduit (19) dimensions can be defined with optimal sections, increased according to the known technique, in order to allow loading of heavier quantities of oil. This makes it possible to increase power transmitted to the valves, and therefore excavation equipment performance.

As will be apparent, wire lines are no longer subjected to torsional forces due to bucket rotation on the vertical axis, because the wire line is fixed to lower element 15 of the telescopic group (that does not rotate) at a determined point, and not on the bucket itself. Lack of torsion stability, apparent in conventional excavation equipment, is therefore eliminated.

In the following, reference will be made to FIG.5, in which a preferred embodiment of the hydraulic rotation device is shown, designated as a whole by numeral 31, interposed between the telescopic group and the bucket body, for rotation of the latter.

The hydraulic device is composed of an upper fixed section, fixed to the telescopic group, and of a lower turning section, fixed to the bucket body. The fixed section and the turning section are normally blocked by hydraulic opening lamellar brake 36.

Motor reducer 32 is fixed to upper telescopic element 13 of the guide group ; output transmission from the motor reduced gears onto toothed ring 33 coaxial to the telescopic group and equipped with one or more cavities (not illustrated) that can be used to engage engaging element 34, fixed, in rotation, to the lower mobile section of the hydraulic device. In the preferred embodiment, engaging element 34 is composed of a pin, mounted in a vertical slidable way with respect to hydraulic cylinder 35, fixed to the bucket. The hydraulic rotation device also includes a rotating, two-way hydraulic joint, 37.

As illustrated in FIG.5, once the bucket is lifted from the hole completely, telescopic guide group 13-15 is moved upwards ; pin 34 is engaged in one of said recesses (not illustrated), obtained in the toothed ring 33, in order that the ring be fixed to the bucket, in rotation. The vertical compression force exerted by the abutment of the top of pin 34 against ring 33 exerts pressure on the unpressurable fluid inside cylinder 35. Lamellar brake 36, fluid communication with cylinder 35, reacts to this pressure variation by moving the rotatable section of the fixed section of hydraulic device 31 ; the bucket body is moved, in rotation, from the telescopic group.

By activating motor reducer 32, toothed ring 33 and pin 34 are rotated, causing the rotation of the bucket body.

The type of bucket rotation can be adjusted as required. Typically, this is adjusted to obtain 180° rotation, to compensate for the deviation caused by the asymmetric geometry of valve teeth.

The hydraulic supply for valve 18 opening and closing should, preferably, be achieved through hydraulic two-way joint 37. Another advantage of this type of configuration is that an unlimited number of rotations is possible, whilst previous solutions allow maximum rotation on 180° only, due to bucket suspension wire line winding.

It is understood that remarks made here apply to an embodiment provided for the purpose of illustration, and that the invention is not to be limited by any manner thereby. The embodiment illustrated can be subjected to changes relative to the shape and the positioning of the constituent parts, constructive and functional details. According to another embodiment, not illustrated here, winding paddle wheels can be mounted on the crane arm, and not on the telescopic group, although remarks made here do not illustrate this possibility.

## Claims

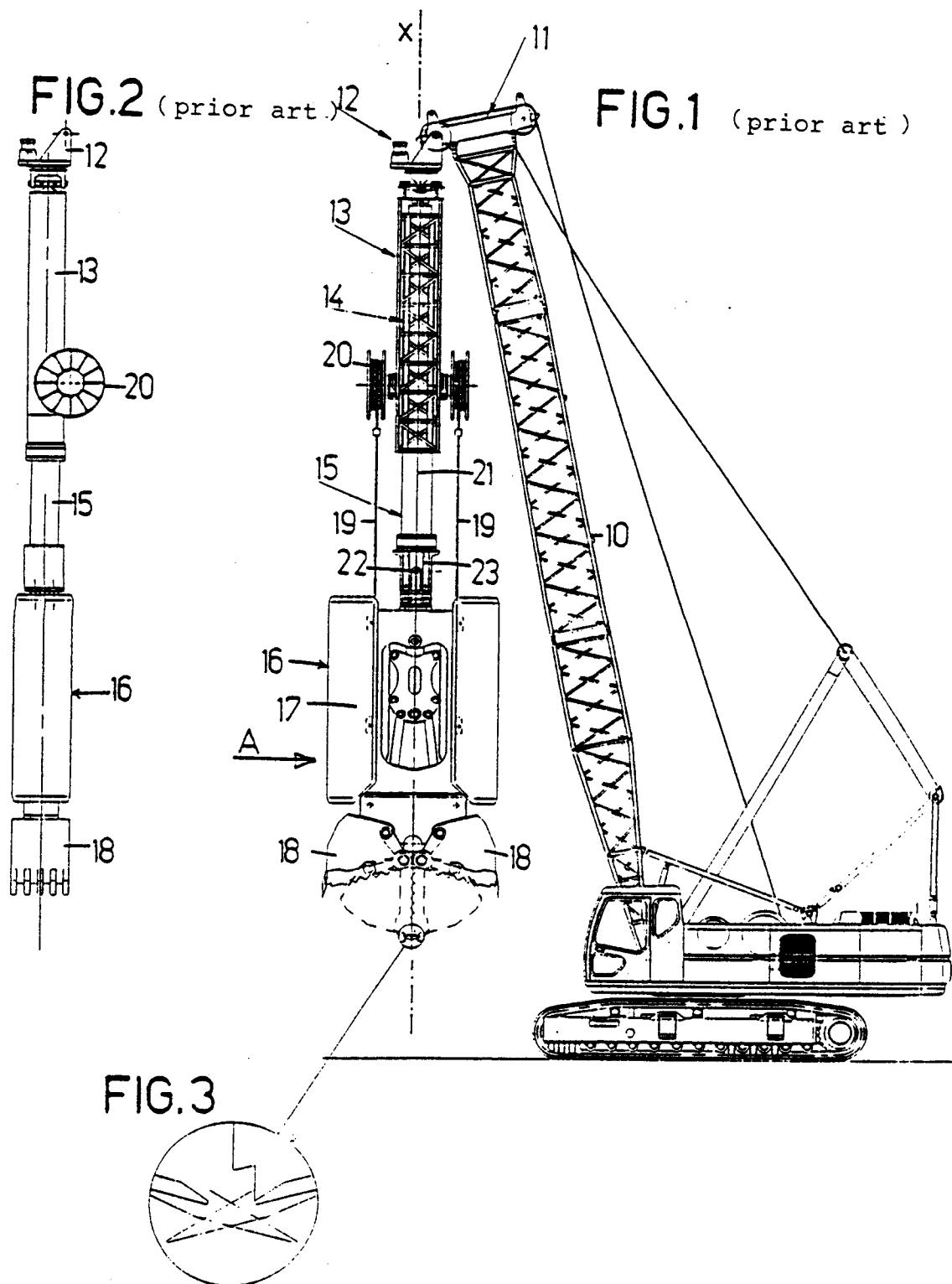
1. Excavation equipment for diaphragm construction, type including :
  - a hydraulic bucket (16),
  - wire line means (21) to lift and lower the bucket (16) along a substantially vertical excavation axis (x)
  - a telescopic guide group (13 - 15) to guide the bucket along the said excavation axis (x)
  - a rotation device (31) to rotate the bucket around the said excavation axis (x) ; characterized by the fact that the said rotation device (31) is interposed between a telescopic guide group (13 - 15) and the bucket (16), and that the wire line means (21) are fixed to an element (15) upstream of the rotation device.
2. Excavation equipment according to claim 1, charac-

terized by the fact that the wire line means (21) are fixed on the lower element (15) of the telescopic guide group.

3. Excavation equipment according to claim 1, of type including flexible conduits (19) for bucket activation and winding means (20) to wind said conduits (19) around a substantially horizontal axis, characterized by the fact that said winding means (20) are mounted on a non-rotating structural element, upstream of the rotation device (31). 5
4. Excavation equipment according to claim 3, characterized by the fact that said winding means (20) are mounted so that they do not protrude on the front of the excavation equipment. 10
5. Excavation equipment according to claim 3, characterized by the fact that the winding means (20) are mounted on the telescopic group (13 - 15) 20
6. Excavation equipment according to claim 5, characterized by the fact that the winding means (20) are mounted on the upper telescopic element (13), of the said telescopic guide group (13 - 15). 25
7. Excavation equipment according to claim 1, characterized by the fact that the rotation device (31) is a hydraulic device. 30
8. Excavation equipment according to claim 7, characterized by the fact that the said rotation device (31) is composed of an upper fixed section, fixed to the telescopic group, and of a lower rotatable section, fixed, in rotation, to the bucket body, and of a hydraulic opening lamellar brake (36), for reciprocal blocking of the fixed and rotatable said parts. 35
9. Excavation equipment according to claim 8, characterized by the fact that one of the two sections, fixed or rotatable, includes motor means (32) to allow rotation of a transmission element (34) capable of gearing, in rotation to the said transmission element (33), the said rotation device being capable of withstanding two alternative arrangements for operation 40  
: 45
  - in the first arrangement, when the telescopic group is stretched
  - a second arrangement of engagement in rotation, when the telescopic group is positioned upwards, in which said engagement element (34) and said transmission element (33) are fixed in rotation. 50
10. Excavation equipment according to claim 9, characterized by the fact that said engagement element (34) is hydraulically fixed to the lamellar brake (36) 55

in order to unblock it in the said second arrangement of engagement in rotation.

11. Excavation equipment according to claim 10, characterized by the fact that the said engagement element (34) is a vertically slidable element with respect to a hydraulic cylinder (35) in fluid communication with said brake (36).
12. Excavation equipment according to any one of claims 7 to 10, characterized by the fact that said hydraulic rotation device (31) includes a two-way rotatable hydraulic joint (37).
13. Excavation equipment according to claim 12, characterized by the fact that the hydraulic supply for valve (18) and bucket (16) opening and closing is achieved through said two-way hydraulic joint (37).



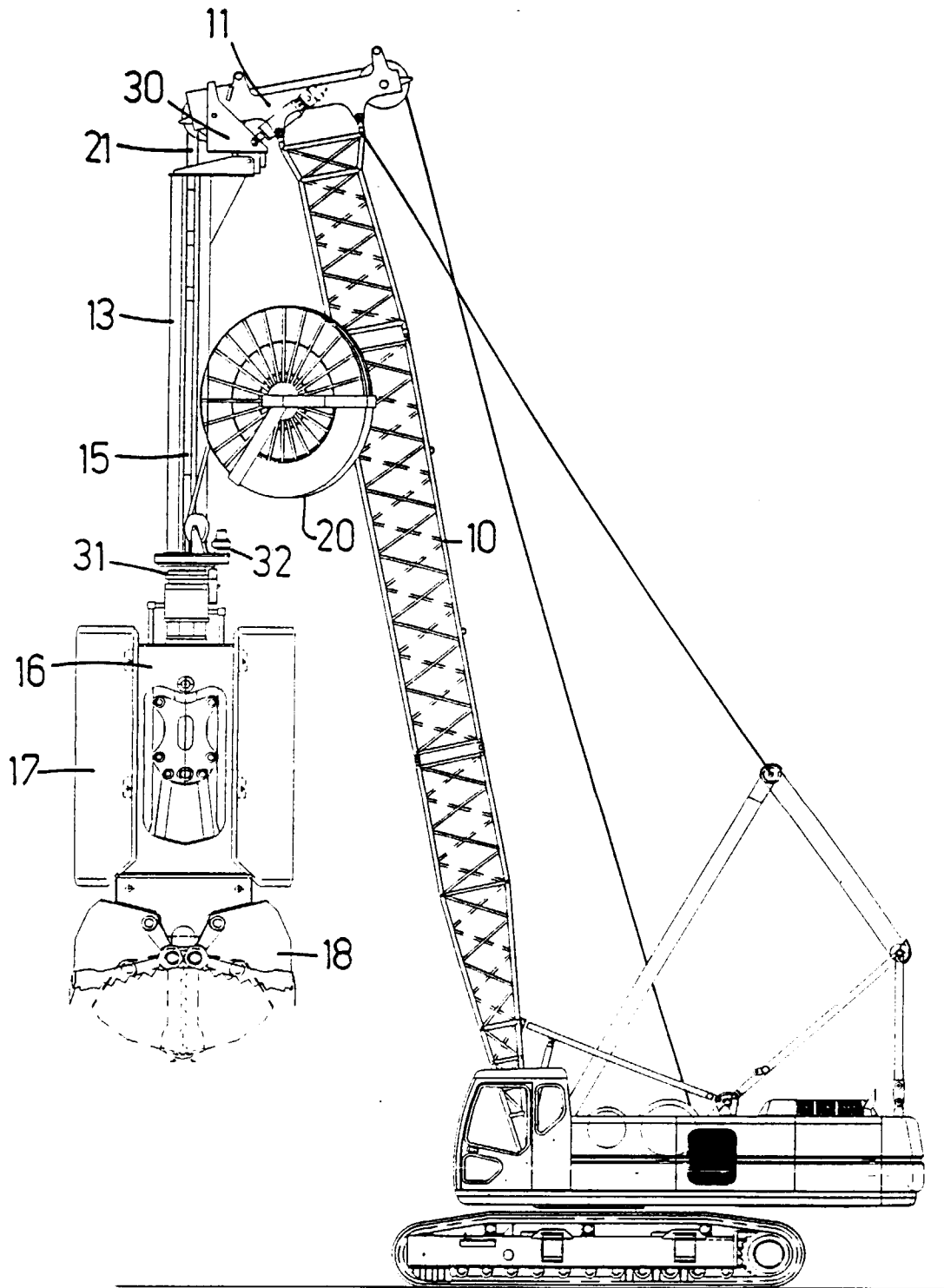


FIG.4

FIG.5

