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(54) **A core sampling apparatus**

(57) A core sampling apparatus (1) comprises a core sampler (2) and a frame (3) adapted to support said sampler (2), said frame (3) comprising a base (3a), a first mobile portion (3c) of the frame (3) being linked to said base (3a) by way of a plurality of linear actuators (4) arranged thereon. The core sampling apparatus also comprises a second mobile portion (3d) adapted to support the sampler (2) and slidable with respect to the first mobile portion (3c) by way of a pulley and rope system (5a, 5b, 6a, 6b), in which said pulleys (5a, 5b) are connected to the first mobile portion (3c) and said ropes (6a, 6b) are respectively connected at an end to the upper and lower ends of the second mobile portion (3d) and at the opposite end to the fixed portion of the frame (3) winding around the pulleys (5a, 5b). Thanks to this configuration, the core sampling apparatus has a very small bulk in a vertical direction substantially facilitating transportation and movement operations.

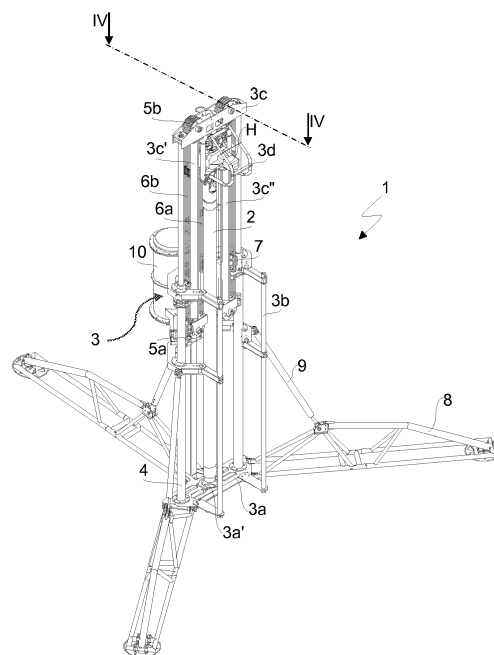


Fig.1

Description

DESCRIPTION

[0001] The present invention concerns a core sampling apparatus and in particular a core sampling apparatus adapted to collect samples of soil from underwater beds.

[0002] It is known that research on sediments that constitute an underwater bed makes it possible to obtain a considerable amount of data relative to the environmental effects that human activity has on the underwater ecosystem, in particular concerning pollution. The need for a rapid removal of the polluting substances from the water environment with cleaning up technologies makes it necessary for there to be a preliminary analyses of the type and/or amount of the materials to be removed, from the chemical, physical and biological point of view.

[0003] The analysis of the underwater beds is also essential to evaluate the impacts on the environment and the repercussions on the aquatic ecosystems of interventions and operations such as periodic or special port dredging, making port infrastructures (docks, piers, containment tanks, etc.), the laying of cables and pipelines, monitoring marine protected areas or locations in which there is environmental risk.

[0004] In order to be able to analyse a sea bed it is necessary, as known, to carry out core sampling operations that make it possible to obtain core samples substantially having a cylindrical shape and comprising a plurality of sections one on top of the other, representative of the composition of the soil below the bed at different depths.

[0005] Generally speaking, core sampling apparatuses comprise a tubular sampler provided with an inner cavity and with one or more cutting elements at a distal end. The core sampler is driven into the sea bed and is forced down to a predetermined depth by actuating a hammer and/or a vibrator. During the forcing down of the sampler, the soil at the bed progressively enters the cavity of the sampler progressively making up the sample. Once the desired depth has been reached, the distal end of the sampler is closed and the sampler is retracted. Then the core sampling apparatus is lifted from the bed; the core sample is extracted from the cavity of the sampler and is placed in suitable boxes to carry out the analysis.

[0006] The core sampler is generally linked to a support structure in turn slidingly linked to a special frame and guided by actuation means like, for example, a winch.

[0007] Patent application EP 1564368, in the name of the present applicant, describes for example core sampling equipment comprising a core sampler provided with a cutting edge at the distal end and suitable for being driven into a sea bed to collect the soil samples. The sampler is supported by a plate slidingly linked to a frame provided with a substantially flat base that is adapted to be rested on the underwater bed. The plate slides along

linear guides that extend vertically from the base of the frame and is actuated by way of a cable linked to a winch through a group of pulleys.

[0008] In the field of core sampling apparatuses for underwater beds there is an ever increasing need for light equipment, with minimum bulk and as independent as possible from the nautical means it rests against. Such equipment must indeed be able to be housed on vessels up to 15 meters or small pontoons and be used for core sampling operations in any underwater sediment deposit, from the coastal line to the edge of the continental shelf, to the river, lake and lagoon areas.

[0009] Another fundamental requirement of the core sampling apparatuses is that of stability. Indeed, such apparatuses are intended to operate on inclined seabeds or seabeds of poor consistency that can cause sudden displacements of the equipment, jeopardising their correct operation. In order to obtain good stability it is necessary to provide a wide resting base, which constitutes a great limitation to the reduction of the bulk of the equipment.

[0010] The present invention makes it possible to reach the aforementioned objectives of minimum bulk and improved stability thanks to an apparatus the main characteristics of which are defined in the first of the appended claims, whereas other characteristics are specified in the remaining claims.

[0011] The core sampling apparatus according to the present invention comprises a core sampler adapted to be driven into a sea bed so as to collect soil samples and to be slidingly linked to a frame. The frame comprises a base adapted to rest on the sea bed, a fixed portion connected to the base, a first mobile portion with respect to the fixed portion and a second mobile portion slidingly linked to the first mobile portion. The second mobile portion of the frame is connected to the first mobile portion through drive means between the mobile portions adapted to realize a displacement multiplication system for multiplying the displacement of said sampler with respect to the displacement of said first mobile portion.

[0012] Preferably, such drive means comprise a system of ropes and pulleys in which the pulleys are connected to the first mobile portion and the ropes are respectively connected at an extremity to the upper and lower ends of the second mobile portion and at the opposite extremity to the fixed portion of the frame and they wind around the pulleys, so that a displacement of the first mobile portion with respect to the fixed portion, corresponds to a displacement that at least doubles that of the second mobile portion.

[0013] The main advantage offered by the invention is that of minimising the bulk of the apparatus in a vertical direction considerably facilitating the transportation and movement operations. The bulk in a vertical direction is in particular reduced substantially of a half thanks to the use of portions of the mobile frame that are connected to one another so as to realize a displacement multiplication system. Consequently, for the same vertical stroke

of the first mobile portion of the frame it is substantially possible to (at least) double the displacement (and the length) of the sampler used in the longitudinal direction.

[0014] When operating, the particular configuration of the system of movement of the mobile portions is such as to reduce of a half the traction loads on the ropes, making it possible to use ropes with a smaller section that make the construction of the apparatus lighter and more cost-effective.

[0015] The core sampling apparatus of the invention is also provided with a plurality of stabilizer feet connected at the base and adapted to pivot with respect to it by way of linear actuators. The stabilizer feet are mobile from a position for transporting and/or transferring the device from the water surface to the underwater bed, in which they are substantially aligned with the frame in a longitudinal direction, to a work position, in which they radially project from the frame outwards, substantially perpendicular to the frame or even further rotated. This solution makes it possible to keep the dimensions of the base of the frame to the minimum, having however, a wide resting base when the apparatus is working.

[0016] The stabilizer feet are also mobile independently from one another, thus making it possible to carry out single adjustments of the support points which allowing for easily obtaining a substantially flat arrangement of the apparatus compensating for the irregularities of the underwater bed.

[0017] According to a further aspect of the invention, the core sampling apparatus comprises a connection system of the core sampler that makes it possible to disconnect the latter from the frame if it is impossible to carry out the extraction due to circumstances beyond control. This makes it possible to protect the core sampling apparatus, wasting only a relatively inexpensive part if necessary.

[0018] Further advantages and characteristics of the core sampling apparatus according to the present invention shall become clearer to the men skilled in the art from the following detailed and non limiting description of one of its embodiments with reference to the attached drawings, in which:

- figure 1 is a schematic perspective view of a core sampling apparatus according to the invention in a work configuration;
- figure 2 is a front view of the apparatus of figure 1 with the core sampler partially inserted in the soil of an underwater bed;
- figures 3a and 3b schematically show the working of the mobile portions of the frame of the apparatus of figure 1; and
- figure 4 is a partial view showing a longitudinal section of the core sampling apparatus taken along the line IV-IV of figure 1.

[0019] With reference to figures 1 and 2, the core sampling apparatus 1 according to the invention comprises

a core sampler 2 and a frame 3 adapted to support the sampler 2. The frame 3 comprises a base 3a on which two first linear actuators 4 are arranged having also the function of uprights, consisting - in the example shown in the figures - of two double-acting hydraulic cylinders, at the free end of which a first mobile portion 3c is linked, configured as a crosspiece, adapted to support the core sampler 2 and to move it in a vertical direction to allow it to be driven into an underwater bed and be extracted from it. A plurality of bars 3b with a protection function can rise, like in the illustrated example, from the base 3a, parallel and spaced apart with respect to the actuators 4.

[0020] The core sampler 2 is not directly connected to the first mobile portion or carriage 3c of the frame 3, but is mounted on a second mobile portion 3d (or carriage) of the frame 3 slidably linked to the first mobile portion 3c.

[0021] In particular, the first mobile portion 3c is provided with a pair of vertical uprights 3c', 3c'' that extend from it in a vertical direction towards the base 3a of the frame 3. At the lower and upper ends of each upright 3c', 3c'' some pulleys 5a, 5b are respectively arranged adapted to engage with the ropes 6a, 6b.

[0022] The mobile portion 3d of the frame 3 is arranged between the vertical uprights 3c', 3c'' and is respectively connected to the ropes 6a, 6b at its lower and upper free ends. From the respective points of connection with the carriage 3d, the ropes 6a, 6b wind around the pulleys 5a, 5b arranged at the ends of the vertical uprights 3c', 3c'' and connect to the fixed portion of the frame 3 at a pair of plates 7 respectively linked to the upper ends of the body (that is the part that is fixed with respect to the base 3a) of the linear actuators 4.

[0023] Due to the connections between the first and the second mobile portion 3c, 3d the displacement of the second mobile portion 3d with respect to the fixed portion of the frame 3 is greater, and in particular double, with respect to the displacement of the first mobile portion 3c, thus making it possible to minimize the bulk of the core sampling apparatus 1 in a vertical direction. Consequently, for the same stroke of the linear actuators 4, it is in fact possible to double the depth of driving the core sampler 2.

[0024] In a transport configuration (not shown), the core sampler 2 is not mounted on the apparatus and the linear actuators 4 are completely retracted keeping the first mobile portion 3c of the frame 3 at the upper ends of the actuators themselves, acting, as mentioned, also as structural support upright elements. In such a way the dimensions of the core sampling apparatus 1 in a vertical direction are minimized.

[0025] Again with reference to figures 1 and 2, in order to carry out a core sampling, the linear actuators 4 are completely extended in a vertical direction moving the first mobile portion 3c away from the base of the frame 3. In this position it is possible to connect, to the second mobile portion or carriage 3d, the core sampler 2, that is thus completely housed inside the frame 3 with the lower end near to its base 3a.

[0026] Once the sampler 2 has been mounted, the actuators 4 are progressively retracted, thus causing the sampler 2 to be driven and progressively forced down into the soil G of the underwater bed. The descent of the core sampler 2 is guided by means of a suitable hole 3a' formed in the base 3a. On the mobile portion 3d of the frame, a hammer or vibrator H is also arranged making it possible to exert a driving-in effect on the sampler 2, with the purpose of facilitating its forcing down into the soil G. Therefore, the driving-in can be due to gravity, due to hydraulic thrust, combined thrust and vibration or drilling.

[0027] With reference now to figures 3a and 3b, which schematically show the mobile portions 3c, 3d connected to the linear actuators 4, the operation of the displacement multiplication system shall now be described in greater detail.

[0028] From a configuration of the core sampling apparatus 1 like that shown in figure 3a, in which the first mobile portion 3c is completely lifted with respect to the base 3a of the frame 3, the return movement of the linear actuators 4 causes a displacement of the first mobile portion 3c downwards, or rather towards the base 3a and the soil G. The ropes 6a that connect the lower end of the carriage 3d to the frame 3 are placed in tension by hauling the second mobile portion 3d downwards.

[0029] Since the portion of rope 6a arranged between the uprights/actuators 4 of the frame 3 and the uprights 3c', 3c" is connected to the fixed portion of the frame 3, a displacement S of the first mobile portion 3c causes a displacement of equal amount of each pulley 5a, as well as a rotation thereof, with respect to the fixed portion of the frame. Due to the "lever" effect exerted by the diameter of each pulley 5a during the rotation, such a displacement is doubled at a point that is diametrically opposite to the point of contact between each pulley 5a and the portion of each rope 6a linked to the frame 3. In other words, the portion of rope 6a that connects each pulley 5a at the lower end of the second mobile portion 3d carries out a double displacement than that which the first mobile portion carries out towards the base 3a of the frame 3, thus causing a double displacement 2S of the second mobile portion or carriage 3d towards the base 3a.

[0030] As shown in figure 3b, the same displacement multiplication effect also occurs during the extraction movement of the sampler 2 from the soil G of the bed. Indeed, the upper end of the second mobile portion 3d is connected to the fixed portion of the frame 3 through the ropes 6b, that wind around the pulleys 5b arranged at the upper ends of the uprights 3c', 3c" of the first mobile portion 3c, obtaining the same aforementioned system of constraints. Therefore, a displacement of the first mobile portion 3c in a direction away from the base 3a and from the soil G leads to a displacement that is double than that of the second mobile portion 3d of the frame 3 in the same direction.

[0031] The aforementioned system of constraints also

makes it possible to advantageously reduce of a half the traction force borne by the ropes 6a and 6b if compared to the fixing in/extraction force exerted by each linear actuator 4, making it possible to use ropes with a smaller diameter. Indeed, for each upright 3c', 3c" the driving-in or extraction force transmitted by the linear actuators 4 to the second mobile portion is symmetrically divided amongst the portion of rope 6a or 6b arranged between each pulley 5a or 5b and the fixed portion of the frame 3, and the portion of rope 6a or 6b arranged between each pulley 5a or 5b and the lower or upper end of the second mobile portion or carriage 3d.

[0032] Depending on the predicted driving-in and extraction forces, and due to reasons of reliability and safety, the core sampling apparatus can advantageously use a plurality of ropes 6a, 6b operating in parallel and a plurality of pulleys 5a, 5b.

[0033] With reference again to figure 1, it can be seen that the base 3a of the frame 3 has rather small dimensions, that are substantially reduced to the minimum necessary to arrange the linear actuators 4 that advantageously also have the structural function of uprights.

[0034] In order to permit a suitable resting on the sea bed, the core sampling apparatus 1 of the invention is provided with a plurality of stabilizer feet 8, three in the example shown in the figure, pivoted to the base 3a and movable with respect thereto between a transport and transfer position from the water surface to the underwater bed, in which they are substantially aligned with the frame 3 in a vertical direction, and a work position, in which they are substantially perpendicular to the frame, or also beyond.

[0035] In order to allow for the movement of the stabilizer feet 8 with respect to the frame 3, the core sampling apparatus 1 comprises a plurality of second linear actuators 9, respectively associated with each foot 8. The second linear actuators 9 are configured so as to allow an overall rotation of the respective feet 8, starting from the transport and transfer position in which they are lowered parallel to the frame 3, comprised between 0° and 110°, so as to make it possible to arrange the core sampling apparatus 1 perfectly levelled, compensating for possible irregularities in the sea bed.

[0036] The hydraulic and electrical connections necessary for the working of the core sampling apparatus according to the invention are advantageously housed in a water-proof container 10 mounted on the frame 3.

[0037] According to a further aspect of the invention, the sampler 2 is connected in a removable fashion to the mobile portion or carriage 3d of the frame 3 to make it possible to disconnect the core sampling apparatus 1 from the sampler 2 in case in which it is impossible to extract the sampler 2 from the soil G.

[0038] As shown in figure 4, the second mobile portion 3d comprises clasp means 11 arranged at the lower end thereof and the core sampler 2 comprises a pin 12 having a shape suitable to couple with the clasp means 11.

[0039] Advantageously, the clasp means are pivoted

on the second mobile portion 3d, allowing for the core sampler 2 to connect to the core sampling apparatus 1 without having to completely lift the first mobile portion 3c of the frame 3.

[0040] The core sampler 2 can be for example rested on the ground and connected to the clasp means 11 in a position that is substantially horizontal. Only subsequently the linear actuators 4 are driven, lifting the sampler 2 and making it rotate in a vertical position to proceed with the core sampling operations.

[0041] This configuration, which can be used also more in general in a core sampling apparatus with a different overall configuration, is also advantageous during the step of extraction of the samples. Indeed, once the sampler 2 has been extracted from the soil and the core sampling apparatus 1 has been recovered from the sea bed, it is possible to rotate the sampler 2 outwards from the frame 3 and retract the linear actuators 4 until the sampler is brought back into a horizontal position, for example on the ground. It is then possible to easily disconnect the sampler 2 from the clasp means 11 without having to support the weight of the sampler 2 and of the material contained in it.

[0042] The embodiment of the invention described and illustrated thus far constitutes only an example which can undergo numerous variants. For example, there could be more than three stabilizer feet 8, e.g. five, with the purpose of conferring an even greater degree of stability to the core sampling apparatus. Moreover, the core sampling apparatus 1 can be equipped with a system for controlling and monitoring the operation, comprising inclination sensors, video cameras, spot lights and the like, as well as a remote control for the operator, thus allowing effective remote control that is substantially independent from the type of support vessel. Again, by adopting different transmission systems, making use for example of a system of ropes and pulleys arranged between a plurality of mobile portions (for example a second and a third mobile portion displaceable with respect to the first mobile portion) displacement multiplications can be obtained that can exceed the doubling.

Claims

1. A core sampling apparatus (1) comprising a core sampler (2) and a frame (3) adapted to support said sampler (2), said frame (3) comprising a base (3a), a first mobile portion (3c) of the frame (3) being linked to said base (3a) by way of a plurality of linear actuators (4) arranged thereon, **characterized in that** it further comprises at least one mobile second portion (3d) adapted to support the sampler (2) and slidable with respect to the first mobile portion (3c), the apparatus further comprising drive means arranged between the mobile portions (3d, 3c), adapted to realize a displacement multiplication system for multiplying the displacement of said sampler with respect to the

displacement of said first mobile portion (3c).

2. The apparatus according to claim 1, wherein said drive means comprise a pulley and rope system (5a, 5b, 6a, 6b), wherein the pulleys (5a, 5b) are connected to the first mobile portion (3c) and the ropes (6a, 6b) are respectively connected at an extremity to the upper and lower ends of the second mobile portion (3d), and at the opposite extremity to the fixed portion of the frame (3), winding around the pulleys (5a, 5b)
3. The apparatus according to claim 2, wherein the first mobile portion (3c) comprises a pair of uprights (3c', 3c'') projecting towards the base (3a) of the frame (3) in a vertical direction, the pulleys (5a, 5b) being respectively arranged at the upper and lower ends of each upright (3c', 3c'').
4. The apparatus according to claim 3, wherein the ropes (6a, 6b) are connected to the fixed portion of the frame (3) by means of a pair of plates (7) respectively linked to the upper ends of the body, that is the part which is fixed to said base (3a), of said linear actuators (4).
5. The apparatus according to one of the previous claims, wherein the base (3a) of the frame (3) comprises a hole (3a') adapted to guide the lowering of the sampler (2) during the sampling operations.
6. The apparatus according to one of the previous claims, **characterized in that** it further comprises a hammer or vibrator (H) arranged on the mobile portion (3d) of the frame (3) and adapted to exert a propulsion effect on the sampler (2) during the sampling operations.
7. The apparatus according to one of the previous claims, **characterized in that** it further comprises a plurality of stabilizer feet (8) pivoted to the base (3a) of the frame (3) and movable with respect thereto between a transportation position, in which they are substantially aligned with said frame (3) in a vertical direction, and a work position, in which they radially project from the frame (3).
8. The apparatus according to claim 7, **characterized in that** it further comprises a plurality of second linear actuators (9) respectively associated with each stabilizer foot (8).
9. The apparatus according to claim 8, wherein said second linear actuators (9) are arranged so as to allow for a rotation of the respective stabilizer feet (8), starting from the transport and transfer position in which they are aligned with the frame (3), comprised between 0° and 110°.

10. The apparatus according to one of the previous claims, **characterized in that** it further comprises a water-proof container (10) mounted on the frame (3) and adapted to house the hydraulic and electrical connections necessary to the operation of the apparatus. 5
11. The apparatus according to one of the previous claims, **characterized in that** the sampler (2) is engaged in a removable fashion with the mobile portion (3d) of the frame (3). 10
12. The apparatus according to claim 11, wherein the second mobile portion (3d) comprises clasp means (11) arranged in correspondence to the lower end thereof, and the sampler (2) comprises a pin (12) having a shape suitable for coupling with the shape of said clasp means (11). 15
13. The apparatus according to claim 12, wherein said clasp means (11) are pivoted on the second mobile portion (3d). 20
14. The apparatus according to any of the previous claims, wherein said first linear actuators (4) take up also the function of structural support uprights. 25
15. The apparatus according to any of the previous claims, wherein a plurality of protection bars (3b) stand from said base (3a), parallel and spaced apart with respect to said linear actuators (4). 30

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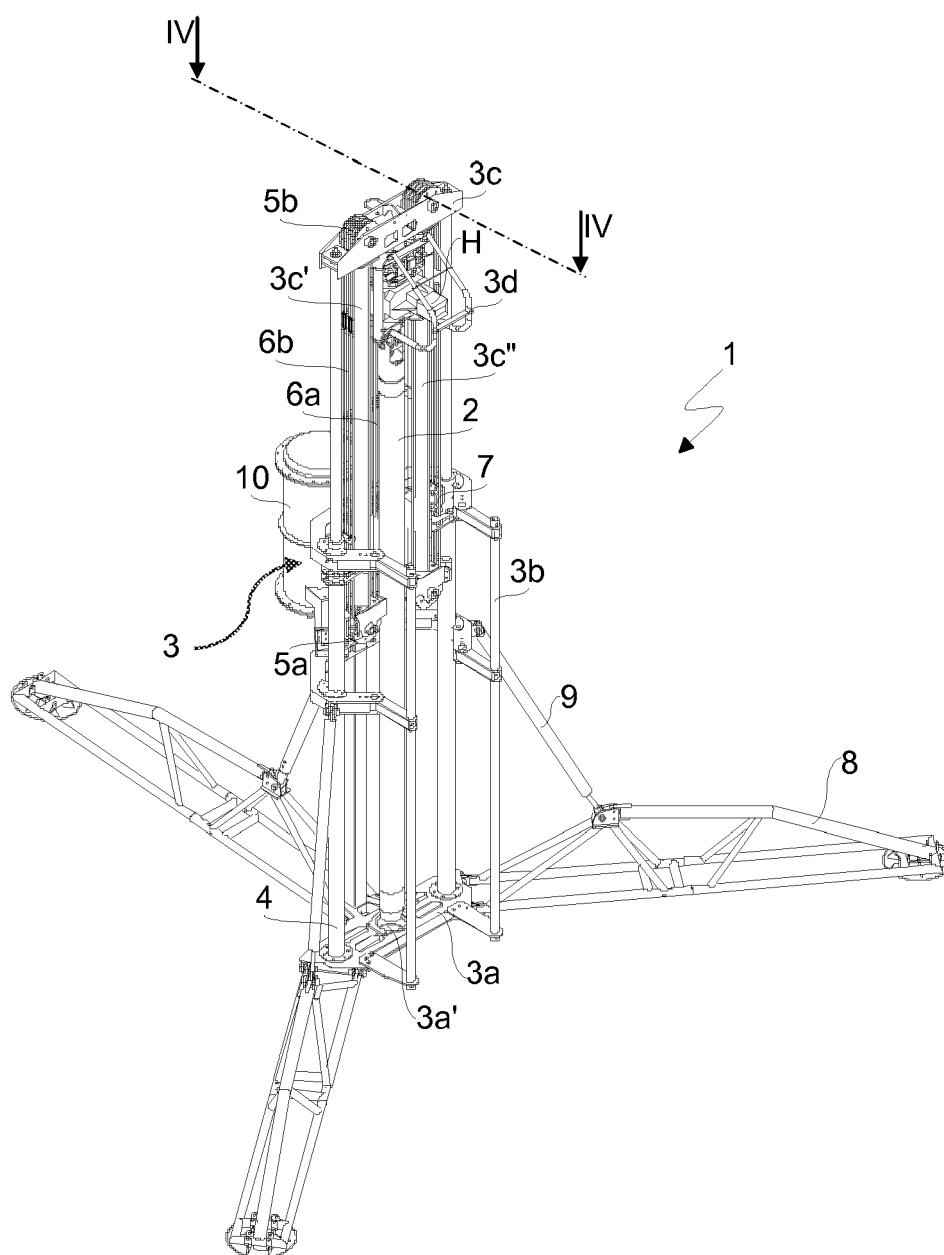


Fig.1

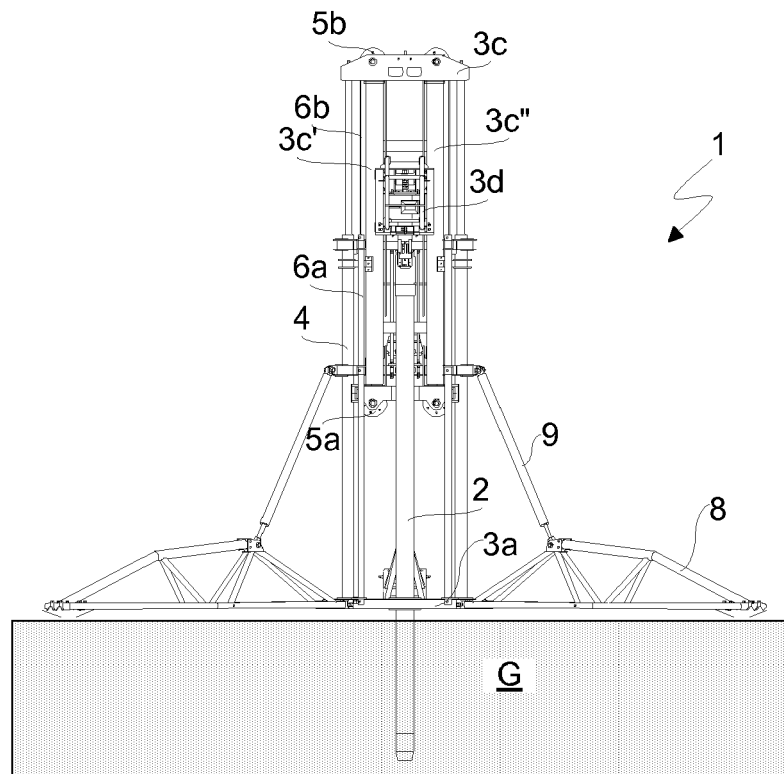


Fig.2

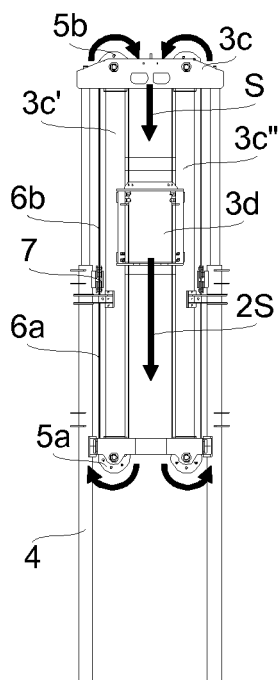


Fig.3a

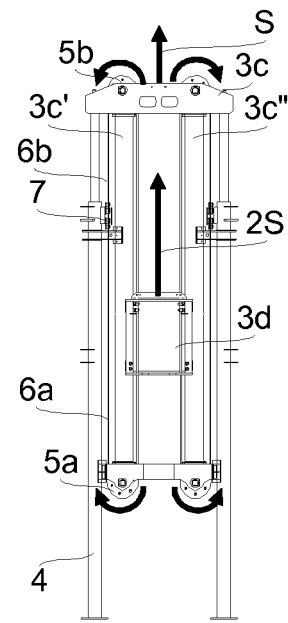


Fig.3b

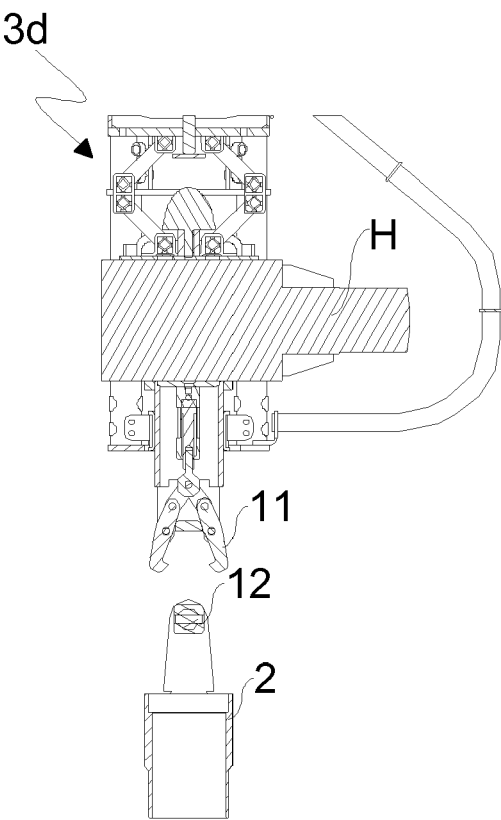


Fig.4



EUROPEAN SEARCH REPORT

Application Number
EP 10 19 6252

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 February 2011	Examiner Strømme, Henrik
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EP 10 19 6252

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14-02-2011

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