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(54) **ENGINE FOR PERFORMING SUBSEA OPERATIONS AND USE OF IT IN A CORE SAMPLER**

**ANTRIEBSMASCHINE ZUM DURCHFÜHREN VON UNTERWASSERARBEITEN UND
VERWENDUNG ZUM ANTRIEB VON EINEM PROBENNEHMER**

**MACHINE MOTRICE POUR OPERATIONS SOUS-MARINES ET SON UTILISATION DANS UN
DISPOSITIFS CAROTTIER**

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Description

The invention concerns a machine which is intended to operate at great depths by utilizing the energy which is released when surrounding water masses under great hydrostatic pressure are admitted into a low pressure reservoir via a hydraulic motor, either of the reciprocating or the rotary type, as stated in the introduction of claim 1 and claim 17.

The invention also concerns a hydrostatic sampler, especially for core samples of marine sediments, wherein the sampler comprises a substantially cylindrical head and a substantially cylindrical sampler section whose longitudinal axis passes approximately through the head's centre of gravity and wherein the sampler section comprises a sampler tube consisting of at least one sampler tube section.

Engines and machines powered by pressure energy deriving from the hydrostatic pressure of a surrounding body of water are well known in prior art. For instance, US-A- 3 418 818 discloses a hydrostatic power source which may be used for supplying power to underwater manipulators and propelling an underwater vehicle. US-A- 3 412 814 discloses a hydrostatic corer driven by the pressure differential between the hydrostatic head and a vacuum chamber. US-A- 3 436 914 discloses a hydrostatic energy accumulator which also is intended for driving a corer and operates in a comparable manner to the foregoing, while US-A- 4 215 544 discloses a method of generating deepsea rotary power by means of a turbine driven by the hydrostatic pressure differential between the surrounding body of water and an evacuated sphere.

The reason behind the invention is that the supply of, e.g., hydraulic or electrical power from, e.g., a ship to a working tool on the seabed, entails increasing difficulties as the depth increases, since transmission lines or pipes become extremely expensive, heavy, difficult to handle and vulnerable.

One possibility may be to have electrical power on site, stored in the form of batteries or eliminators, but this too will be extremely vulnerable in the environment to which the tool is exposed, and from the operational safety point of view hydraulic operation will be far preferable to electrical power.

The machine according to the invention uses an integral low pressure reservoir as a "hydrostatic accumulator", the energy which is released when the surrounding liquid is admitted into the low pressure reservoir under controlled conditions being determined by the product of the pressure difference and the internal volume of the low pressure reservoir.

For example, a low pressure reservoir with an internal volume of 1 m³ and approximately empty of gas, when lowered to a depth of 2000 metres (corresponding to a pressure of approximately 20 MPa) will be capable of releasing a pressure energy from surrounding water masses of 20 x 10⁷ Nm, or approximately 5.5 kWh. The

energy thus available will increase in proportion to the water depth and in proportion to the volume of the low pressure reservoir.

The invention concerns with various different arrangements for the utilization of this energy, together with various relevant applications.

Hydrostatic samplers are used to take core samples of the sediments in deep sea reservoirs. Such core samples are of great interest with regard to paleoceanography and paleoclimatology, since deep sea sediments consist mainly of deposits resulting from the biogenic activity in the water masses. Small calcareous and siliceous organisms accumulate on the seabed at a rate of approximately 1 cm in the course of 1,000 years. The fauna and flora populations in the water masses are adapted to the special temperatures and salinities which exist at any given time, and their fossil deposits therefore bear testimony to the physical properties of the water over the ages. In the course of the 1970's it became possible to transfer the paleontological information on the relative frequency of species and their preferred temperature range via a mathematical transfer function to paleotemperatures for the sea water with an accuracy of 0.50°C. The use of the oxygen-isotope method also provides a temperature indication as well as a measurement of the global ice volume. Used on sediment cores from deep sea reservoirs, these methods have formed the basis for major international research programmes aimed at integrating all biological information on the climatic conditions in the Quaternary Period, and particularly the global climatic changes which have taken place since the last ice age maximum approximately 20,000 years ago. In recent years this research has gained additional relevance in connection with problems allied to the alleged effects of anthropogenically produced climatic changes.

By taking core samples of the upper sedimentary layer in deep sea reservoirs, and up to the upper part of the continental shelf, by using a core length of approximately 10-12 m, a record can be obtained of the geological and paleontological history over a period of approximately 1,000,000 years. Since the core samples do not require to be of greater length than this and moreover the sedimentary layers are not especially hard, a hydrostatic sampler is well-suited to this purpose. The use of hydrostatic samplers entails driving a sampler tube down into the sedimentary layer under the influence of the hydrostatic pressure, i.e. the water pressure at the depth at which the sample is taken. Furthermore it is possible to make hydrostatic samplers particularly light and simple in design compared with samplers which require an external power supply, via, e.g., mechanical or hydraulic motors or with a built-in motor of some kind. There is also a special advantage with this feature of hydrostatic samplers, since the surveys often take place in distant waters and extremely demanding environments, where it is a considerable advantage to have equipment which is easy to transport and operate.

There are a number of known gravitation samplers which fulfil these conditions to some degree, but if they are to obtain a satisfactory depth of penetration, they have to be relatively heavy as they require a ballast in the order of around 1,000 kg.

From the periodical Marine Geology, volume 54 (1983/1984, pages M33-M41), there is known an active hydrostatic sampler developed by F. W. McCoy and S. Selvin in 1981. Selvin and McCoy's sampler uses a hydrostatic piston engine which via an internal pulley system is used to lift a drop weight which is then dropped and drives the sampler tube down into the sedimentary layer. The cycle is repeated until the hydrostatic energy potential is exhausted. Some of the available hydrostatic energy, however, helps to lift the drop weight and moreover the lifting arrangement with pulleys and rope entails a constructional complication.

The object of the present invention is to provide an active hydrostatic sampler which represents an improvement over and increases the efficiency of Selvin and McCoy's known sampler. By using the pressure reservoir as a housing for the complete system, including the valve control, all sensitive components can be safely housed in the pressure reservoir's container. Together with its contents, this constitutes the mass which is used as a pile-driver. At the same time the piston in the hydrostatic motor is used directly to run the lifting and dropping operations, thus minimising the losses during the energy conversion. When the pressure reservoir which forms the sampler's head is lifted, a downward directed recoil effect is obtained, and this again causes a double-acting effect which further contributes to the improvement of the present sampler over the prior art. The hydrostatic sampler according to the present invention thus offers a number of advantages in comparison with the known sampler. Compared to Selvin and McCoy's sampler, the sampler according to the present invention provides a greater ratio between drop weight and hammer mass, a higher pump pressure, thus avoiding the need for power transfer and a greater lifting acceleration, which gives a substantial recoil effect, since the lifting acceleration is of the same order as the drop acceleration, which provides a doubling of the force of impact per blow. At great depths, moreover, the lifting forces become even more predominant. In addition the sampler according to the present invention is directly activated by the surrounding sea water, while Selvin and McCoy's sampler uses a membrane and hydraulic oil as a moderator. The sampler according to the invention can therefore be expected to give substantially lower internal losses.

The hydrostatic machine according to the invention is characterized by the features and improvements disclosed in the claims 1-18, the reference numbers in these claims corresponding to the reference numbers in figs. 1-9, while a sampler according to the present invention is characterized by the features and improvements disclosed in the claims 19-31, the reference num-

bers in these claims corresponding to the reference numbers in figs. 10-18.

The invention will now be described in more detail with reference to drawing figures. In particular will an embodiment of the invention in the form of a hydrostatic sampler be taken as an example, since the sampler can be regarded as a special case of the hydrostatic machine according to the invention. In connection with the description of the sampler, reference will be made to figures 10-18 of the drawing.

Fig. 1 shows schematically the general principle of the present invention.

Fig. 2 is an arrangement wherein an axial piston motor is provided in a low pressure chamber.

Fig. 3 is a more refined version of the arrangement in Fig. 2.

Fig. 4 is an arrangement with a separate, closed hydraulic system.

Fig. 5 illustrates an embodiment of the invention as an impact device or percussion drill.

Fig. 6 illustrates an embodiment of the invention as a sampler for taking core samples of marine sediments on the seabed.

Fig. 7 illustrates an embodiment of the invention for driving an anchor 70 down into sediments on the seabeds.

Fig. 8 illustrates another embodiment of a "hydrostatic anchor".

Fig. 9 illustrates schematically an application of the hydrostatic machine of the invention for providing propulsion of a subsea vehicle.

Fig. 10 is a basic view of a sampler according to the present invention.

Fig. 11a illustrates a preferred embodiment of a deep water version of the sampler according to the present invention.

Fig. 11b illustrates a preferred embodiment of a version of the sampler according to the present invention for shallow water.

Figs. 12a and 12b illustrate a preferred embodiment of the hydrostatic operating mechanism.

Figs. 13a and 13b illustrate another preferred embodiment of the hydrostatic operating mechanism.

Figs. 14a and 14b illustrate details of the embodiment in figs. 13a and 13b.

Fig. 15 illustrates schematically the lowering of the hydrostatic sampler according to the present invention.

Fig. 16 illustrates the sampler in fig. 15 ready for operation.

Fig. 17 illustrates the sampler in fig. 16 during operation.

Fig. 18 illustrates schematically the sampler in operation with full penetration of the sampler tube in the sedimentary layer.

Fig. 1 shows schematically the general principle of the present invention and the basic connection of its main components. A hydraulic motor 2 is connected to the surrounding water masses over an intake valve 4

and a fluid filter 5. The hydrostatic pressure of the surrounding water masses leads water through the filter 5 and the valve 4 into the motor 2 which is adapted to converting the pressure energy of the through-flowing fluid into pressure energy which may be used by a work tool 1 connected with the motor 2. The spent working fluid of the motor 2, i.e. the water now at a substantially lower pressure than the surrounding hydrostatic pressure, is conveyed to a low pressure reservoir 3. It is to be understood that the low pressure reservoir 3 is essentially free of gases other than water vapour, such that the pressure in the low pressure reservoir is limited to the water vapour pressure throughout operating period of the motor 2, this operating period being determined by the cycle capacity of the motor 2 and the capacity of the low pressure reservoir. In each work cycle of the motor a certain amount of water at the surrounding hydrostatic pressure is depressurized and emptied to the low pressure reservoir. The operating cycles of the motor 2 continue until the low pressure reservoir is full of water.

A particular embodiment of the general principle of the invention is shown in Fig. 2, wherein the hydraulic motor 2a is provided in a low pressure chamber 11. The low pressure chamber 11 is rigidly connected with a high pressure cylinder 12 which forms part of the hydraulic motor 2a which further consists of a piston 15 and a piston rod 16. The high pressure cylinder 12 is divided in two cylinder volumes 120a and 120b on either side of piston 15. During operation the cylinder volumes 120a and 120b are brought into alternating connection with the surrounding water masses via valves 13a and 13b and with the low pressure chamber 11 via valves 14a, 14b such that the hydraulic motor 2a now acts as a water-driven axial piston motor and a pulsating movement will be imparted to the piston 15 and the piston rod 16.

In the arrangement depicted in Fig. 3 the hydraulic piston motor 2a is connected with a piston pump 20 comprising a second piston 21 at the end of the piston rod 16 and provided in the second cylinder 22 which is rigidly connected with and has the same center axis as the first cylinder 12. Separate cylinder volumes above and below the piston 21 is connected to the surroundings over two non-return valves depicted on the right hand of the cylinder 22 and with a second hydraulic motor 2b via two non-return valves depicted on the left side of the cylinder 22. The axial pump may now be used for driving the second hydraulic motor 2b which may be equipped with a work tool 1. The second hydraulic motor 2b may be of either the reciprocating or the rotary type, for instance a turbine. In the same way as the axial hydraulic piston pump 2a empties to a low pressure reservoir 3 or low pressure chamber 11, the second hydraulic motor 2b empties to an external low pressure reservoir 3b. It will be seen that the medium displaced by the axial pump 20 is the surrounding liquid and that the pump operates as an open system which "consumes" the surrounding liquid. The choke valve 18 and an accumulator 19 are provided between the valves 4 and

13a, 13b, in order to equalize the flow of the surrounding liquid through the filter 5.

Fig. 4 shows a further embodiment of the invention with a separate, closed hydraulic system. The piston pump 20 and a hydraulic engine 31, preferably a rotary engine now together with the accumulators 32 and pressure control valves comprise a closed system which is operated by a separate hydraulic medium, for instance a suitable hydraulic oil, while only the hydraulic piston motor 2a still uses the surrounding water as its operating medium. The accumulators, one of which is indicated by 32 and the pressure regulating valves, one of which is indicated by 33 respectively are used for equalizing the supply pressure of the axial pump 20. In order to ensure a smooth operation of the primary hydraulic motor 2a, the low pressure chamber 11 is connected with an accumulator 40 and an additional low pressure reservoir 3 via a pressure regulating valve 41. The additional low pressure reservoir 3 may be used for extending the operating period of the engine in Fig. 4 as the connection between the low pressure chamber 11 and the reservoir 3 may be engaged or disengaged according to need. The valve 41, of course, controls the differential pressure between the chamber 11 and the reservoir 3, being a differential pressure limiting valve.

Fig. 5 shows the hydrostatic engine according to the invention embodied as an impact device or percussion drill. The high pressure cylinder 12 is now arranged with its longitudinal axis approximately perpendicular to the seabed and the piston rod 16 is rigidly connected with an impact device with the same longitudinal axis as the piston rod 16. The lower chamber 120b in the high pressure cylinder 12 has a permanently open fluid connection with the low pressure chamber 11 and a constantly closed fluid connection with the external pressure, while only the upper chamber 120a in the high pressure cylinder 12 is adapted to provide an axial motor action. The valve 13a opens at a first stroke, while valve 14a is kept closed and hence the piston 15 is imparted a downwards directed movement and imparts a downwards directed impulse to the impact device 17. Simultaneously the cylinder 12 with the low pressure chamber 11 is given an upwards directed reaction movement. At the next stroke the valve 14a opens, while valve 13a is kept closed and the low pressure chamber 11 and the high pressure cylinder 12 are now imparted a dropping movement that ends with a second downwards directed impulse to the impact device 17, whereafter the first stroke once more is repeated. The cycles repeat until the low pressure reservoir 11, 3 is full or the intake valve 4 is closed. As mentioned the impact device 17 may be a percussion drill, but a person skilled in the art will see that it is possible to convert the downwards directed pulsation or stroke at least partially to a rotational movement via a per se known mechanical movement converter 170 attached to the drill stem. As shown in Fig. 6, the axial pump 20 may be used for operating a hydraulic rotary motor 50 which imparts a rotational movement to

the impact or percussion device 17. The impact device 17 may form the uppermost end of a sampler tube 60 consisting of one or more sampler tube sections which are adapted for taking samples of sediments in the seabed. Hence the embodiment of the invention as rendered in Fig. 6 operates as a hydrostatic corer.

Fig. 7 shows a further embodiment of the hydrostatic machine according to the invention. In this embodiment the machine is used for driving an anchor 70 down into the sediments on the seabed. The impact device 17 forms the crown of an anchor 70 consisting of several arms 71 hinged near the crown 17 in order to offer as little resistance as possible when the anchor is driven into the seabed. The hinged arm 71 forms flukes when the anchor chain 72 is tensioned, as the arms 71 then unfolds. The anchor chain 72 is attached to the top of the low pressure chamber 11 and it is seen that the anchor device and the hydrostatic engine according to the invention forms an integral whole in which the machine's specific weight also makes a possible contribution to the effect of the anchor.

Another version of an anchor combine the hydrostatic machine according to invention is shown in Fig. 8. In this case the machine is equipped with a screw 17 with large threads 171 which make it possible to firmly attach the screw to the seabed by imparting a rotary movement to the screw 17. The threads 171 are driven into the sediments with a combined hammering and screwing movement caused by the hydraulic axial piston pump 20 and a rotary hydraulic motor 75 respectively. The screw may hence be used for mooring or attaching the machine or any vessel attached to the machine via e.g. an anchor chain 72 fastened to the top of the low pressure chamber 11.

Finally the machine according to the invention may be used for moving a wheeled or caterpillared vehicle 100 on the sea bed, in which case the vehicle 100 may be thought of as the machine 1 according to the invention. A hydraulic motor 8 is connected either directly with hydraulic motor 2a or the axial pump 20. In this case the hydraulic motor 80 is preferably a rotary engine used for imparting a rotary movement to rolling wheels or the driving wheels of a caterpillar and thus providing the necessary tractive force for the vehicle to move on the seabed. In this case the hydraulic motor 80 will be equipped with suitable speed regulating means and allow for the steering and the speed of the vehicle to be controlled.

Fig. 10 illustrates schematically the sampler according to the present invention. The hydrostatic sampler comprises a pressure reservoir 1 which forms the head of the sampler and which is composed of sections, thus enabling the volume of the pressure reservoir to be regulated according to the number of sections used in the embodiment. Within the pressure reservoir 1 there is provided a high pressure cylinder 13 attached to the walls of the pressure reservoir. The high pressure cylinder has a high pressure chamber which via openings

133 and 134 is connected with a low pressure chamber 14 which is formed by the upper volume of the pressure reservoir 1, and via an inlet valve 11 in connection with the outside of the pressure reservoir. Furthermore the high pressure chamber 130 constitutes the cylinder of a pump device which in reality is the sampler's motor, there being provided in the high pressure chamber 130 a first piston 131. This piston 131 is rigidly connected via the piston rod with a second piston 21 in a secondary pump system 2 which is fitted to an extension of the pressure reservoir 1. The object of the second piston 21 is first of all to cause the transfer of impact, or the lifting movement between the pressure reservoir 1 and a sampler section 3 which comprises the sampler tube 30, and secondly to provide a secondary pump system 2, in which the pump cylinder 2 can be emptied into the environment or used to inject water into the conduit 35 in order to provide lubrication of the sampler tube 30 via a three-way valve 22.

In the low pressure chamber 14 of the pressure reservoir 1 there is further provided a pressure relief valve 10 to the environment, while an equalization of pressure is obtained in the non-active cylinder volume in the secondary pump system 2, via opening 203 and three-way valve 22 respectively. The top plate of the pressure reservoir 1 is provided with an eye-bolt for the attachment of lines, while the pressure reservoir's top and bottom plates are attached by means of assembly bolts 7. The fitting of further sections to the pressure reservoir 1 can then be performed very easily by loosening the top or bottom plate of the pressure reservoir 1 and fitting the required number of extra sections, the length of the assembly bolts used naturally corresponding to the required length of the pressure reservoir 1.

Figures 11a and 11b illustrate in more detail a preferred embodiment of the hydrostatic sampler according to the invention. Fig. 11a illustrates a deep water version of the sampler, wherein the internal volume of the high pressure chamber 130 in the high pressure cylinder is reduced by the insertion of a lining 135, as is more clearly illustrated in fig. 12a. The ratio between the volume of the low pressure chamber 14 and the high pressure chamber 130 is thereby increased, thus enabling a correspondingly larger number of strokes to be achieved at great depth under a greater hydrostatic pressure, the number of impacts obviously being determined by the ratio between the chamber volumes. Fig. 11b illustrates a shallow water version of the hydrostatic sampler and, apart from the lining in the high pressure chamber 130, is exactly the same as the version in fig. 11a. On the outside of the pressure reservoir 1 there are provided protective bars 4 and between these and the pressure reservoir 1 or the head there is installed a water filter which is connected with the inlet valve 11. This inlet valve 11 is closed during lowering and not opened until the sampler is in position on the seabed and ready for use, via, e.g., a line-triggered manoeuvring device 110 for the inlet valve 11. The high pressure cylinder 13 is

illustrated in more detail in figures 12a, 12b, 13a and 13b. Around the upper section of the high pressure cylinder 13 there is provided a sleeve-shaped slide valve 15 which can be moved axially around the upper section of the high pressure cylinder. The valve housing 15 is provided with an inlet opening 150 which communicates with a corresponding inlet opening 133 in the high pressure cylinder 13 when the slide valve is located in an upper position on the high pressure cylinder, at the same time as the piston 131 in the high pressure cylinder is located in a starting position. The inlet opening 150 on the slide valve 15 is further connected with the inlet valve 11 via a flexible hose 12. When the sampler is positioned on the bottom, the manoeuvring device 110 is triggered, the inlet valve 11 opened and water under the surrounding pressure streams through the flexible hose 12 and into the high pressure chamber 130, the piston 131 in the high pressure cylinder as shown in, e.g., fig. 12a or 13a, being located in the starting position and the slide valve 15 in an upper position. The water which now flows into the high pressure chamber 130 under the hydrostatic pressure drives the piston 131 downwards and a corresponding movement of the connected piston 21 in the attached secondary pump system is obtained, this piston 21 also being in the upper starting position, as is most clearly illustrated in fig. 11a. In the starting position the slide valve 15 is kept pressed against the upper part of the high pressure cylinder 13 by a compression spring mechanism 16 which is arranged to work in conjunction with the piston 131, which will be explained in more detail in the following section.

A first embodiment of the compression spring mechanism 16 is illustrated in fig. 12a, where the piston 131 is located in the starting position and in fig. 12b, where the piston is located in the final position. The compression spring mechanism here comprises a helical spring which is placed in a spring housing 162 and fitted around a spring bolt 161. The spring bolt 161 is passed through a fixed circumferential disc 151 on the slide valve 15 and a fixed locating disc 132 arranged on the piston rod at the bottom of the piston 131. The spring bolts are provided parallel to the piston and the spring housing 162 is installed in the high pressure cylinder 13 beside this, as illustrated in fig. 12a or fig. 12b. On the end of the spring bolts are fitted stop nuts 163 and 164. In the starting position of the piston 131, the slide valve is kept pressed into its upper position by the compression spring 160 by means of the capture disc 132 which causes the spring housing to abut against the stop nut 164, thus causing the tension in the compression spring 160 to be completely relaxed and the upper stop nut 163 on the spring bolt 161 to abut against the circumferential disc 151 on the slide valve 15 and to draw this with it into a lower position, thus interrupting the communication between the inlet openings 133 and 150 and stopping the flow of water to the high pressure chamber 130. Thus when the tension on the compression spring 160 is relaxed, a tension spring 170 which is attached to the

high pressure cylinder 13 and the slide valve 15 is pulled into a lower position and the outlet opening in the high pressure chamber 130 is now connected with the low pressure chamber 14 and emptied into it. The pressure in the high pressure chamber 130 is thereby equalized to the pressure in the low pressure chamber 14, which initially, e.g., is under atmospheric pressure. Under the weight of the pressure reservoir 1 or the sampler's head and if the pressure in the high pressure chamber 130 is equalized, the piston 131 now returns from the starting position to the final position, while at the same time the capture disc 132 once more abuts against the valve housing 160 and stretches the compression spring 160 which via the circumferential disc 151 again presses the slide valve into the upper position and creates a connection from the inlet valve 111 and through the openings 150 and 133 to the high pressure chamber which is filled once again, whereafter the piston stroke is repeated. The tension spring 170 which is considerably weaker than the compression spring 160 is again stretched during this operation, but naturally cannot counteract the return movement of the slide valve 15. Thus it can be seen that the slide valve 15, together with the openings 133, 134 and 150 constitute a valve mechanism for the high pressure cylinder 130 which, together with the piston 131 in reality constitute a hydrostatic motor for the operation of the sampler. Figures 13a and 13b illustrate a second embodiment of the spring mechanism for manoeuvring the slide valve 15, fig. 13a illustrating the piston 131 in the starting position and fig. 13b the piston in the final position. Furthermore, figs. 13a and 13b correspond to figures 11a and 11b respectively and describe the same embodiment as illustrated there. Here too, parallel to piston 131 beside the high pressure cylinder, there is provided a spring bolt 161 which is passed through an opening on the side of the high pressure cylinder, and through the circumferential disc 151 with which it is permanently connected. During a piston stroke when the chamber 130 is filled, the capture disc 132 abuts against the stop nut 164 at the end of the rod and compresses the spring 160a against the circumferential disc 151 on the valve housing 15, which under the influence of the spring 160a is pressed against its lower position. At the same time the capture disc 132 also abuts against a stop nut 194 on the end of a camshaft 190, which similarly is arranged parallel to the first piston 131 on the outside of the high pressure cylinder 13 and passed through an opening on the side of this. On the camshaft 190 there is provided a cam disc 191, the camshaft and cam disc thus constituting a cam mechanism which can engage with cam groove 182 on a ratchet mechanism 18. The blocking mechanism 18 is located in the starting position of the slide valve 15 in blocking abutment against the circumferential disc 151, but the blocking is cancelled when the camshaft 190 is pulled with the capture disc 132, thus cancelling the engagement between the camshaft 191 and the cam groove 182 in the ratchet mechanism. The slide valve 15 there-

by moves without hindrance under the influence of the compression spring 160a to the lower position, while a helical spring mechanism 17 which is attached to the upper section of the high pressure cylinder 13 and the camshaft, now that the cam disc is disengaged from the ratchet mechanism, pulls the camshaft 191 upwards, thus engaging the cam disc once again with the cam groove 182 in the ratchet mechanism 18, and the slide valve 15 via the circumferential disc engages in a locking manner with a locking groove 181 on the ratchet mechanism 18. The slide valve is thereby moved by the compression spring 160a and ends in its lower position, securely locked in this position by the ratchet mechanism 18, whereby free passage is created between the high pressure chamber 130 and the low pressure chamber 14 via the opening 134, thus equalizing the hydrostatic pressure, and the piston 131 begins the return stroke back to the starting position under the weight of the pressure reservoir or head 1 and the falling pressure in the high pressure chamber 130. During the return stroke the capture disc 132 pulls the sleeve 195 which is permanently fitted on to the camshaft 190 and also the sleeve 165 on to the spring bolt 161, during which the cam disc 191 is disengaged from the ratchet mechanism 18 and at the same time the compression spring 160b is stretched. The locking of the slide valve in the lower position is thereby cancelled and it is moved under the influence of the compression spring 160b back to its upper position, while the connection between the environment and the high pressure chamber 130 via the openings 150 and 133 is reestablished, thus enabling the cycle to be repeated.

The compression springs 160a and 160b are preferably designed as Belleville springs. As already described, the springs in the helical spring mechanism 17 are a tension spring 171.

The first piston 131, as illustrated schematically in fig. 10 and in more detail in, e.g., fig. 12a, is rigidly connected via the piston rod with the second piston 21 in the secondary pump system 2, as is most clearly illustrated in figures 11a and 11b. In fig. 11a both the pistons 131 and 21 are shown in their starting positions. When the first piston 131 moves, the second piston 21 in the secondary pump cylinder 20 is moved to act upon the sampler tube which is connected to the lower end of the secondary pump piston 21 via the sampler tube adaptor 33. This can slide on the control bolt 24 which is attached in the locking ring 201 on the lower part of the secondary pump cylinder 20, and prevents the sampler tube 30 or the sampler tube adaptor 33 from rotating on the secondary pump piston 21. On the secondary pump cylinder 20 there is provided a three-way valve 22 which is opened during the lowering of the sampler and causes water to enter in under hydrostatic pressure into an annular space 202 which in the secondary pump piston's 21 starting position is created between the sliding bearing 200 on the secondary pump piston and the sliding bearing 211 on the inside of the wall of the secondary

pump cylinder 20 when the sampler is positioned on the seabed, while at the same time it is opened for the working stroke of the piston 132. The secondary pump piston 21 is forced downwards, while at the same time the inlet opening in the three-way valve 22 is closed. In its place a connection is obtained between the annular space 202 and an outlet opening in the three-way valve which is connected with a flexible hose 23. Under the influence of the secondary pump piston 21 the water is now forced out of the annular space and into the flexible hose 23 which is connected to an inlet opening in the sampler tube adaptor 33. This inlet opening in the sampler tube adaptor 33 is connected with one or more water injection conduits 35 on the side of the sampler tube. The object of these water injection conduits is to reduce the friction and provide fluid lubrication during the penetration of the sampler tube 30 into the sedimentary layer.

During the drop stroke, i.e. the return movement of the piston 131, the secondary pump cylinder 21 and thus the head 1 abut against the sampler tube adaptor 133, the secondary pump piston 21 returns to the starting position and the water is forced out via the opening 203 in the upper volume of the secondary pump cylinder 20, while the annular space 202 which is again formed during the return movement via the three-way valve 22 is connected with the environment and once again filled with water under hydrostatic pressure, after which the cycle is repeated.

The operation of the hydrostatic sampler according to the invention will be described in more detail in connection with figs. 15-18. In reality the procedures used are not substantially different from those used in gravitation samplers. In fig. 15 the sampler 1 is illustrated during lowering from, e.g., a research vessel. The head or pressure reservoir 1 is attached to the lowering line and on the sampler section 3 there is provided an attachment point for a support leg 6, which is shown closed around the sampler tube 30. Release lines 60 for the support legs are shown hanging in a slack arc around the sampler. Inside those safety bars illustrated, e.g., in fig. 11b, the sampler according to the invention will be equipped with completely different instruments, including an inclination sensor for detecting the sampler's true inclination on the seabed, a sonar device for measuring the distance to the bottom, depths of penetration and also for the transfer of information on inclination. The sonar device, which is not illustrated in more detail, but which may be, e.g., a known per se modulated pinger, indicates the distance to the bottom, thereby enabling the support legs 6 to be released and brought into position by the release line 60 before the sampler reaches the bottom, the support legs sliding along the sampler tube to abut against the sampler head 31 as illustrated in fig. 16. Any inclination indicated can now be compensated by means of the lines 60, thus allowing the sampler tube to be positioned in a substantially vertical manner. By means of the initial impact the sampler tube 30 is now driven down into the sedimentary layer as illus-

trated in fig. 17. The driving operation continues in an alternating stroke cycle until the desired depth of penetration is achieved or the hydrostatic energy potential approaches zero. This usually involves approximately 200 strokes, depending, as mentioned above, on the ratio between the volume of the low pressure chamber and the volume of the high pressure chamber. After sampling is completed, the sampler and the sampler tube with the core sample are pulled up to the surface by means of a lifting line, the pressure in the high pressure chamber 130 and the low pressure chamber 14 now being the same and identical with the surrounding hydrostatic pressure. During lifting the borehole is refilled with water to prevent the creation of a vacuum when the core sample and the sampler tube are pulled out. During lifting the pressure reservoir is decompressed via the pressure relief valve 10.

In a typical and preferred embodiment the hydrostatic sampler according to the invention weighs approximately 550 kg without the sampler tube. It is arranged to work at water depths between 200 and 6,000 m and consequently must be designed to resist the pressure forces which prevail at such depths. Depending on the water depth the number of strokes can be approximately 200 with an stroke length of approximately 350 mm. The possible penetration, depending on the nature of the sediments, can amount to up to 30 m, which means that the core sample's length is 30 m and this again means that special precautions must be taken on the mother vessel when the core sample is taken aboard. The stroke frequency used can vary from, e.g. 0.6 - 3 Hz, i. e. the actual sampling operation can be performed in the course of a few minutes or less. The stroke frequency can be adjusted via the inlet valve 111, and this is usually necessary as too high an stroke frequency results in severe dynamic loads on the piston rod. It will be obvious to those skilled in the art that there are a number of structural requirements which have to be satisfied in a hydrostatic sampler of this kind, with the purpose of operating at depths as low as 6,000 m. It is, e. g., important to dimension conduits and valves in order to avoid flow friction loss and there are naturally special requirements regarding resistance to corrosion, which can be met by the choice of the correct corrosion- and pressure-resistant materials.

The operation of the sampler can be monitored by means of a hydrophone connected to an amplifier aboard the mother vessel in order to record the sound of the impacts.

If the sampler is to be used in particularly hard sediments, the sampler head 31 can be designed as a rotary drill chisel to which a rotating motion is provided by, e. g., converting a part of the impact energy to rotary motion by means of a suitable device, and in a known per se manner. The rotary movement could possibly also be provided directly by an additional hydrostatic motor.

With regard to the sampler tube itself, it is designed in a known per se manner and composed of sections

which may, e.g., be 3 m in length. The individual sampler tube sections are connected by means of a tube section adaptor 36 which also provides fluid connection between the water injection conduits 35 inside the individual sections. In the sampler tube there is further provided a core retaining device 32 which grips the core and is pushed upwards in the tube sections during penetration.

Claims

1. A machine for performing work at great depths, consisting of at least one arbitrary work tool (1) of known per se type, at least one hydraulic motor (2) which is adapted in order to be able to be operated by the surrounding water masses, at least one low pressure reservoir (3), at least one intake valve (4) which is arranged so that the hydrostatic pressure in surrounding water masses leads water through the valve (4) via a pipe or hose connection to the motor (2) and further via a corresponding pipe or hose connection to the low pressure reservoir (3), and a per se known fluid filter (5) arranged in the surrounding water masses such that the fluid flow through the intake valve (4) to the motor (2) flows through the fluid filter (5), the motor (2) to the greatest possible extent by means of per se prior art converting the pressure energy in the through-flowing fluid into pressure energy which can be used by the work tool (1), characterized in that the at least one hydraulic motor (2) comprises a hydrostatic axial piston motor (2a) installed in communication with the low pressure reservoir (3) a low pressure chamber (11) thereof being rigidly connected with a high pressure cylinder (12) with at least two separate volumes (120a and 120b) forming an integral part of the axial piston motor (2a) and containing a piston (15) and piston rod (16) of the latter, that per se known valve devices (13a, 13b, 14a, 14b) bring one or more of the cylinder volumes (120a and 120b) into alternating communication with the surrounding water masses and the low pressure chamber (11) respectively in such a manner that the high pressure cylinder (12) acts as the working cylinder of a water-driven axial motor, imparting a pulsating or reciprocating movement to the piston (15) and the piston rod (16) provided in the high pressure cylinder (12).
2. A machine according to claim 1, characterized in that between the valves (4) and (13a, 13b) there are provided a choke valve (18) and an accumulator (19) in order to equalize the fluid flow through the filter (5).
3. A machine according to claim 1, characterized in that the low pressure reservoir (3) is approximately

free of gases other than water vapour, the pressure in the low pressure reservoir being approximately limited to water vapour pressure at the relevant temperature throughout the entire work period from the time the reservoir is empty of water until it is completely full of water supplied from the environment.

4. A machine according to claim 1, characterized in that the piston (15) and the piston rod (16) are rigidly connected with a second piston (21) provided in a second cylinder (22), that the second cylinder (22) is rigidly connected with and has the same centre axis as the first cylinder (12), and that the second cylinder (22) with the second piston (21) is equipped with per se known non-return valves, the second cylinder thus acting as an axial pump (20).

5. A machine according to claim 4, characterized in that the medium pumped by the axial pump (20) is the surrounding liquid, and that the pump operates as an open system which "consumes" surrounding liquid.

6. A machine according to claim 4, characterized in that the medium pumped by the axial pump (20) is a commercial hydraulic oil which is provided in a closed system comprising at a minimum the axial pump (20), a hydraulic motor (31) and related hose and valve connections.

7. A machine according to claim 6, characterized in that the closed hydraulic system also comprises at least one accumulator (32) and at least one pressure regulating valve (33) for equalizing the supply pressure from the axial pump (20).

8. A machine according to claim 1, characterized in that the low pressure chamber (11) is disengageably connected with an extra low pressure reservoir (3) via a hose or pipe connection, that the low pressure chamber (11) is directly connected with an accumulator (40), and that the differential pressure between the low pressure chamber (11) and the low pressure reservoir (3) is controlled by means of a differential pressure limiting valve (41).

9. A machine according to claim 1, characterized in that the high pressure cylinder (12) is arranged with its longitudinal axis approximately perpendicular to the seabed, that the piston rod (16) is rigidly connected with an impact device (17) with approximately the same longitudinal axis as the piston rod (16), that the lower chamber (120b) has a constantly open fluid connection with the low pressure chamber (11) and constantly closed connection with the external pressure, while only the upper chamber (120a) is arranged so as to provide an axial motor effect, the valve (13a) being opened at the first

stroke, while valve (14a) is kept closed, thus imparting to the piston (15) a downwards directed movement and causing a first downwards directed impulse to the impact device (17), the cylinder (12) with the low pressure chamber (11) being simultaneously given an upwards directed reaction movement, and that at the next stroke the valve (14a) is opened, while valve (13a) is kept closed, thus imparting to the low pressure chamber (11) and the high pressure cylinder (12) a dropping movement which ends with a second downwards directed impulse to the impact device (17) after which the first stroke is repeated, and so on until the differential pressure between the surrounding water and the low pressure chamber (11, 3) is insufficient, or the intake valve (4) is closed.

10. A machine according to claim 9, characterized in that at least one motor (2) drives an electric generator.

11. A machine according to claim 9, characterized in that the impact device (17) is in the form of a percussion drill and that the downwards directed pulsations are partially converted to rotational movement through a per se known mechanical device (170).

12. A machine according to claims 4 and 9, characterized in that the impact device (17) is in the form of a percussion drill and that the axial pump (20) is used to operate a hydraulic rotary engine (50) which imparts a rotational movement to the impact device (17).

13. A machine according to claims 9, 11 and 12, characterized in that the impact device (17) forms the top of a sampler tube (60) consisting of one or more sampler tube sections (61) arranged to take samples of sediments on the seabed.

14. A machine according to claim 9, characterized in that the impact device (17) forms the bottom end of an anchor (70) which in known per se manner can consist of several arms (71) hinged near the bottom end (17) so that the anchor offers little resistance when driven into the seabed, but strong resistance when attempts are made to pull it up by means of, e.g., an anchor chain (72) attached to the top of the low pressure chamber (11), since the arms (71) are then unfolded.

15. A machine according to claims 11 or 12, characterized in that the impact device (17) is in the form of a screw with relatively large threads (171), thus causing the screw to be attached to the bottom in such a manner that it anchors the machine and any vessel attached to it via, e.g., an anchor chain (72).

16. A machine for performing work at great depths, consisting of at least one arbitrary work tool (1) of known per se type, at least one hydraulic motor (2) which is adapted in order to be able to be operated by the surrounding water masses, at least one low pressure reservoir (3), and at least one intake valve (4) which is arranged so that the hydrostatic pressure in surrounding water masses leads water through the valve (4) via a pipe or hose connection to the motor (2) and further via a corresponding pipe or hose connection to the low pressure reservoir (3), and a per se known fluid filter (5) arranged in the surrounding water masses such that the fluid flow through the intake valve (4) to the motor (2) flows through the fluid filter (5), the motor (2) to the greatest possible extent by means of per se prior art converting the pressure energy in the through-flowing fluid into pressure energy which can be used by the work tool (1), characterized in that the at least one hydraulic motor (2) is a rotary motor installed directly in the low pressure reservoir (3).
17. A machine according to claim 16, characterized in that the at least one motor (2) drives an electrical generator.
18. Use of the hydrostatic machine according to any of the claims 1-15 in a hydrostatic sampler especially for core samples of marine sediments, wherein the sampler consists of a cylindrical head (1) and a substantially cylindrical sampler section (3) whose longitudinal axis passes approximately through the head's (1) centre of gravity, and wherein the sampler section comprises a sampler tube (30) which consists of at least one sampler tube section, characterized in that the head (1) constitutes a pressure reservoir consisting of at least one reservoir section, that the pressure reservoir (1) comprises a low pressure chamber (14) and a working cylinder (13) with a high pressure chamber (130) provided in or directly connected with the low pressure chamber (14), that the high pressure chamber (130) is connected via an inlet opening (133) with the outside of the pressure reservoir and via a further opening (134) with the low pressure chamber (14), that in the high pressure chamber (130) there is provided a first piston (131), with direction of movement along the longitudinal axis of the sampler section (3), and that the sampler section (3) with the sampler tube (30) are arranged to perform a stroke movement generated by the effect of the hydrostatic pressure on the first piston (131), during which the said piston (131) moves from a starting position to a final position in the high pressure chamber (130) and thereafter due to the weight of the head (1) returns to the starting position during a downwards directed movement of the head (1) and the secondary pump cylinder (20) to abut against the sampler section (3).
19. Use according to claim 18, characterized in that there is provided a secondary pump system (2) consisting of a secondary pump cylinder (20) with a second piston (21), the secondary pump cylinder (20) being rigidly connected with the head (1) and having the same central longitudinal axis as the head (1) and the sampler tube (30), and that the first piston (131) is rigidly connected with the second piston (21) and with the sampler section (3).
20. Use according to claim 18 or 19, characterized in that the high pressure cylinder (13) on the outside of its upper section is surrounded by a sleeve-shaped slide valve (15) moveable in axial direction around this section, arranged to provide fluid communication between the high pressure chamber (130) and the environment respectively via the inlet opening (133) and between the high pressure chamber (130) and the low pressure chamber (14) via the additional opening (134), the additional opening (134) being composed of at least one outlet opening on the upper section of the first piston's (131) cylinder (13) in order to provide fluid communication between the high pressure chamber (13) and the low pressure chamber (14).
21. Use according to claim 20, characterized in that the inlet opening (133) is in fluid communication with the high pressure chamber (130) via a first flexible hose (12) which is attached to an inlet opening (150) on the slide valve (15), the inlet opening (150) on the slide valve (15) being capable of fluid communication with at least one inlet opening (133) in the upper section of the cylinder (13).
22. Use according to claim 20, characterized in that there are provided two sets of spring mechanisms (16) around one or more spring bolts (161) which are slidingly arranged parallel to the central longitudinal axis, that the first set of spring mechanisms (16) comprises springs which extend between a circumferential disc (151) on the slide valve (16) and a stop disk permanently connected to the spring bolts (161), that the second set of spring mechanisms (16) extends between the circumferential disc (151) and a locating disc (132) on the lower end of the first piston (131), and that the capture disc (132) abuts against a stop disk on the lower end of the spring bolts (161) when the first piston (131) approaches its lower end position, thus causing the first set of spring mechanisms to be tensioned, while the locating disc (132) tensions the second set of spring mechanisms when the first piston (131) approaches its upper position, the circumferential disc (151) and the slide valve (15) being affected by a spring load directed towards the same end posi-

tion when the first piston (131) is located close to an end position.

23. Use according to claim 20, characterized in that spring mechanisms (17) are provided around one or more camshafts (190) on both sides of a disk (136) which is permanently connected to the high pressure chamber (130), that the springs (170) in the spring mechanism (17) extend between the disc (136) and fixed points on the camshafts (190), that the camshafts (190) pass freely through the disc (136) and are axially slidingly arranged parallel to the central longitudinal axis, and that cam discs (191) are rigidly connected with the camshafts.

24. Use according to claim 23, characterized in that there is provided a ratchet mechanism (18) which is arranged to lock the slide valve (15) axially when it is located in its upper or lower end position, that the ratchet mechanism (18) is spring loaded in the direction of the locking position and the cam discs (191), that the ratchet mechanism is located in the locking position when the cam discs (191) are located in a groove (182) in the ratchet mechanism, that this position of the cam discs (191) which corresponds to the groove (182) also corresponds to a neutral position of the spring mechanism (17) in relation to the camshafts' (190) axial movement, and that the ratchet mechanism (18) is forced away from the camshaft and out of the locking position when the cam disks (191) are forced downwards or upwards and out of the groove (182).

25. Use according to claim 24, characterized in that the camshafts (190) pass through a capture disc (132) which is permanently connected with the lower end of the first piston (131), that when the piston approaches its lower end position, the capture disc (132) abuts against a disk, nut or the like which is rigidly connected with the lower end of the camshafts, and that when the first piston (131) approaches its upper final position, the capture disk abuts against a disk, sleeve (195), cross section extension or the like which is axially rigidly connected with the camshafts, so that close to an arbitrary final position the first piston forces the camshafts (190) with the cam disks (191) out of their neutral position and causes an opening of the ratchet mechanism (18).

26. Use according to claim 18, characterized in that the volume of the first piston's (131) cylinder (13) is reduced by a lining (135) being provided in the high pressure chamber (130), the first piston being given a correspondingly reduced dimension.

27. Use according to claim 18, characterized in that between the low pressure chamber (14) and the out-

side of the head (1) there is provided a one-way pressure relief valve (10), which opens from the chamber (14) to the outside of the head (1).

28. Use according to claim 19, characterized in that the secondary pump cylinder (20) is provided with a three-way valve (22) on at least one end, the three-way valve (22) providing fluid communication between the outside of an annular space (202) which is created in the secondary pump cylinder on the side of the second piston (21) where the three-way valve (22) is provided, and that the three-way valve has an approximately direct connection with the outside when the second piston (21) causes a suction effect in the annular space (202), while the approximately direct connection is blocked at the same time as a connection is opened to a water injection conduit (35) via a second flexible hose (23) when the annular space (202) is compressed by the second piston (21), and that the water injection conduit (35) is provided in the sampler section (3) in order to provide fluid lubrication of the sampler tube (30) or water injection in the core hole when lifting the sampler tube (30).

29. Use according to any of claims 18 to 28, characterized in that a valve (11) with a spring-loaded valve arm (110) closes the fluid connection between the high pressure chamber (130) and the environment when the valve arm (110) is located in its lower position when overcoming the spring moment which will tend to open the valve and move the valve arm (110) to its upper position, and that a weight is attached by a line to the outer end of the valve arm (110), the weight thus keeping the valve (11) closed until the weight hits the seabed when the sampler is being lowered, and the hydrostatic sampler will automatically begin to perform the impact movement when the distance between the seabed and the head (1) corresponds approximately to the length of the line between the valve arm (110) and the weight.

30. Use according to any of the claims 18-29, characterized in that a high pressure hose connects the valve (11) directly or indirectly with a fluid compressor, thus enabling the supply of fluid from the said compressor to replace fluid from the environment under operating conditions where the hydrostatic pressure in the head's (1) environment is not sufficient to operate the sampler.

Patentansprüche

1. Maschine zum Durchführen einer Arbeit unter großen Tiefen, die aus mindestens einem wahlweisen Arbeitswerkzeug (1) eines per se bekannten Typs,

mindestens einem hydraulischen Motor (2), der dazu angepaßt ist, in der Lage zu sein, durch die umgebenden Wassermassen betätigt zu werden, mindestens einem Niederdruck-Reservoir (3), mindestens einem Einlaßventil (4), das so angeordnet ist, daß der hydrostatische Druck in den umgebenden Wassermassen Wasser durch das Ventil (4) über eine Rohr- oder Schlauch-Verbindung zu dem Motor (2) und weiter über eine entsprechende Rohr- oder Schlauchverbindung zu dem Niederdruck-Reservoir (3) führt, und einem per se bekannten Fluid-Filter (5), der in den umgebenden Wassermassen angeordnet ist, so daß die Fluidströmung durch das Einlaßventil (4) zu dem Motor (2) durch den Fluid-Filter (5) fließt, besteht, wobei der Motor (2) in dem größtmöglichen Umfang mit Mitteln, die per se nach dem Stand der Technik bekannt sind, die Drucker-
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- Hub geöffnet wird, während das Ventil (14a) geschlossen gehalten wird, um so auf den Kolben (15) eine nach unten gerichtete Bewegung aufzubringen und um einen ersten, nach unten gerichteten Impuls auf die Stoßvorrichtung (17) aufzubringen, wobei dem Zylinder (12) mit der Druckkammer (11) simultan eine nach oben gerichtete Reaktionsbewegung verliehen wird, und daß bei dem nächsten Hub das Ventil (14a) geöffnet wird, während das Ventil (13a) geschlossen gehalten wird, um der Niederdruck-Kammer (11) und dem Hochdruckzylinder (12) eine abfallende Bewegung zu verleihen, die mit einem zweiten, nach unten gerichteten Impuls auf die Stoßvorrichtung (17) endet, wonach der erste Hub wiederholt wird, und so weiter, bis der differentielle Druck zwischen dem umgebenden Wasser und der Niederdruck-Kammer (11, 3) unzureichend ist, oder das Einlaßventil (4) geschlossen wird.
10. Maschine nach Anspruch 9, dadurch gekennzeichnet, daß mindestens ein Motor (2) einen elektrischen Generator antreibt.
11. Maschine nach Anspruch 9, dadurch gekennzeichnet, daß die Stoßvorrichtung (17) in der Form eines Schlagbohrers vorliegt und daß das nach unten gerichtete Pulsieren teilweise in eine rotationsmäßige Bewegung durch eine per se bekannte mechanische Vorrichtung (170) konvertiert wird.
12. Maschine nach Anspruch 4 und 9, dadurch gekennzeichnet, daß die Prallvorrichtung (17) in der Form eines Schlagbohrers vorliegt, und daß die Axialpumpe (20) dazu verwendet wird, eine hydraulische Rotationsmaschine (50) zu betätigen, die eine rotationsmäßige Bewegung auf die Stoßvorrichtung (17) aufbringt.
13. Maschine nach Anspruch 9, 11, und 12, dadurch gekennzeichnet, daß die Stoßvorrichtung (17) die Oberseite eines Probennehmerrohrs (60) bildet, das aus einem oder mehreren Probennehmerrohrabschnitten (61) besteht, die so angeordnet sind, um Proben von Sedimenten auf dem Meeresboden zu nehmen.
14. Maschine nach Anspruch 9, dadurch gekennzeichnet, daß die Stoßvorrichtung (17) das Bodenende eines Ankers (70) bildet, der in einer per se bekannten Art und Weise aus mehreren Armen (71) bestehen kann, die nahe des Bodenendes (17) gelenkig verbunden sind, so daß der Anker einen kleinen Widerstand liefert, wenn er in den Meeresboden getrieben wird, allerdings einen starken Widerstand liefert, wenn Versuche unternommen werden, ihn mittels z.B. einer Ankerkette (72) zu ziehen, die an der Oberseite der Niederdruck-Kammer (11) befestigt ist, da die Arme (71) dann entfaltet werden.
15. Maschine nach Anspruch 11 oder 12, dadurch gekennzeichnet, daß die Stoßvorrichtung (17) in der Form einer Schraube mit relativ großen Gewindengängen (171) vorliegt, um so zu bewirken, daß die Schraube in dem Boden in einer solchen Art und Weise befestigt wird, daß sie die Maschine, und irgendein Wasserfahrzeug, das an ihr über z. B. eine Ankerkette (72), befestigt ist, verankert.
16. Maschine zum Durchführen einer Arbeit in großen Tiefen, die aus mindestens einem Hilfsarbeitswerkzeug (1) eines per se bekannten Typs, mindestens einem Hydraulikmotor (2), der dazu angepaßt ist, in der Lage zu sein, durch die umgebenden Wassermassen betätigt zu werden, mindestens einem Niederdruck-Reservoir (3) und mindestens einem Einlaßventil (4), das so angeordnet ist, daß der hydrostatische Druck in umgebenden Wassermassen Wasser durch das Ventil (4) über eine Rohr- oder Schlauchverbindung zu dem Motor (2) und weiter über eine entsprechende Rohr- oder Schlauchverbindung zu dem Niederdruck-Reservoir (3) führt, und einem per se bekannten Fluid-Filter (5), der in den umgebenden Wassermassen so angeordnet ist, daß die Fluidströmung durch das Einlaßventil (4) zu dem Motor (2) durch den Fluid-Filter (5) fließt, besteht, wobei der Motor (2) in dem größtmöglichen Umfang mit Mitteln, die per se nach dem Stand der Technik bekannt sind, die Druckenergie in dem hindurchfließenden Fluid in Druckenergie konvertiert, die durch das Arbeitswerkzeug (1) verwendet werden kann, dadurch gekennzeichnet, daß mindestens ein Hydraulikmotor (2) ein Rotationsmotor ist, der direkt in dem Niederdruck-Reservoir (3) installiert ist.
17. Maschine nach Anspruch 16, dadurch gekennzeichnet, daß der mindestens eine Motor (2) einen elektrischen Generator antreibt.
18. Verwendung der hydrostatischen Maschine nach einem der Ansprüche 1 bis 15 in einem hydrostatischen Probennehmer, insbesondere für Kernproben von Meeressedimenten, wobei der Probennehmer aus einem zylindrischen Kopf (1) und einem im wesentlichen zylindrischen Probennehmer-Abschnitt (3) besteht, dessen longitudinale Achse ungefähr durch den Schwerpunkt des Kopfs (1) hindurchführt, und wobei der Probennehmerabschnitt ein Probennehmerrohr (30) aufweist, das aus mindestens einem Probennehmerrohrabschnitt besteht, dadurch gekennzeichnet, daß der Kopf (1) ein Druckreservoir bildet, das aus mindestens einem Reservoir-Abschnitt besteht, daß das Druckreservoir (1) eine Niederdruck-Kammer (14) und einen Arbeitszylinder (13) mit einer Hochdruck-Kammer (130), die in der Niederdruck-Kammer (14) vorgesehen ist oder direkt mit dieser verbunden ist,

- aufweist, daß die Hochdruck-Kammer (130) über eine Einlaßöffnung (133) mit der Außenseite des Druckreservoirs und über eine weitere Öffnung (134) mit der Niederdruck-Kammer (14) verbunden ist, daß in der Hochdruck-Kammer (130) ein erster Kolben (131) vorgesehen ist, mit einer Bewegungsrichtung entlang der longitudinalen Achse des Probennehmerabschnitts (3), und daß der Probennehmerabschnitt (3) mit dem Probennehmerrohr (30) so angeordnet ist, um eine Hubbewegung durchzuführen, die durch den Effekt des hydrostatischen Drucks auf den ersten Kolben (131) erzeugt ist, während der sich der Kolben (131) von einer Startposition zu einer Endposition in der Hochdruck-Kammer (130) bewegt und danach aufgrund des Gewichts des Kopfs (1) zu der Startposition während einer nach unten gerichteten Bewegung des Kopfs (1) zurückkehrt, und um den sekundären Pumpzylinder (20) gegen den Probennehmerabschnitt (3) anzustoßen.
- 19.** Verwendung nach Anspruch 18, dadurch gekennzeichnet, daß ein sekundäres Pumpsystem (2) vorgesehen ist, das aus einem sekundären Pumpzylinder (20) mit einem zweiten Kolben (21) besteht, wobei der sekundäre Pumpzylinder (20) starr mit dem Kopf (1) verbunden ist und dieselbe, zentrale, longitudinale Achse wie der Kopf (1) und das Probennehmerrohr (30) besitzt, und daß der erste Kolben (131) starr mit dem zweiten Kolben (21) und mit dem Probennehmerabschnitt (3) verbunden ist.
- 20.** Verwendung nach Anspruch 18 oder 19, dadurch gekennzeichnet, daß der Hochdruckzylinder (13) auf der Außenseite seines oberen Abschnitts durch ein hülsenförmiges Gleitventil (15) umgeben ist, das in eine axiale Richtung um diesen Abschnitt bewegbar ist, angeordnet so, um eine Fluidverbindung zwischen der Hochdruck-Kammer (130) und der Umgebung jeweils über die Einlaßöffnung (133) und zwischen der Hochdruck-Kammer (130) und der Niederdruck-Kammer (14) über die zusätzliche Öffnung (134) zu schaffen, wobei die zusätzliche Öffnung (134) aus mindestens einer Auslaßöffnung auf dem oberen Abschnitt des Zylinders (13) des ersten Kolbens (131) aufgebaut ist, um eine Fluidkommunikation zwischen der Hochdruck-Kammer (13) und der Niederdruck-Kammer (14) zu bilden.
- 21.** Verwendung nach Anspruch 20, dadurch gekennzeichnet, daß die Einlaßöffnung (133) in Fluidkommunikation mit der Hochdruck-Kammer (130) über einen ersten, flexiblen Schlauch (12) steht, der an einer Einlaßöffnung (150) auf dem Gleitventil (15) befestigt ist, wobei die Einlaßöffnung (150) auf dem Gleitventil (15) für eine Fluidkommunikation mit mindestens einer Einlaßöffnung (133) in dem oberen Abschnitt des Zylinders (13) geeignet ist.
- 22.** Verwendung nach Anspruch 20, dadurch gekennzeichnet, daß zwei Sätze von Federmechanismen (16) um einen oder mehrere Federbolzen (161) vorgesehen sind, die gleitbar parallel zu der zentralen, longitudinalen Achse angeordnet sind, daß der erste Satz der Federmechanismen (16) Federn aufweist, die sich zwischen einer umfangsmäßigen Scheibe (151) auf dem Gleitventil (16) und einer Anschlagsscheibe, die permanent mit den Federbolzen (161) verbunden ist, erstrecken, daß sich der zweite Satz der Federmechanismen (16) zwischen der umfangsmäßigen Scheibe (151) und einer Lokalisierungsscheibe (132) auf dem unteren Ende des ersten Kolbens (131) erstreckt, und daß die Aufnahmescheibe (132) gegen eine Anschlagsscheibe auf dem unteren Ende der Federbolzen (161) anstößt, wenn sich der erste Kolben (131) seiner unteren Endposition nähert, was demzufolge bewirkt, daß der erste Satz der Federmechanismen gespannt wird, während die Lokalisierungsscheibe (132) den zweiten Satz der Federmechanismen spannt, wenn sich der erste Kolben (131) seiner oberen Position nähert, wobei die umfangsmäßige Scheibe (151) und das Gleitventil (15) durch eine Federlast beeinflusst werden, die zu derselben Endposition gerichtet ist, wenn der erste Kolben (131) nahe zu einer Endposition angeordnet ist.
- 23.** Verwendung nach Anspruch 20, dadurch gekennzeichnet, daß die Federmechanismen (17) um eine oder mehrere Nockenwelle(n) (190) auf beiden Seiten einer Scheibe (136) vorgesehen sind, die permanent mit der Hochdruck-Kammer (130) verbunden ist, daß sich die Federn (170) in den Federmechanismen (17) zwischen der Scheibe (136) und festgelegten Punkten auf den Nockenwellen (190) erstrecken, daß die Nockenwellen (190) frei durch die Scheibe (136) hindurchführen und axial gleitend parallel zu der zentralen, longitudinalen Achse angeordnet sind, und daß die Nockenscheiben (191) starr mit den Nockenwellen verbunden sind.
- 24.** Verwendung nach Anspruch 23, dadurch gekennzeichnet, daß ein Klinkenmechanismus (18) vorgesehen ist, der so angeordnet ist, um das Gleitventil (15) axial zu verriegeln, wenn es in seiner oberen oder unteren Endposition angeordnet ist, daß der Klinkenmechanismus (18) in der Richtung der Verriegelungsposition und der Nockenscheiben (191) federvorgespannt ist, daß der Klinkenmechanismus in der Verriegelungsposition angeordnet ist, wenn die Nockenscheiben (191) in einer Nut (182) in dem Klinkenmechanismus angeordnet sind, daß diese Position der Nockenscheiben (191), die der Nut (182) entspricht, auch einer neutralen Position des Federmechanismus (17) in Relation zu der axialen Bewegung der Nockenwellen (190) entspricht, und daß der Klinkenmechanismus (18) von

der Nockenwelle weg und aus der Verriegelungsposition heraus gezwungen wird, wenn die Nockenscheiben (191) nach unten oder nach oben und aus der Nut (182) heraus gedrückt werden.

25. Verwendung nach Anspruch 24, dadurch gekennzeichnet, daß die Nockenwellen (190) durch eine Aufnahmescheibe (132) hindurchführen, die permanent mit dem unteren Ende des ersten Kolbens (131) verbunden ist, daß dann, wenn sich der Kolben seiner unteren Endposition nähert, die Aufnahmescheibe (132) gegen eine Scheibe, eine Mutter, oder dergleichen, anschlägt, die starr mit dem unteren Ende der Nockenwellen verbunden ist, und daß dann, wenn sich der erste Kolben (131) seiner oberen Endposition nähert, die Aufnahmescheibe gegen eine Scheibe, eine Hülse (195), eine Querschnittserweiterung, oder dergleichen, anstößt, die axial steif mit den Nockenwellen verbunden ist, so daß nahe zu einer wahlweisen Endposition der erste Kolben die Nockenwellen (190) mit den Nockenscheiben (191) außerhalb deren neutralen Position drückt und eine Öffnung des Klinkenmechanismus (18) bewirkt.

26. Verwendung nach Anspruch 18, dadurch gekennzeichnet, daß das Volumen des Zylinders (13) des ersten Kolbens (131) durch eine Auskleidung (135) reduziert ist, die in der Hochdruck-Kammer (130) vorgesehen ist, wobei dem ersten Kolben eine entsprechend reduzierte Dimension verliehen ist.

27. Verwendung nach Anspruch 18, dadurch gekennzeichnet, daß zwischen der Niederdruck-Kammer (14) und der Außenseite des Kopfs (1) ein Einweggedrucktlastungsventil (10) vorgesehen ist, das sich von der Kammer (14) zu der Außenseite des Kopfs (1) öffnet.

28. Verwendung nach Anspruch 19, dadurch gekennzeichnet, daß der sekundäre Pumpzylinder (20) mit einem Dreiwegeventil (22) auf mindestens einem Ende versehen ist, wobei das Dreiwegeventil (22) eine Fluidkommunikation zwischen der Außenseite eines ringförmigen Raums (202), der in dem sekundären Pumpzylinder auf der Seite des zweiten Kolbens (21) erzeugt ist, wo das Dreiwegeventil (22) vorgesehen ist, versehen ist, und daß das Dreiwegeventil eine annähernd direkte Verbindung mit der Außenseite besitzt, wenn der zweite Kolben (21) einen Saugeffekt in dem ringförmigen Raum (202) verursacht, während die annähernd direkte Verbindung zu derselben Zeit blockiert wird, wenn eine Verbindung zu einem Wasserinjektionskanal (35) über einen zweiten, flexiblen Schlauch (23) geöffnet wird, wenn der ringförmige Raum (202) durch den zweiten Kolben (21) komprimiert wird, und daß der Wasserinjektionskanal (35) in dem Probennehmer-

abschnitt (3) vorgesehen ist, um eine Fluidschmierung des Probennehmerrohrs (30) oder eine Wasserinjektion in das Kernloch zu liefern, wenn sich das Probennehmerrohr (30) anhebt.

29. Verwendung nach einem der Ansprüche 18 bis 28, dadurch gekennzeichnet, daß ein Ventil (11) mit einem federvorgespannten Ventilarm (110) die Fluidverbindung zwischen der Hochdruck-Kammer (130) und der Umgebung schließt, wenn der Ventilarm (110) in seiner unteren Position angeordnet ist, wenn das Federmoment überwunden wird, das dazu tendieren wird, das Ventil zu öffnen und den Ventilarm (110) zu seiner oberen Position zu bewegen, und daß ein Gewicht durch ein Seil an dem anderen Ende des Ventilarms (110) befestigt ist, wobei das Gewicht demzufolge das Ventil (11) geschlossen hält, bis das Gewicht auf den Meeresboden aufschlägt, wenn der Probennehmer herabgesenkt wird, und wobei der hydrostatische Probennehmer automatisch beginnen wird, die Stoßbewegung durchzuführen, wenn der Abstand zwischen dem Meeresboden und dem Kopf (1) ungefähr der Länge des Seils zwischen dem Ventilarm (110) und dem Gewicht entspricht.

30. Verwendung nach einem der Ansprüche 18 bis 29, dadurch gekennzeichnet, daß ein Hochdruckschlauch das Ventil (11) direkt oder indirekt mit einem Fluidkompressor verbindet, was demzufolge die Zufuhr von Fluid von dem Kompressor ermöglicht, um Fluid von der Umgebung unter Betriebsbedingungen zu ersetzen, wo der hydrostatische Druck in der Umgebung des Kopfs (1) nicht ausreichend ist, den Probennehmer zu betätigen.

Revendications

1. Machine pour effectuer un travail dans les grandes profondeurs, constituée d'au moins un outil de travail arbitraire (1) de type connu *per se*, au moins un moteur hydraulique (2) qui est adapté de manière à pouvoir être actionné par les masses d'eau environnantes, au moins un réservoir (3) à basse pression, au moins une soupape d'admission (4) qui est prévue pour que la pression hydrostatique dans les masses d'eau environnantes amène l'eau à travers la soupape (4), via un raccord de canalisation ou de tuyau, jusqu'au moteur (2) et ensuite, via un raccord de canalisation ou de tuyau correspondant, jusqu'au réservoir (3) à basse pression, et un filtre (5) pour fluide connu *per se* disposé dans les masses d'eau environnantes de telle façon que l'écoulement de fluide à travers la soupape d'admission (4) jusqu'au moteur (2) traverse le filtre (5) pour fluide, le moteur (2) convertissant, dans la plus grande mesure possible au moyen de l'art antérieur *per se*.

l'énergie de la pression dans le fluide en écoulement en énergie de pression qui peut être utilisée par l'outil de travail (1), **caractérisée en ce que** ledit au moins un moteur hydraulique (2) comprend un moteur hydrostatique (2a) à piston axial installé en communication avec le réservoir (3) à basse pression, une chambre (11) à basse pression de celui-ci étant raccordée rigidement à un cylindre (12) à haute pression avec au moins deux volumes séparés (120a et 120b) formant une partie intégrale du moteur (2a) à piston axial et contenant un piston (15) et une tige de piston (16) de ce dernier, **en ce que** des dispositifs de soupapes (13a, 13b, 14a, 14b) connus *per se* amènent un ou plusieurs des volumes (120a et 120b) du cylindre en communication alternée avec respectivement les masses d'eau environnantes et la chambre (11) à basse pression d'une manière telle que le cylindre (12) à haute pression agisse comme le cylindre moteur d'un moteur axial mû par l'eau, imprimant un mouvement pulsant ou alternatif au piston (15) et à la tige (16) de piston présents dans le cylindre (12) à haute pression.

2. Machine selon la Revendication 1, **caractérisée en ce que**, entre les soupapes (4) et (13a, 13b), sont prévus un clapet restricteur (18) et un accumulateur (19) de manière à égaliser l'écoulement du fluide à travers le filtre (5).

3. Machine selon la Revendication 1, **caractérisée en ce que** le réservoir (3) à basse pression est à peu près exempt de gaz autres que de la vapeur d'eau, la pression dans le réservoir à basse pression étant approximativement limitée à la pression de vapeur d'eau à la température concernée pendant toute la durée du travail, du moment où le réservoir est vide d'eau jusqu'au moment où il est complètement rempli d'eau fournie par l'environnement.

4. Machine selon la Revendication 1, **caractérisée en ce que** le piston (15) et la tige (16) de piston sont raccordés rigidement à un second piston (21) présent dans un second cylindre (22), **en ce que** le second cylindre (22) est raccordé rigidement au premier cylindre (12) et possède le même axe central que celui-ci, et **en ce que** le second cylindre (22) avec le second piston (21) est équipé de clapets anti-retour connus *per se*, le second cylindre agissant ainsi comme une pompe axiale (20).

5. Machine selon la Revendication 4, **caractérisée en ce que** le milieu pompé par la pompe axiale (20) est le liquide environnant, et **en ce que** la pompe agit comme un système ouvert qui "consomme" le liquide environnant.

6. Machine selon la Revendication 4, **caractérisée en**

ce que le milieu pompé par la pompe axiale (20) est une huile hydraulique du commerce qui est présente dans un système fermé comprenant au moins la pompe axiale (20), un moteur hydraulique (31) et les raccords de tuyauterie et de soupapes connexes.

7. Machine selon la Revendication 6, **caractérisée en ce que** le système hydraulique fermé comprend aussi au moins un accumulateur (32) et au moins un régulateur de pression (33) pour égaliser la pression d'alimentation de la pompe axiale (20).

8. Machine selon la Revendication 1, **caractérisée en ce que** la chambre (11) à basse pression est raccordée de manière désaccouplable à un réservoir (3) à très basse pression via un raccord de canalisation ou de tuyau, **en ce que** la chambre (11) à basse pression est directement raccordée à un accumulateur (40), et **en ce que** la pression différentielle entre la chambre (11) à basse pression et le réservoir (3) à basse pression est contrôlée au moyen d'une soupape (41) de limitation de la pression différentielle.

9. Machine selon la Revendication 1, **caractérisée en ce que** le cylindre (12) à haute pression est placé avec son axe longitudinal approximativement perpendiculaire aux fonds marins, **en ce que** la tige (16) du piston est raccordée rigidement à un dispositif de percussion (17) avec approximativement le même axe longitudinal que la tige (16) de piston, **en ce que** la chambre inférieure (120b) est en relation fluidique ouverte permanente avec la chambre (11) à basse pression et en relation fermée permanente avec la pression extérieure, tandis que seule la chambre supérieure (120a) est prévue pour offrir un effet de moteur axial, la soupape (13a) étant ouverte à la première course, tandis que la soupape (14a) est maintenue fermée, communiquant ainsi au piston (15) un mouvement dirigé vers le bas et occasionnant une première impulsion dirigée vers le bas au dispositif de percussion (17), le cylindre (12) avec la chambre (11) à basse pression recevant simultanément un mouvement de réaction dirigé vers le haut, et **en ce que** lors de la course suivante, la soupape (14a) est ouverte, tandis que la soupape (13a) est maintenue fermée, communiquant ainsi à la chambre (11) à basse pression et au cylindre (12) à haute pression un mouvement de chute qui se termine avec une seconde impulsion dirigée vers le bas occasionnée au dispositif de percussion (17) après lequel la première course est répétée, et ainsi de suite jusqu'à ce que la pression différentielle entre l'eau environnante et la chambre (11, 3) à basse pression soit insuffisante, ou que la soupape d'admission (4) soit fermée.

10. Machine selon la Revendication 9, caractérisée **en ce qu'**au moins un moteur (2) actionne un générateur électrique.
11. Machine selon la Revendication 9, **caractérisée en ce que** le dispositif de percussion (17) se présente sous la forme d'une sonde percutante et **en ce que** les impulsions dirigées vers le bas sont partiellement converties en mouvement de rotation grâce à un dispositif mécanique (170) connu *per se*.
12. Machine selon les Revendications 4 et 9, **caractérisée en ce que** le dispositif de percussion (17) se présente sous la forme d'une sonde percutante et **en ce que** la pompe axiale (20) est utilisée pour faire fonctionner un moteur hydraulique rotatif (50) qui communique un mouvement de rotation au dispositif à percussion (17).
13. Machine selon les Revendications 9, 11 et 12, **caractérisée en ce que** le dispositif de percussion (17) forme la tête d'un tube de sonde (60) constitué d'une ou plusieurs sections (61) de tube de sonde adaptées pour prélever des échantillons de sédiments sur les fonds marins.
14. Machine selon la Revendication 9, **caractérisée en ce que** le dispositif de percussion (17) forme l'extrémité inférieure d'une ancre (70) qui, d'une manière connue *per se*, peut être constituée de plusieurs bras (71) articulés à proximité de l'extrémité inférieure (17) afin que l'ancre offre peu de résistance lorsqu'elle est entraînée dans les fonds marins, mais une forte résistance lorsque des tentatives sont faites de la tirer vers le haut au moyen de, par exemple, une chaîne (72) d'ancre fixée sur la partie supérieure de la chambre (11) à basse pression, car les bras (71) sont alors dépliés.
15. Machine selon les Revendications 11 ou 12, **caractérisée en ce que** le dispositif de percussion (17) se présente sous la forme d'une vis avec des filets relativement grands (171). ce qui fait que la vis se fixe au fond de telle manière qu'elle ancre la machine et tout bâtiment qui lui est rattaché via, par exemple, une chaîne (72) d'ancre.
16. Machine pour effectuer un travail dans les grandes profondeurs, constituée d'au moins un outil de travail arbitraire (1) de type connu *per se*, au moins un moteur hydraulique (2) qui est adapté de manière à pouvoir être actionné par les masses d'eau environnantes, au moins un réservoir (3) à basse pression, et au moins une soupape d'admission (4) qui est prévue pour que la pression hydrostatique dans les masses d'eau environnantes amène l'eau à travers la soupape (4), via un raccord de canalisation ou de tuyau, jusqu'au moteur (2) et ensuite, via un
- raccord de canalisation ou de tuyau correspondant, jusqu'au réservoir (3) à basse pression, et un filtre (5) pour fluide connu *per se* disposé dans les masses d'eau environnantes de telle façon que l'écoulement de fluide à travers la soupape d'admission (4) jusqu'au moteur (2) traverse le filtre (5) pour fluide. le moteur (2) convertissant, dans la plus grande mesure possible au moyen de l'art antérieur *per se*, l'énergie de la pression dans le fluide en écoulement en énergie de pression qui peut être utilisée par l'outil de travail (1), **caractérisée en ce que** ledit au moins un moteur hydraulique (2) est un moteur rotatif installé directement dans le réservoir (3) à basse pression.
17. Machine selon la Revendication 16, **caractérisée en ce que** ledit au moins un moteur (2) entraîne un générateur électrique.
18. Usage de la machine hydrostatique selon l'une quelconque des Revendications 1 à 15 dans une sonde hydrostatique, en particulier pour des carottes-échantillons de sédiments marins. dans lequel la sonde est constituée d'une tête cylindrique (1) et d'une section sonde (3) substantiellement cylindrique dont l'axe longitudinal passe approximativement par le centre de gravité de la tête (1), et dans lequel la section sonde comprend un tube (30) de sonde qui est constitué d'au moins une section de tube de sonde, **caractérisé en ce que** la tête (1) constitue un réservoir à pression constitué d'au moins une section de réservoir, **en ce que** le réservoir à pression (1) comprend une chambre (14) à basse pression et un cylindre moteur (13) avec une chambre (130) à haute pression prévue dans, ou directement reliée à, la chambre (14) à basse pression, **en ce que** la chambre (130) à haute pression est reliée via une ouverture d'entrée (133) à l'extérieur du réservoir à pression et via une autre ouverture (134) à la chambre (14) à basse pression, **en ce que** dans la chambre (130) à haute pression se trouve un premier piston (131) avec une direction de déplacement le long de l'axe longitudinal de la section sonde (3), et **en ce que** la section sonde (3) et le tube (30) de sonde sont prévus pour effectuer un mouvement de course généré par l'effet de la pression hydrostatique sur le premier piston (131) pendant lequel ledit piston (131) se déplace d'une position de départ à une position finale dans la chambre (130) à haute pression, et après quoi, du fait du poids de la tête (1), revient à la position de départ pendant un mouvement dirigé vers le bas de la tête (1) et du cylindre (20) de la pompe secondaire pour s'abouter contre la section sonde (3).
19. Usage selon la Revendication 18, **caractérisé en ce que** est prévu un système (2) de pompe secondaire constitué d'un cylindre (20) de pompe secon-

daire avec un second piston (21). le cylindre (20) de pompe secondaire étant raccordé rigidement à la tête (1) et ayant le même axe longitudinal central que la tête (1) et le tube (30) de sonde, et **en ce que** le premier piston (131) est raccordé rigidement au second piston (21) et à la section sonde (3).

20. Usage selon la Revendication 18 ou 19, **caractérisé en ce que** le cylindre (13) à haute pression, sur l'extérieur de sa section supérieure, est entouré par un tiroir (15) en forme de manchon mobile dans le sens axial autour de cette section, prévu pour assurer la communication fluidique entre la chambre (130) à haute pression et l'environnement. respectivement via l'ouverture d'entrée (133) et entre la chambre (130) à haute pression et la chambre (14) à pression inférieure via l'ouverture additionnelle (134), l'ouverture additionnelle (134) étant composée d'au moins une ouverture de sortie sur la section supérieure du cylindre (13) du premier piston (131) de manière à assurer la communication fluidique entre la chambre (130) à haute pression et la chambre (14) à basse pression.

21. Usage selon la Revendication 20, **caractérisé en ce que** l'ouverture d'entrée (133) est en communication fluidique avec la chambre (130) à haute pression et via un premier tuyau souple (12) qui est fixé à une ouverture d'entrée (150) sur le tiroir (15), l'ouverture d'entrée (150) sur le tiroir (15) étant capable de communication fluidique avec au moins une ouverture d'entrée (133) dans la section supérieure du cylindre (13).

22. Usage selon la Revendication 20. **caractérisé en ce que** sont prévus deux jeux de mécanismes (16) à ressorts autour d'un ou plusieurs étoquiaux (161) (syn. corps de boulon de ressort) qui sont disposés à glissement et parallèles à l'axe longitudinal central, **en ce que** le premier jeu de mécanismes (16) à ressorts comprend des ressorts qui s'étendent entre un disque circonférentiel (151) sur le tiroir (15) et un disque d'arrêt raccordé de manière permanente aux étoquiaux (161), **en ce que** le second jeu de mécanismes (16) à ressorts s'étend entre le disque circonférentiel (151) et un disque de positionnement (132) sur l'extrémité inférieure du premier piston (131), et **en ce que** le disque de capture (132) s'aboute contre un disque d'arrêt sur l'extrémité inférieure des étoquiaux (161) lorsque le premier piston (131) s'approche de sa position finale inférieure. provoquant ainsi la mise sous tension du premier jeu de mécanismes à ressorts, tandis que le disque de positionnement (132) met sous tension le second jeu de mécanismes à ressorts lorsque le premier piston (131) s'approche de sa position supérieure, le disque circonférentiel (151) et le tiroir (15) étant influencés par une charge de ressort di-

rigée vers la même position finale lorsque le premier piston (131) est situé à proximité d'une position finale.

23. Usage selon la Revendication 20, **caractérisé en ce que** les mécanismes (17) à ressorts sont installés autour d'un ou plusieurs arbres à cames (190) sur les deux faces d'un disque (136) qui est raccordé de manière permanente à la chambre (130) à haute pression, **en ce que** les ressorts (170) du mécanisme (17) à ressorts s'étendent entre le disque (136) et des points fixes sur les arbres à cames (190), **en ce que** les arbres à cames (190) passent librement à travers le disque (136) et sont disposés axialement à glissement et parallèles à l'axe longitudinal central, et **en ce que** des disques à came (191) sont raccordés rigidement aux arbres à cames.

24. Usage selon la Revendication 23, **caractérisé en ce qu'il** est prévu un mécanisme (18) à cliquet qui est configuré pour verrouiller axialement le tiroir (15) lorsqu'il est situé dans sa position finale supérieure ou inférieure, **en ce que** le mécanisme (18) à cliquet est chargé par ressort dans la direction de la position de verrouillage et des disques à came (191), **en ce que** le mécanisme à cliquet est en position de verrouillage lorsque les disques à came (191) sont situés dans une rainure (182) du mécanisme à cliquet, **en ce que** cette position des disques à came (191) qui correspond à la rainure (182) correspond aussi à une position neutre du mécanisme (17) à ressorts par rapport au mouvement axial des arbres à cames (190), et **en ce que** le mécanisme (18) à cliquet est écarté en force de l'arbre à cames et hors de la position de verrouillage lorsque les disques à came (191) sont forcés vers le bas ou vers le haut et hors de la rainure (182).

25. Usage selon la Revendication 24, **caractérisé en ce que** les arbres à cames (190) traversent un disque de capture (132) qui est raccordé de manière permanente à l'extrémité inférieure du premier piston (131), **en ce que**, lorsque le piston s'approche de sa position finale inférieure, le disque de capture (132) s'aboute contre un disque, un écrou ou similaire, qui est rigidement raccordé à l'extrémité inférieure des arbres à cames, et **en ce que**, lorsque le premier piston (131) s'approche de sa position finale supérieure. le disque de capture s'aboute contre un disque, un manchon (195), un prolongement en section transversale ou similaire qui est axialement raccordé rigidement aux arbres à cames, afin que, à proximité d'une position finale arbitraire. le premier piston force les arbres à cames (190) avec les disques à came (191) hors de leur position neutre et provoque une ouverture du mécanisme (18) à cliquet.

26. Usage selon la Revendication 18, **caractérisé en ce que** le volume du cylindre (13) du premier piston (131) est réduit par une chemise (135) présente dans la chambre (130) à haute pression, le premier piston étant affecté d'une dimension réduite de manière correspondante. 5
27. Usage selon la Revendication 18, **caractérisé en ce que**, entre la chambre (14) à basse pression et l'extérieur de la tête (1), est prévu un clapet de sûreté à sens unique (10) qui s'ouvre de la chambre (14) vers l'extérieur de la tête (1). 10
28. Usage selon la Revendication 19, **caractérisé en ce que** le cylindre (20) de la pompe secondaire est muni d'un distributeur trois voies (22) sur au moins une extrémité, le distributeur trois voies (22) assurant la communication fluide entre l'extérieur d'un espace annulaire (202) qui est créé dans le cylindre de la pompe secondaire sur le flanc du second piston (21) où se trouve le distributeur trois voies (22), et **en ce que** le distributeur trois voies possède une communication approximativement directe avec l'extérieur lorsque le second piston (21) provoque un effet d'aspiration dans l'espace annulaire (202), tandis que la communication approximativement directe est bloquée au moment où une communication est ouverte vers une canalisation d'injection d'eau (35) via un second tuyau souple (23) lorsque l'espace annulaire (202) est comprimé par le second piston (21), et **en ce que** la canalisation d'injection d'eau (35) est prévue dans la section sonde (3) de manière à assurer une lubrification par les fluides du tube (30) de sonde ou une injection d'eau dans le trou de la carotte lorsqu'on soulève le tube (30) de sonde. 15
20
25
30
35
29. Usage selon l'une quelconque des Revendications 18 à 28, **caractérisé en ce qu'un** clapet (11) avec un bras (110) de clapet chargé par ressort ferme la communication fluide entre la chambre (130) à haute pression et l'environnement lorsque le bras (110) du clapet est situé dans sa position inférieure lorsqu'est surmonté le moment du ressort qui tend à ouvrir le clapet et déplacer le bras (110) du clapet vers sa position supérieure, et **en ce qu'un** poids est attaché par une ligne à l'extrémité extérieure du bras (110) du clapet, le poids maintenant ainsi le clapet (11) fermé jusqu'à ce que le poids heurte le fond marin lorsque la sonde est abaissée, et la sonde hydrostatique commencera automatiquement à effectuer le mouvement de percussion lorsque la distance entre le fond marin et la tête (1) correspond approximativement à la longueur de la ligne entre le bras (110) du clapet et le poids. 40
45
50
55
30. Usage selon l'une quelconque des Revendications 18 à 29, **caractérisé en ce qu'un** tuyau à haute

pression relie le clapet (11) directement ou indirectement à un compresseur de fluides, permettant ainsi l'alimentation en fluide par ledit compresseur pour remplacer le fluide de l'environnement sous des conditions de fonctionnement où la pression hydrostatique dans l'environnement de la tête (1) n'est pas suffisante pour faire fonctionner la sonde.

Fig.1.

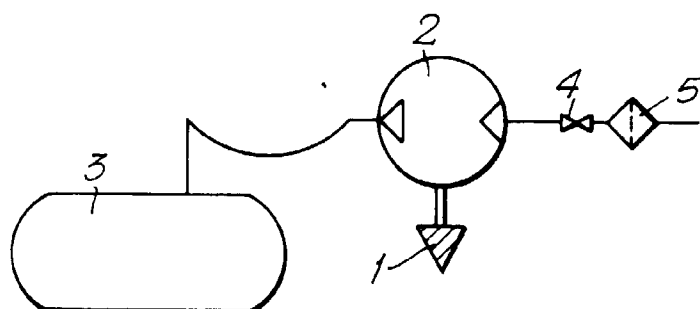


Fig.2.

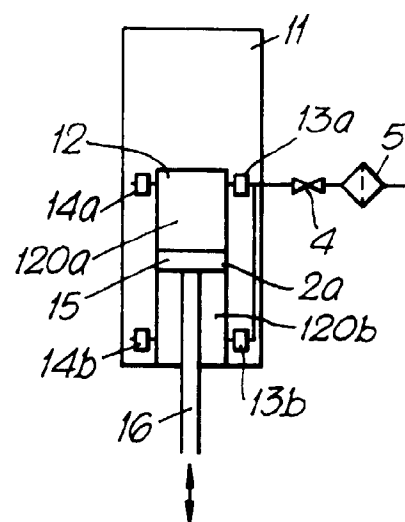


Fig.3.

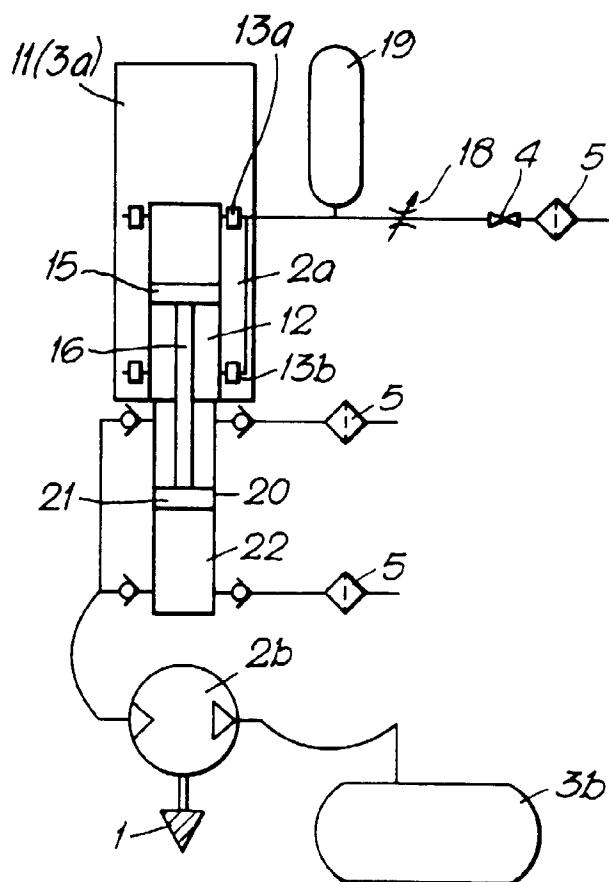


Fig.4.

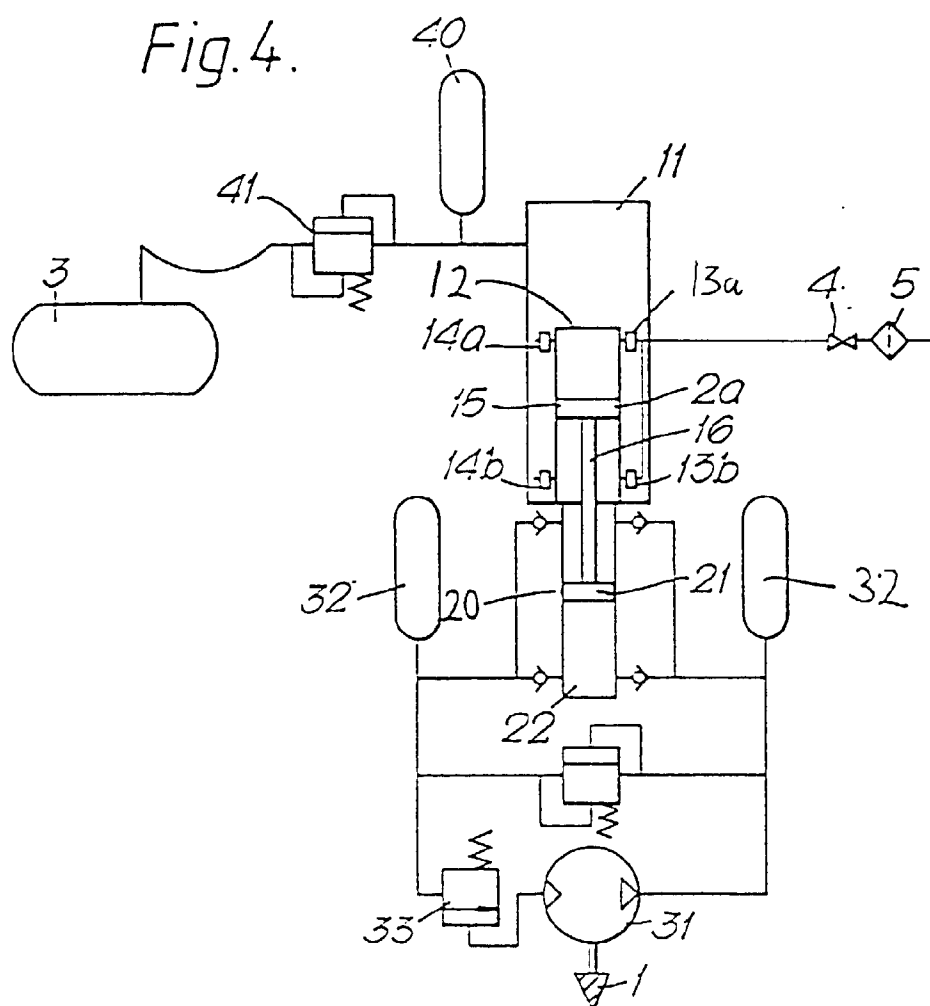


Fig.5.

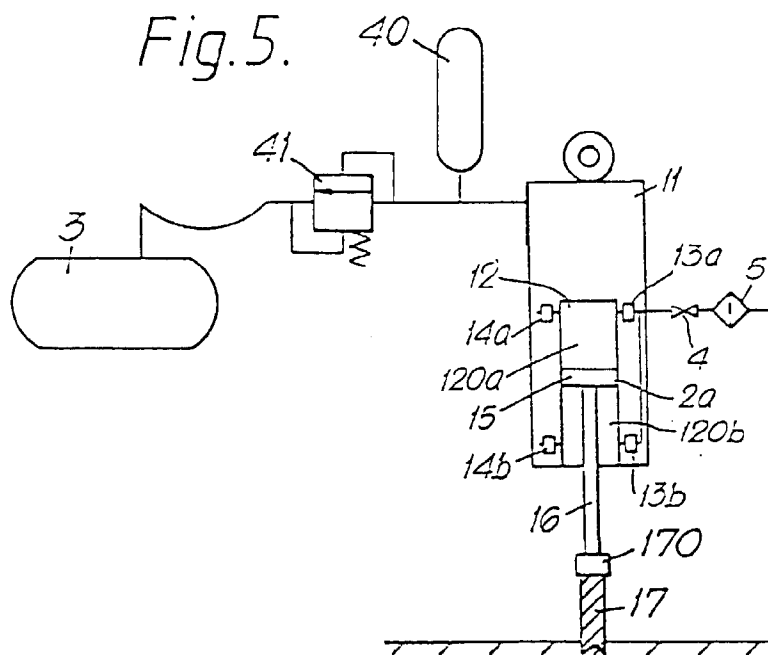


Fig. 6.

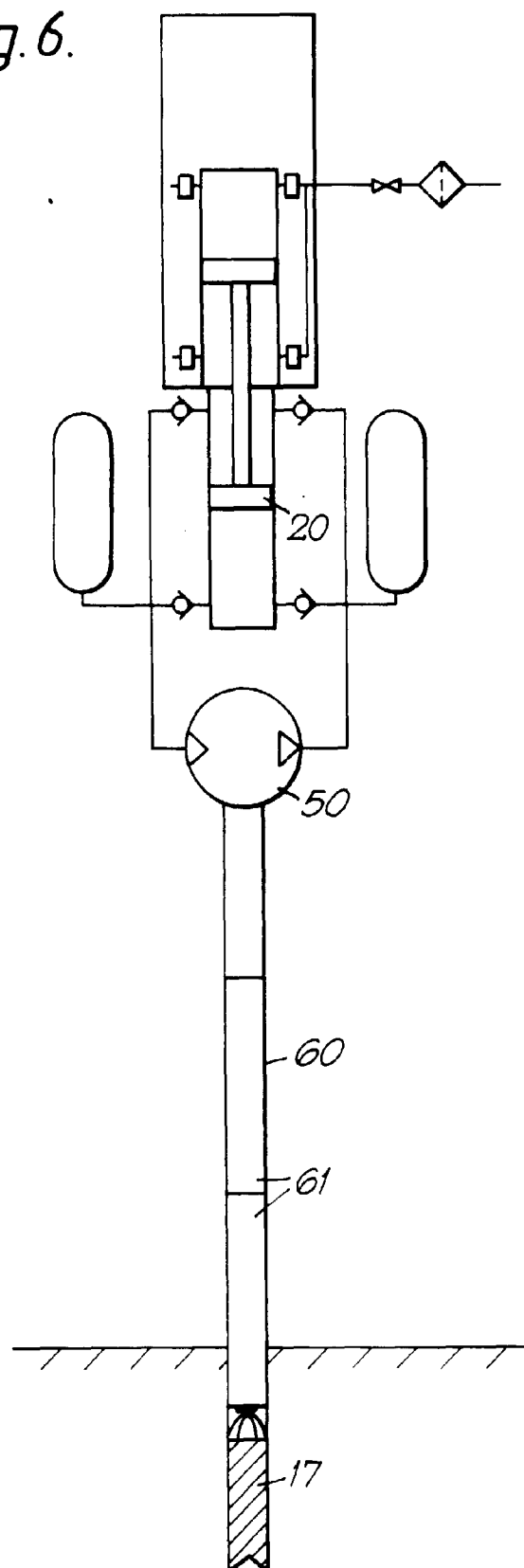


Fig.7.

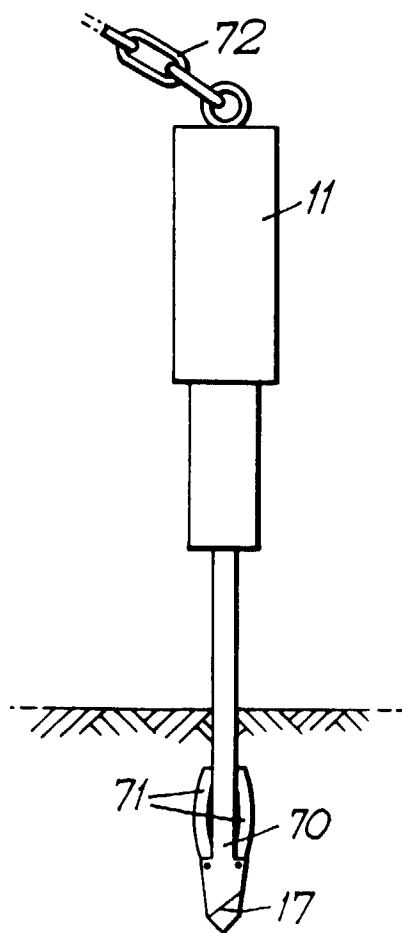


Fig.8.

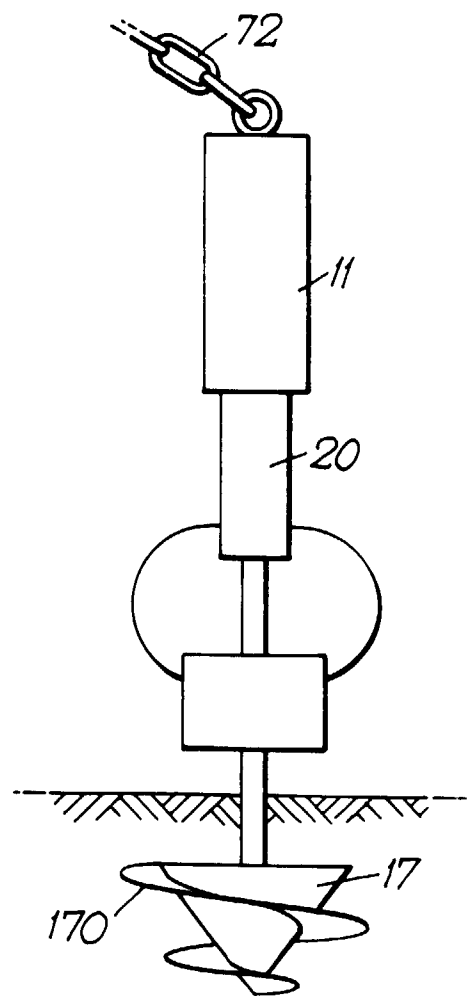


Fig. 9.

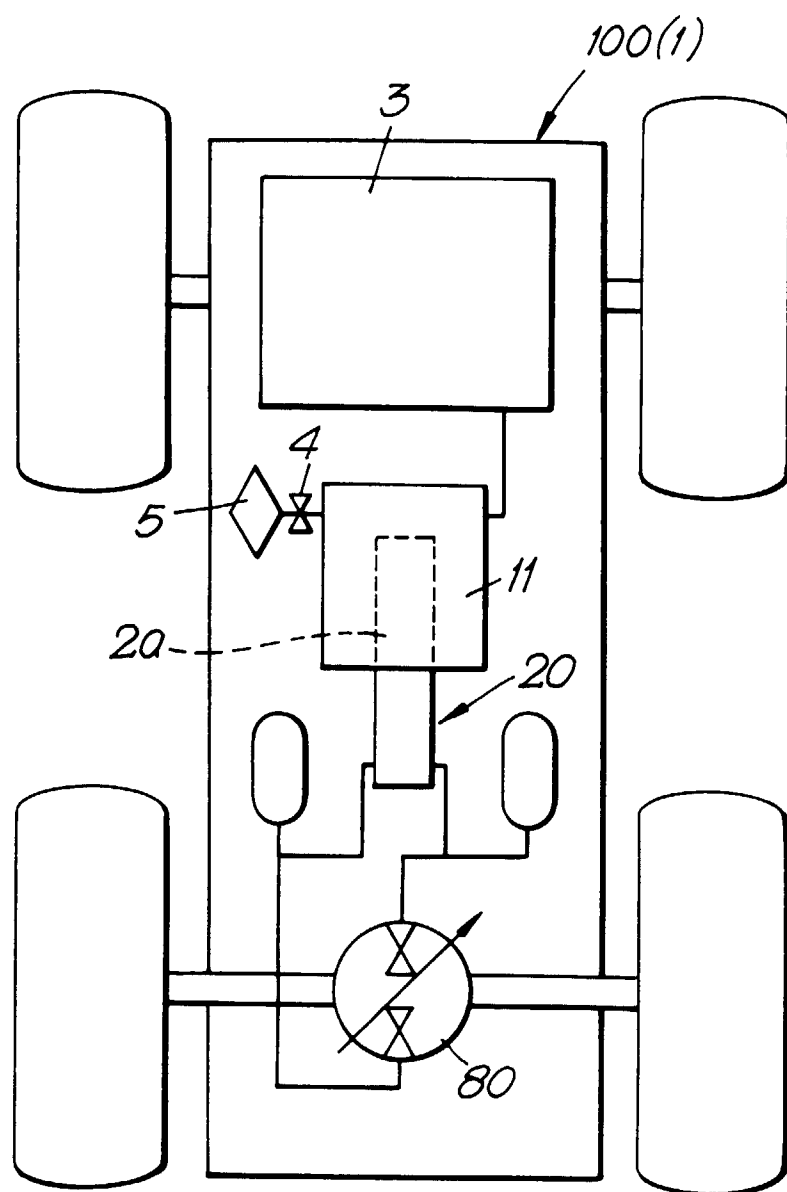


Fig.10.

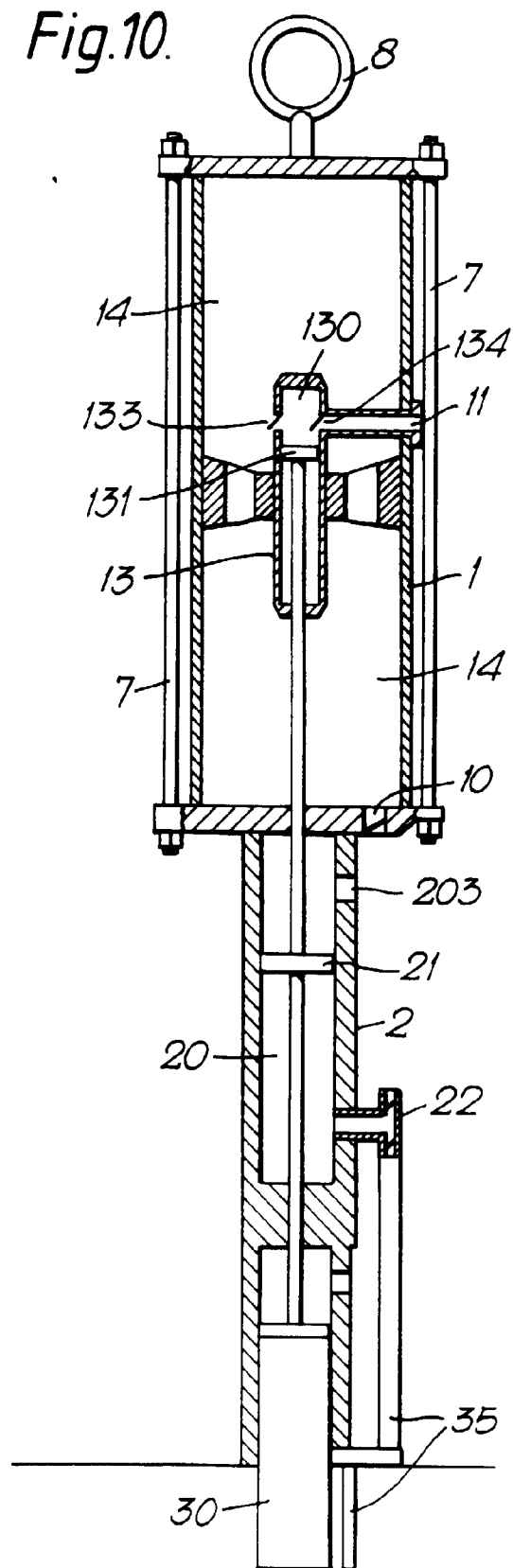


Fig. 11a.

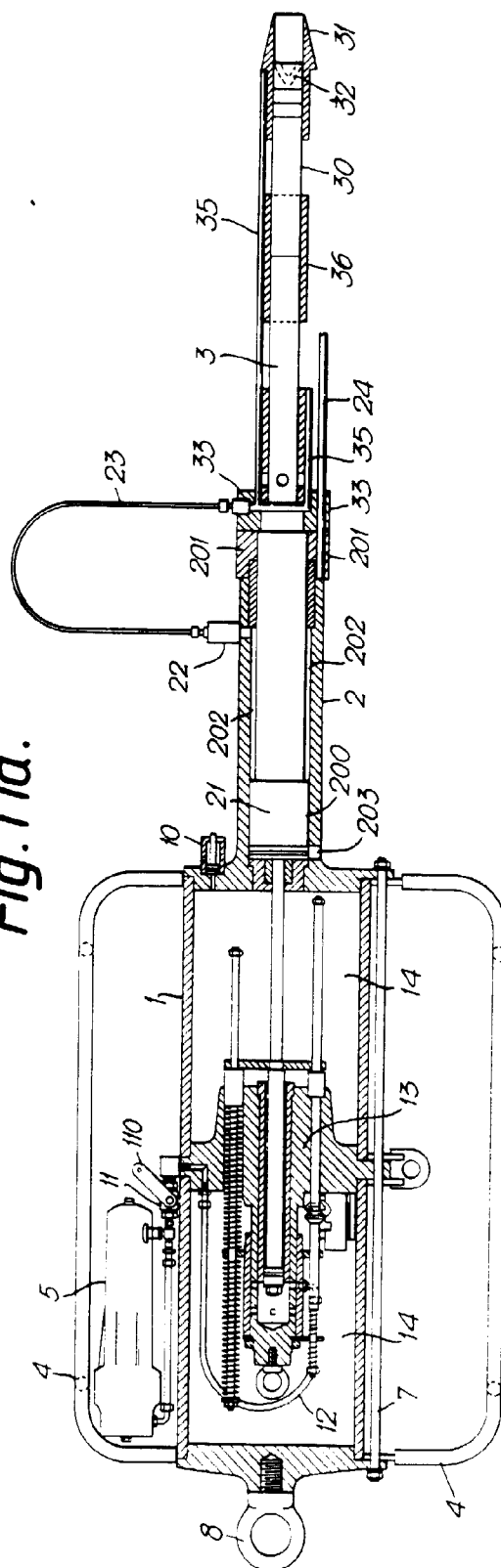


Fig. 11b.

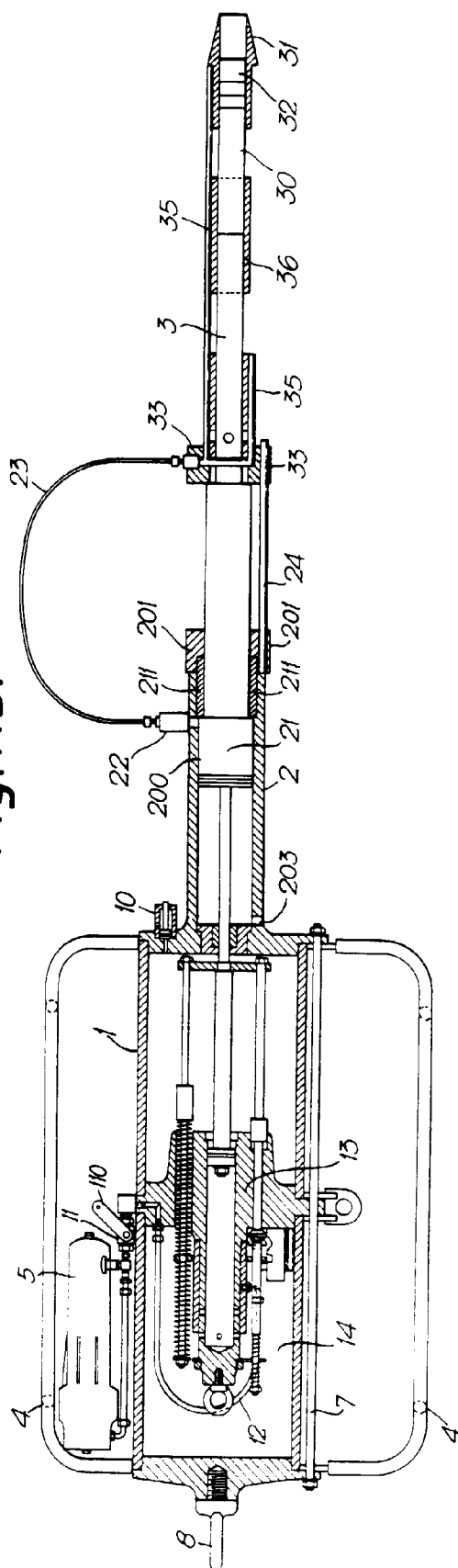


Fig. 12a

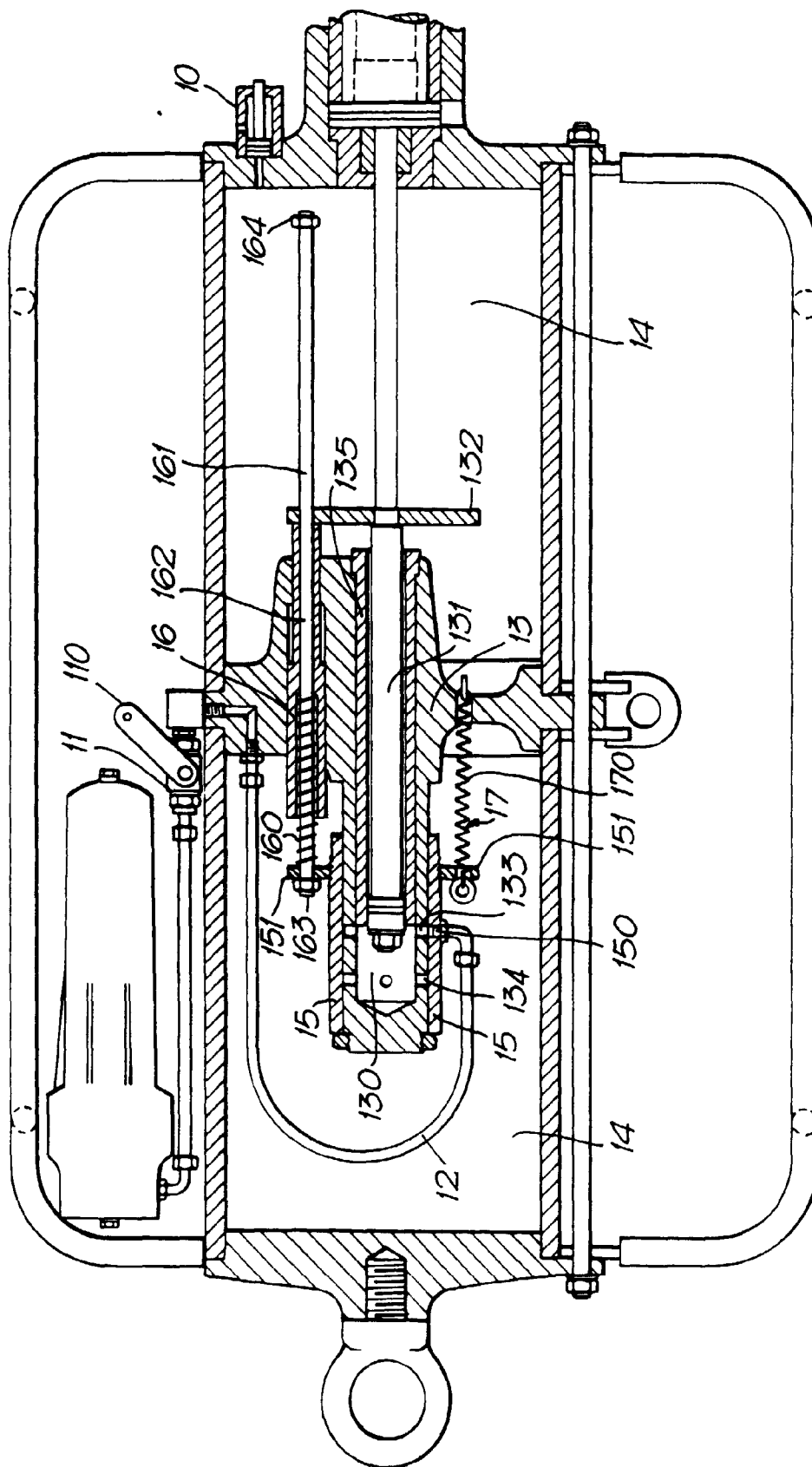


Fig. 12b

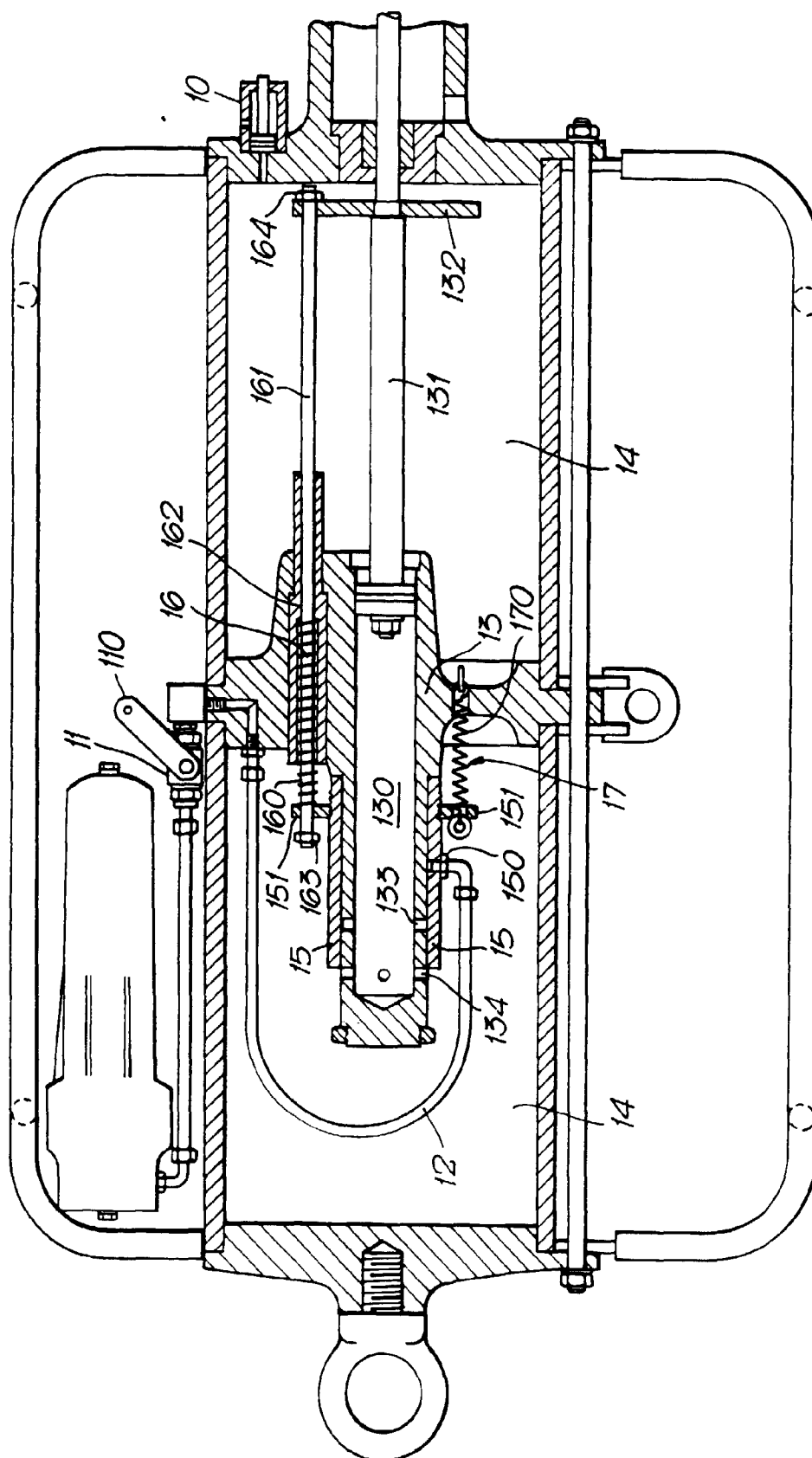


Fig. 13a

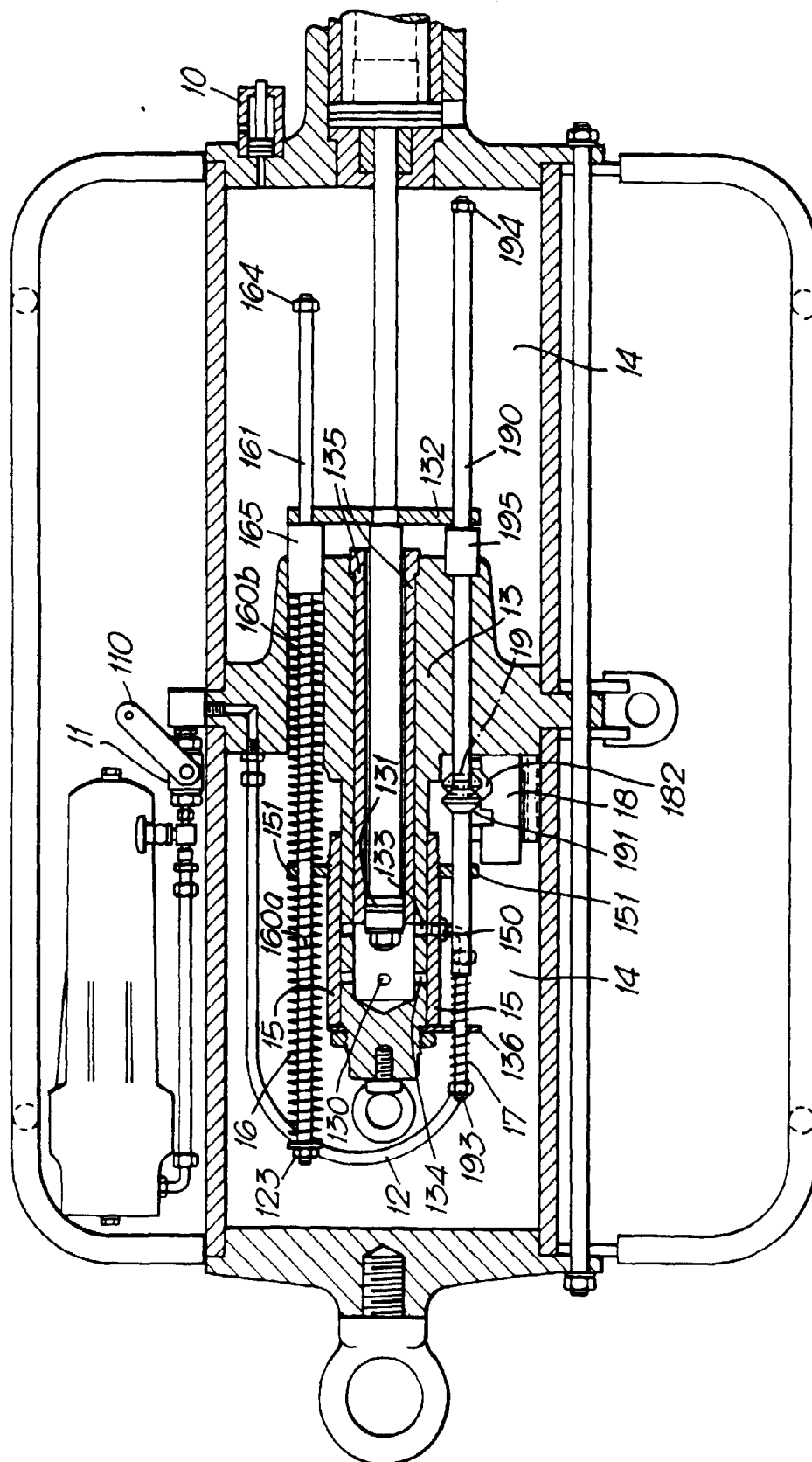


Fig. 13b

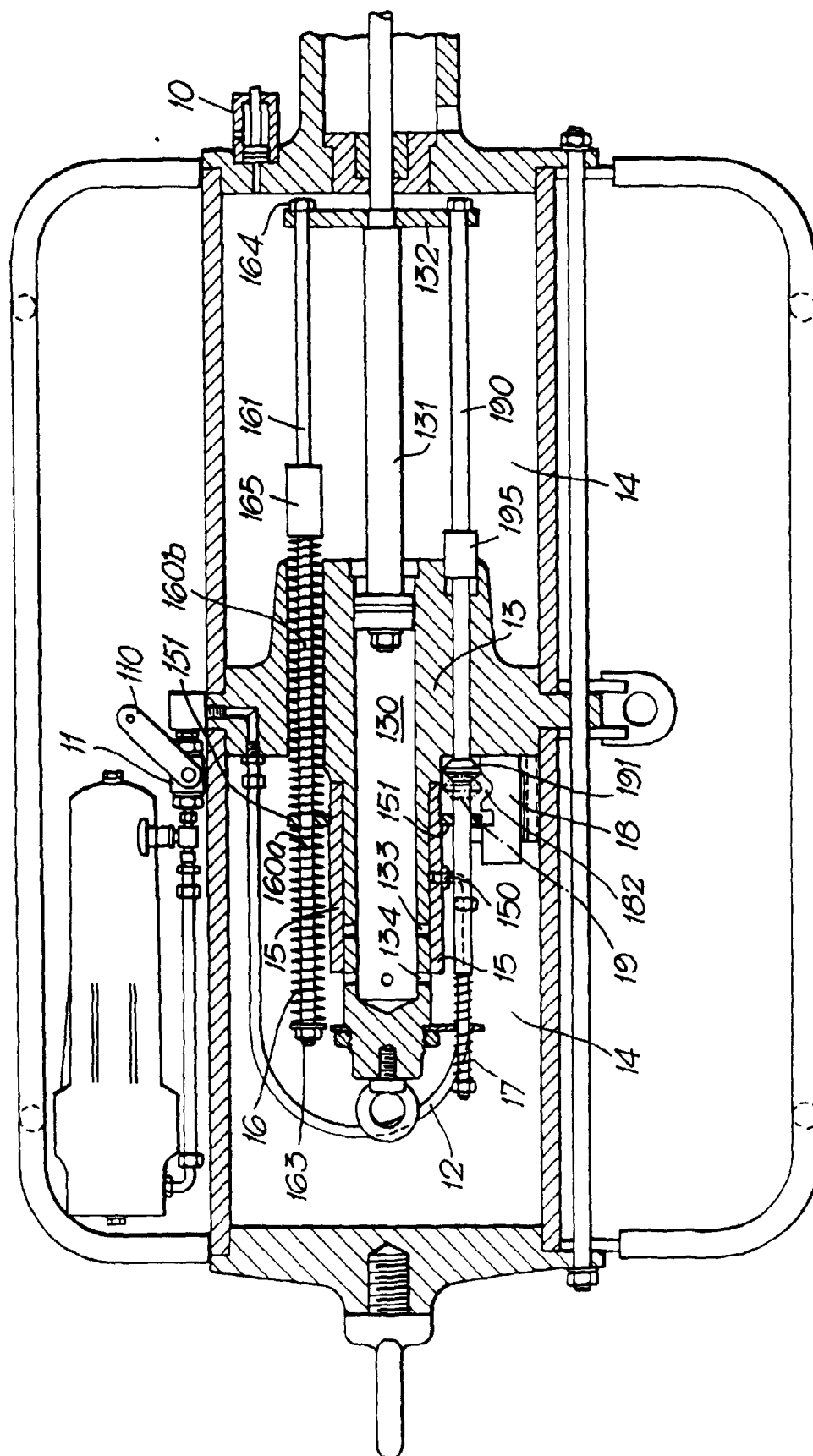
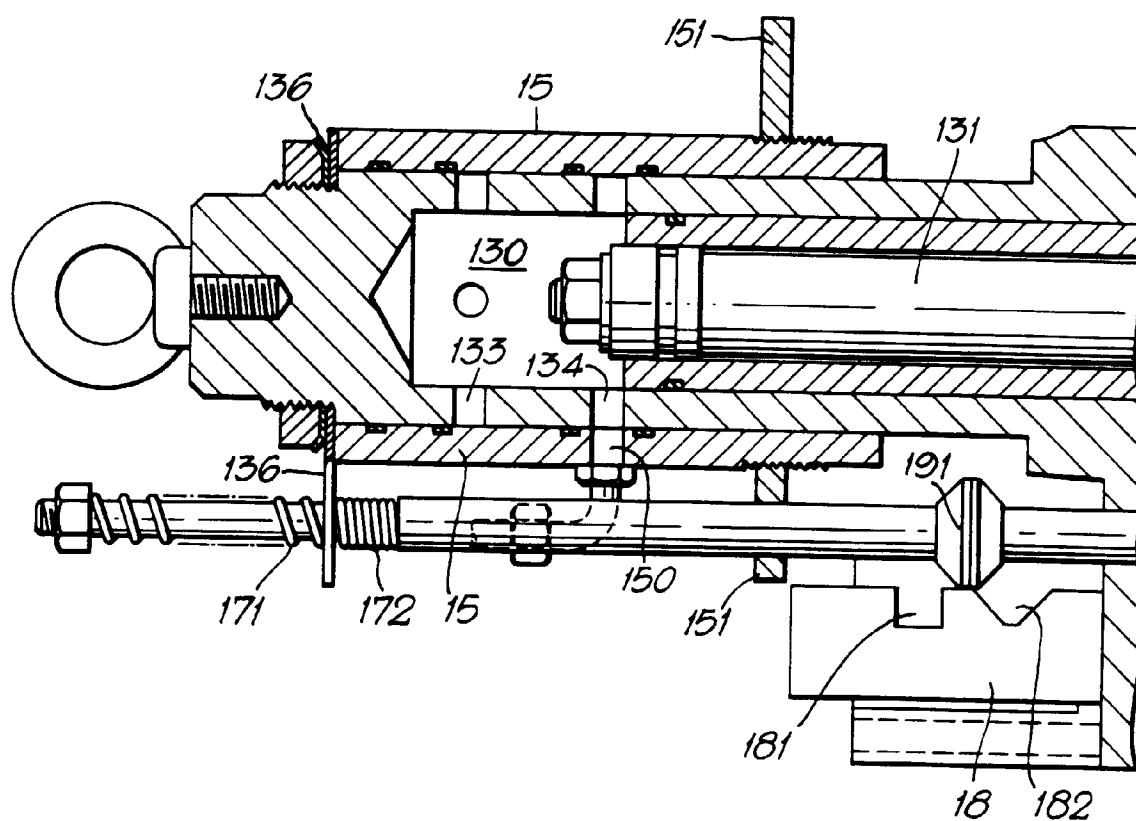


Fig. 14a.



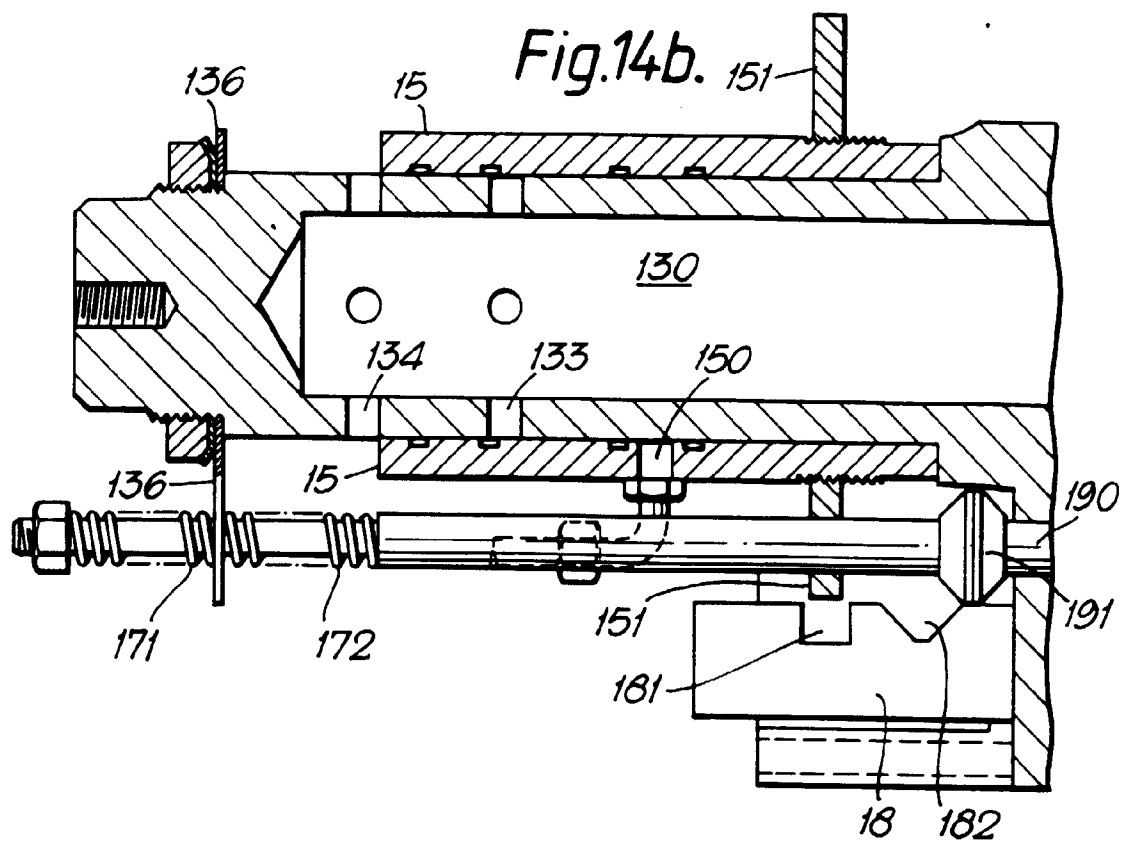


Fig.14c.

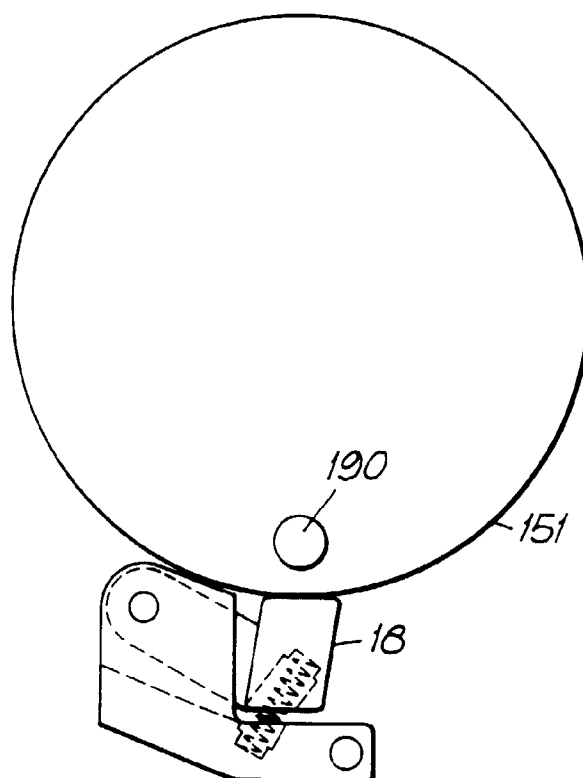


Fig.15.

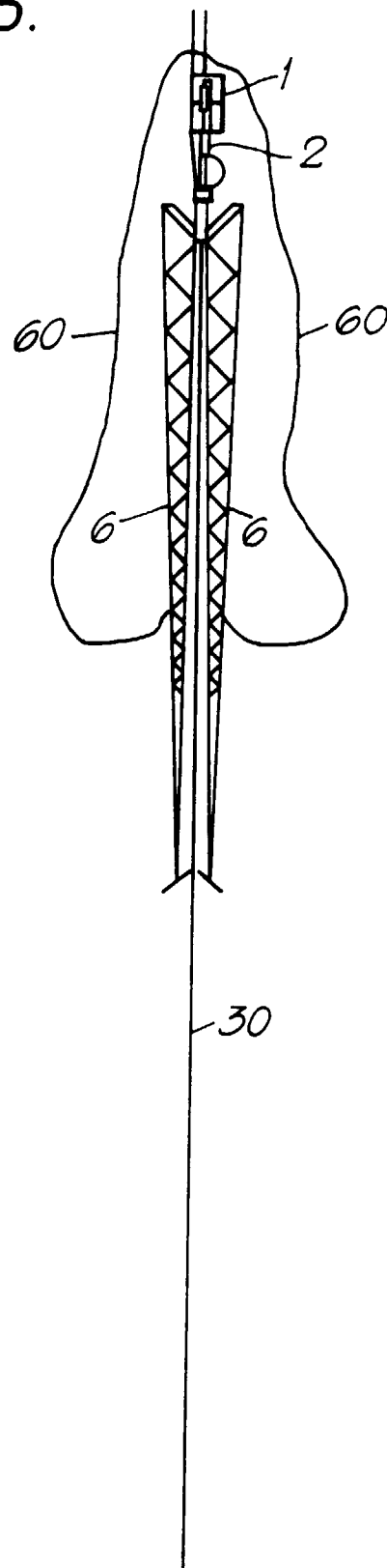


Fig. 16.

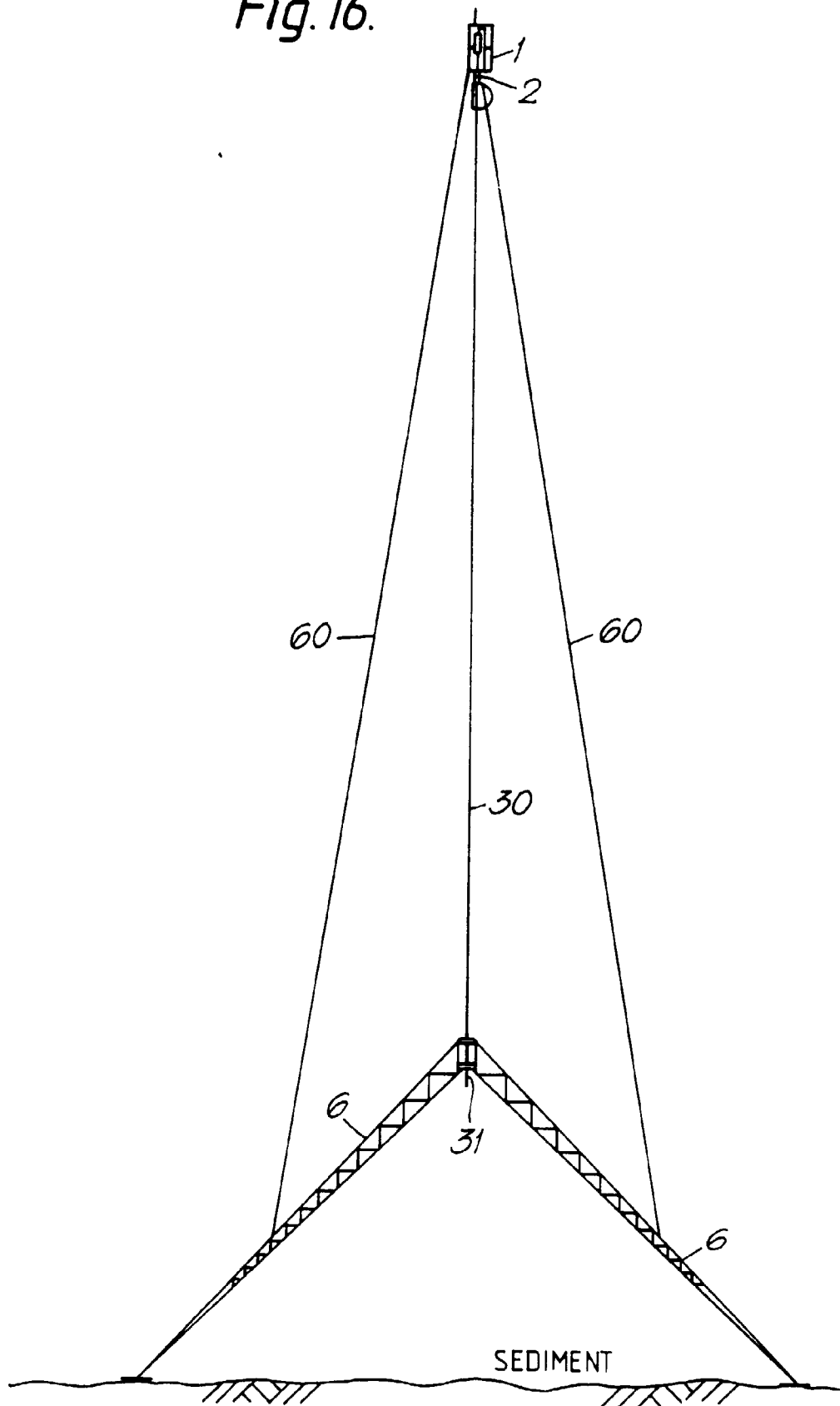


Fig.17.

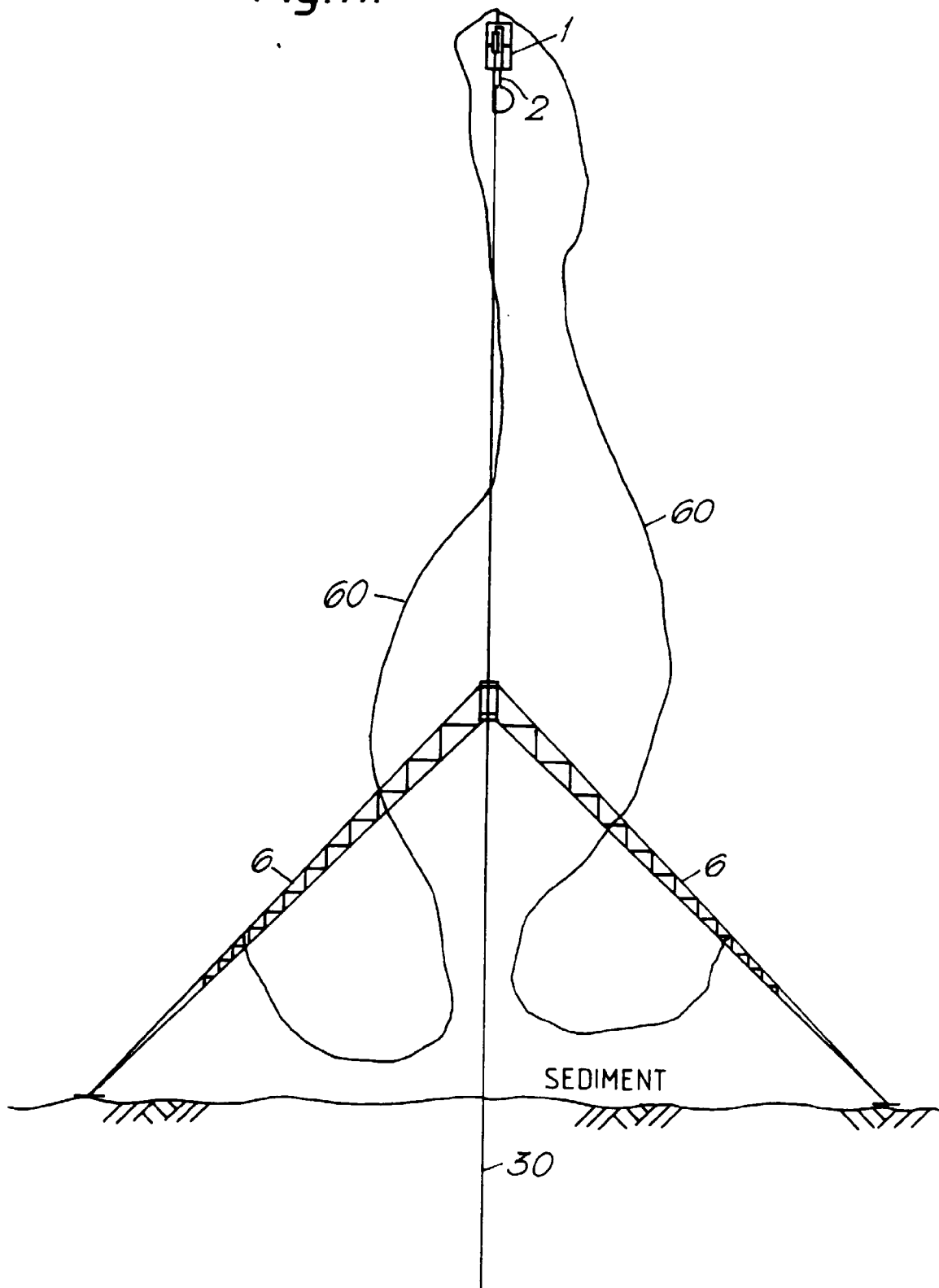


Fig.18.

