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(54) Device for displacing bottom material under water and method for applying such a device

(57) The invention relates to a device (1) for displacing bottom material (26) under water. The device comprises a frame (2) which is displaceable under water by being coupled to a vessel (17). The frame (2) comprises a tubular liquid container (3) with outflow openings (7) for a liquid directed toward the bottom (22), wherein the outflow openings (7) are placed such that during use the liquid is injected into or against the bottom (22). The device further comprises suction means (5a, 5b) driven by means of a drive (18) for supplying the liquid under pressure from a source to the container (3), wherein the suction means are situated under water during use, in addition to a pusher member (13) bounded on a base part thereof by a cutting edge (14). The invention also relates to a method for displacing bottom material under water by making use of a device according to the invention. The invented device can be utilized more flexibly than the existing device and is moreover more efficient.

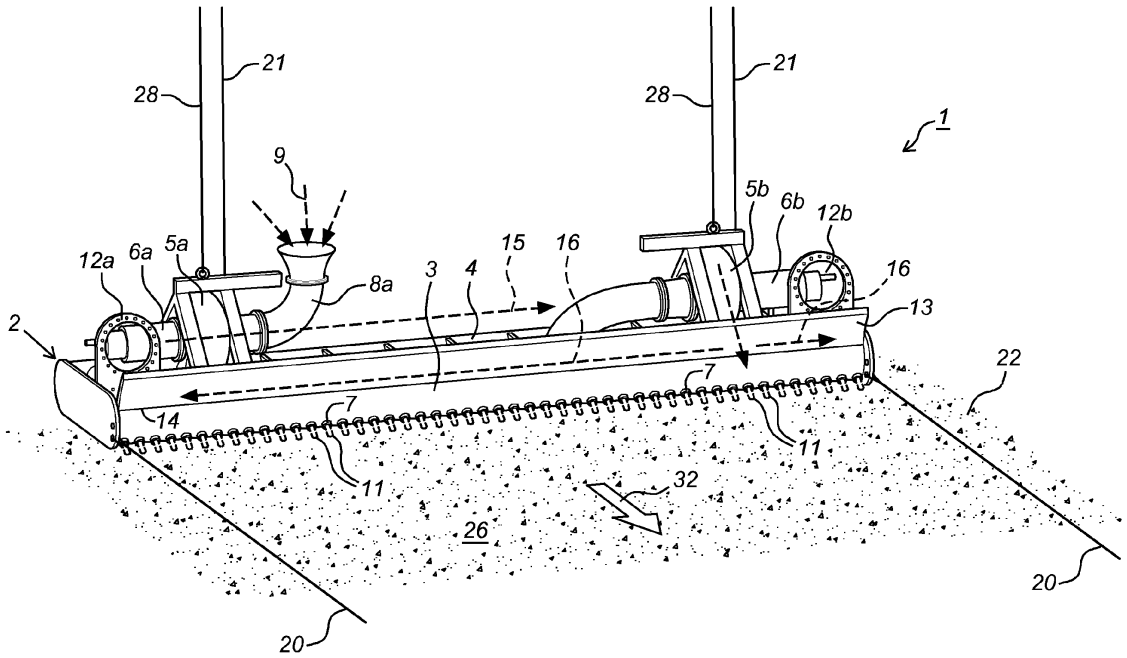

Fig. 2

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Description

[0001] The invention relates to a device and method for displacing bottom material under water.

[0002] Known from NL 8300990 is a method wherein a tubular container which is provided with outflow openings and is coupled to a vessel and connected to a source of water under pressure injects a small quantity of water into the layer to be treated such that this layer begins to act as a liquid and then, owing to its greater specific mass relative to water, flows to an area at a lower level or flows out over a flat bottom. The tubular container is coupled to the vessel by means of a steel pipe construction, wherein the pipe construction also serves to carry the water flow from above-deck pumps on the vessel to the tubular container. The pipe construction further ensures that the tubular container can be positioned properly relative to the underwater bottom. The water injection does indeed provide considerable reactive forces on the container, which could displace it to an undesirable extent. Using the known method sludge layers can be removed from deposition areas, such as harbour areas, with relatively little energy, without the liquefied sludge entering the surface water, which could result in contamination.

[0003] A drawback of the known method is that it is not sufficiently flexible because it can only be applied on vessels built or converted for this purpose. The efficiency of the known method is further open to improvement.

[0004] An object of the invention is therefore to provide a device and method which can be applied in more efficient and flexible manner than is possible with the known method.

[0005] The invention provides for this purpose a device according to claim 1. More particularly a device is provided for displacing bottom material under water, comprising a frame which is displaceable under water by being coupled to a vessel, which frame comprises a tubular liquid container with outflow openings for the liquid directed toward the bottom, which outflow openings are placed such that during use the liquid is injected into or against the bottom, wherein the device further comprises suction means driven by means of a drive for supplying the liquid under pressure from a source to the container, wherein the suction means are situated under water during use, in addition to a pusher member bounded on a base part thereof by a cutting edge. The drive for the suction means can comprise any drive available to the skilled person, such as for instance, though not limited to, a power generator and/or a hydraulic or electro-hydraulic power source. By making use of, among other parts, a tubular liquid container equipped with suction means located under water for the liquid, the steel pipe construction, which in the known device couples the tubular container to the vessel, can be dispensed with. The device according to the invention can hereby be coupled in simple manner to any type of vessel, such as for instance a ploughing vessel, tugboat, multicat or the like, whereby the utility of such a device becomes much more flexible. This has great logistical advantages. It has moreover been found that the suction means located under water evidently have sufficient weight to sufficiently stabilize the liquid tube against undesired displacements.

[0006] In order to enhance dislodging of bottom material, particularly in the case of harder or more coarse-grained bottoms, the device, and preferably the tubular container, is provided with a pusher member bounded on a base part thereof by a cutting edge. A base part of the pusher member is understood to mean a part situated in or against the bottom during use. The device according to the invention allows displacement of bottom material by means of injecting liquid jets from the outflow openings into the bottom. The device is held some distance from the bottom here by the pressure developed by the liquid jets on the bottom and the coupling to the vessel, this greatly enhancing the efficiency of the bottom material displacement. It thus becomes possible to displace more than 1000 m^3 of bottom material per hour, wherein quantities of more than 2000 m^3 of bottom material per hour and even more than 3000 m^3 of bottom material per hour are likewise possible. It may occur here that displaced bottom material accumulates elsewhere. Such an accumulation of displaced bottom material can then be efficiently removed with the pusher member at locations where removal with the liquid jets is less efficient.

[0007] It will be apparent from the above that the pusher member, and particularly the cutting edge thereof, is preferably placed relative to the outflow openings such that the device either displaces bottom material under the influence of the injection of liquid into or against the bottom, or by means of the pusher member. In the injection mode of the device, wherein the liquid jets are activated, the cutting edge of the pusher member will preferably be located at a height such that the pusher member hardly touches the bottom. In the pushing mode of the device the liquid jets are preferably deactivated and the cutting edge of the pusher member will preferably be located at a height such that the pusher member substantially comes into contact with the bottom and displaces bottom material.

[0008] In the case of softer bottoms, such as for instance (fine) sludge-containing bottoms, the liquid jets will usually be activated, while in the case of harder bottoms, such as for instance (coarse) sand-containing bottoms, the pusher member will be utilized. Optimal use is in this way made of the power to be employed, wherein this power comprises on the one hand propellor power for driving the vessel and the device connected thereto, and on the other power for driving the suction means for the purpose of feeding the liquid under pressure from a source to the container.

[0009] In a preferred embodiment of the device, the device comprises second outflow openings and/or nozzles adapted to emit water jets for the purpose of additionally stabilizing the liquid tube, wherein the outflow openings and/or nozzles are more preferably adapted such that the water jets are emitted in forward direction,

i.e. in upstream direction of the liquid tube.

[0010] The invention also relates to a method for displacing bottom material under water, comprising of coupling a device according to the invention to a vessel and displacing the device under water, wherein liquid is supplied from a source under pressure to a tubular liquid container of the device and injected under pressure out of the outflow openings and in the direction of the bottom, wherein the density of a treated mass of bottom material is reduced and this mass is displaced relative to the surrounding water.

[0011] The outflow openings can be located on the outer ends of the tubular container, although they may also be located between the outer ends, at irregular or regular mutual distances. It is also possible to provide outflow openings which extend substantially parallel and/or at a certain angle to the longitudinal axis of the container.

[0012] According to the invention the frame can be dragged under water by being connected to the vessel by means of tow-cables for moving the frame and, if desired, by means of lifting cables for lowering and raising the frame. It is also possible to provide the device with measuring and control means for the tension in and/or the payed-out length of the lifting and/or tow-cables.

[0013] The length of the tubular liquid container(s) can be chosen within wide limits, but is preferably a tube length corresponding to the width of the vessel or differing therefrom to only limited extent. The tubular container can however also be made longer, for instance by arranging attachments, thus further increasing the working width of the exiting liquid jets.

[0014] In an embodiment of the device according to the invention the drive which drives the suction means is located during use above water, in particular on the vessel, for instance above-deck, and is connected to the suction means by means of electrical cables and/or hydraulic hoses in the case of a hydraulic or electro-hydraulic power source. According to the present embodiment, the relatively heavy steel pipe construction, which in the known device carries a water flow to the liquid tube from pumps arranged above-deck, is replaced by several power cables and/or hydraulic hoses. A further advantage is that only a generator is required for the drive. Such a generator can be considerably lighter than the diesel-driven pump groups applied in the known device, so that relatively smaller boats can also be equipped with this system.

[0015] In order to avoid the electrical cables being damaged they are preferably protected, for instance by being guided along towing and/or lifting cables or being carried through an articulated tube mounted alongside the ship. A preferred embodiment is **characterized in that** the electrical cables connecting the power generator to the suction means are arranged on a self-tensioning cable reel. This measure limits the free length of the downward hanging electrical cables, so reducing the chance of damage.

[0016] Provided according to another embodiment of the invention is a device in which the source comprises the water surrounding the device and the suction means are provided on the suction side with an inlet for the surrounding water. In this embodiment the water in the area surrounding the device is suctioned in by the suction means located on the frame and guided under pressure to the outflow openings, where it is injected in the direction of the underwater bottom. Because the injected water is applied in the vicinity of the injection location there is no appreciable loss of pressure, this indeed being the case in the known device where the water is after all brought to pressure above-deck and guided through the pipe structure to the underwater bottom.

[0017] In order to avoid treated bottom material being suctioned in again by the suction means it is advantageous to characterize the device in that the inlet for the surrounding water lies between 1-10 m and more preferably between 2-5 m higher than the outflow openings of the container.

[0018] The suction means can comprise any suction means known to the skilled person which can operate under water. Particularly suitable is a per se known submerged pump. It has further been found that for good operation the suction means are preferably adapted to generate a liquid pressure between 1 and 2 bar. It is however possible to increase this liquid pressure, for instance with an embodiment comprising at least two suction means placed in series.

[0019] In another embodiment of the device according to the invention at least one suction means, and preferably all suction means, is adapted to generate a liquid flow rate of between 3000 and 7500 m^3/hour, preferably at a pressure between 1 and 2 bar, and preferably between 4000 and 6500 m^3/hour, preferably at a pressure between 1 and 2 bar. Not only are such flow rates found to produce the desired effect - displacement of bottom material - but also to ensure that the tubular liquid container is held substantially in position (in balance) by the suction means.

[0020] According to the invention the device can comprise one tubular liquid container, although an embodiment of the invention provides a device comprising at least two tubular liquid containers, both provided if desired with outflow openings. The liquid containers can be connected to each other by means of transverse ribs, this enhancing the stiffness of the device.

[0021] In a further embodiment of the device, the device comprises control means adapted to control the height of the outflow openings relative to the underwater bottom, wherein the control means comprise a least a computer which controls lifting means for the frame, such as for instance lifting winch(es), on the basis of depth information and/or depths measured by measuring means.

[0022] The device according to the invention can be applied in principle in combination with any vessel and is thus flexible in use. This advantage becomes still more manifest in an embodiment in which the frame, the tubular

liquid container(s) and/or the suction means can be divided or disassembled. Such an embodiment is easy to transport by land, sea or air, and is assembled on site.

[0023] The invention will now be further elucidated with reference to the following figures, without otherwise being limited thereto. In the figures:

Fig. 1 shows a perspective view of an embodiment of the device according to the invention;
Fig. 2 shows a perspective view of another embodiment of the device according to the invention; and
Fig. 3 shows a vertical cross-sectional view in longitudinal direction of an assembly of a vessel and a device according to the invention.

[0024] Device 1 for displacing bottom material 26 under water is provided with a towable frame 2 in which a tubular liquid container 3 with outflow openings 7 for a liquid directed toward the bottom 22 is received at least on the front side (or, if desired, on the rear side) . Outflow openings 7 are connected to an internal cavity of liquid container 3, which cavity acts operates as a distribution chamber for the liquid. In order to further strengthen frame 2, a second tubular element 4 can be arranged on the rear side of frame 2, this second tubular element 4 being rigidly connected by means of transverse plates 10 to liquid container 3. If desired, second tubular element 4 is likewise provided with an internal cavity, which can optionally serve as liquid container, and/or with outflow openings. Liquid containers 3 can have highly variable lengths, for instance 10-15 m, although shorter or longer tubes are possible.

[0025] Device 1 further comprises suction means in the form of two submerged pumps 5a, 5b of the centrifugal type. It is however possible to optionally apply one larger submerged pump or to work with a plurality of smaller submerged pumps, for instance three. In the embodiment shown in figure 1 the two pumps 5a, 5b are connected by means of an outlet 6a, 6b to liquid container 3 and draw in surrounding water via two inlets 8a, 8b as according to arrows 9. Pumps 5a, 5b are mounted on frame 2 so that they are situated under water during use. Outflow openings 7 operate as an array of nozzles directed substantially toward the bottom 22. The number of outflow openings 7 can be chosen within wide limits and depends on the length of the liquid containers and other factors. A liquid container 7 can for instance thus comprise one outflow opening every 10 cm, each provided with a suitable opening diameter as a function of the pump flow rate and the pressure developed by the pumps. It is possible in principle to first select the pumps such that they (together) have a working point at a desired flow rate and a desired pressure (for instance 12,000 m^3/h and 1.5 bar pressure). The intermediate distance between the outflow openings then defines the number of outflow openings that can be placed. The intermediate distance between the outflow openings amounts generally to between 0.15 m and 0.5 m, although other intermediate distances are possible. In order to ensure that the pump(s) will then operate at the correct working point the diameter of the outflow openings is finally calculated, wherein particularly suitable diameters lie between 50 mm and 120 mm. Suitable pressures lie generally between 1 and 10 bar, wherein a pressure of 1-2 bar is particularly suitable, with a flow rate depending on the overall pump power and the pressure. A suitable flow rate lies generally between 1500 and 15,000 m^3/hour. It is possible to uncouple inlets 8a, 8b and/or outlets 6a, 6b of pumps 5a, 5b from liquid container 3 via closing valves 12a, 12b.

[0026] For the purpose of balance and stability the pumps 5a, 5b are preferably mounted on frame 2 symmetrically relative to the central plane of tubular container 3, for instance at both outer ends. The weight of pumps 5a, 5b achieves a substantially stable horizontal towing position of device 1, wherein the reactive forces generated on bottom 22 by liquid jets 11 during the advance of device 1 over a bottom 26 are more or less counterbalanced by the weight of the device. Device 1 will hereby generally move a determined distance above ground surface 22 during use.

[0027] According to the invention the pumps 5a, 5b are situated under water during use and are electrically driven by one or more drives 18 which are situated above water during use, usually above-deck on vessel 17, and which are connected to pumps Sa, 5b by means of electrical cables 21 and/or hydraulic hoses (not shown) in the case a hydraulic or electro-hydraulic power source is applied. A suitable generator comprises for instance an 800 kVA generator with frequency control to enable variation of the flow rate of pumps 5a, 5b. The drive, and particularly the power generator, has to be adapted to the power required by the pumps, wherein a power must in any case be supplied which rises above the net pump power (desired pressure x desired flow rate) because of diverse losses which occur.

[0028] Device 1 is dragged along above a bottom surface 22 via tow-cables 20 coupled to frame 2 (in a towing direction 32 and usually at, though not limited to, a height of 5-25 cm, typically ten centimetres, above the bottom surface), wherein liquid container(s) 3 move substantially transversely of the towing direction 32. The dragging force is provided by a vessel 17 which can be provided at each corner with a propellor 23 for the purpose of an advantageous control. Lifting cables 28 are provided for lowering and raising device 1 in a more or less vertical direction 31. The surrounding water drawn in under pressure via inlets 8a, 8b is supplied under a pressure of preferably 1-2 bar to a tubular liquid container 3 of device 1 and injected under pressure out of outflow openings 7 in the direction of bottom 22, wherein the density of a treated mass of bottom material 26 is reduced to a density of preferably between 1050 and 1200 kg/m^3, and this mass 26 is displaced relative to the water lying upstream of the device. Device 1 can be coupled in simple manner to any vessel by making use of underwater pumps 5a,

5b, which increases the flexibility of use. The efficiency of displacing bottom material 26 is also found to increase.

[0029] In another embodiment, shown in figure 2, device 1, particularly tubular container 3, is further provided with a pusher member 13 bounded on a base part thereof by a cutting edge 14. This cutting edge 14 of pusher blade 13 can make contact with, and optionally cut into, bottom material 26 in order to facilitate 'flushing away' of bottom material 26 by the water jets 11 coming out of outflow openings 7. In the present embodiment it can moreover be advantageous for pumps 5a, 5b to be connected in series, whereby a water flow is created from inlet 8a of a first pump 5a via a connecting tube (shown schematically with broken lines 15) between pumps 5a, 5b to outlet 6b of pump 5b and into liquid container 3 (see arrows 16). A higher pressure can hereby be developed. The bottom material 26 for displacement is transported over a distance to another area below water line 27, for instance a deeper-lying area. The result is a levelled, deeper bottom level 22.

[0030] It is finally noted that the device according to the invention can preferably be divided or disassembled, particularly frame 2, the tubular liquid container(s) 3 and/or suction means 5. This allows easy (dis)assembly and transportation of the device.

Claims

1. Device for displacing bottom material under water, comprising a frame which is displaceable under water by being coupled to a vessel, which frame comprises a tubular liquid container with outflow openings for the liquid directed toward the bottom, wherein the outflow openings are placed such that during use the liquid is injected into or against the bottom, wherein the device further comprises suction means driven by means of a drive for supplying the liquid under pressure from a source to the container, wherein the suction means are situated under water during use, in addition to a pusher member bounded on a base part thereof by a cutting edge.

2. Device as claimed in claim 1, wherein the tubular container is provided with the pusher member.

3. Device as claimed in any of the foregoing claims, wherein the source comprises the water surrounding the device and the suction means are provided on the suction side with an inlet for the surrounding water.

4. Device as claimed in claim 3, wherein the inlet for the surrounding water lies between 2-5 m higher than the outflow openings of the container.

5. Device as claimed in any of the foregoing claims, wherein the suction means comprise a submerged pump.

6. Device as claimed in any of the foregoing claims, comprising at least two tubular liquid containers.

7. Device as claimed in any of the foregoing claims, comprising closing valves for the inlet and the outlet of the suction means.

8. Device as claimed in any of the foregoing claims, comprising at least two suction means placed in series.

9. Device as claimed in any of the foregoing claims, wherein a suction means is adapted to generate a liquid pressure between 1 and 2 bar.

10. Device as claimed in any of the foregoing claims, wherein a suction means is adapted to generate a liquid flow rate of between 3000 and 7500 m^3/hour at a pressure between 1 and 2 bar.

11. Device as claimed in any of the foregoing claims, wherein the frame, the tubular liquid container(s) and/or the suction means can be divided or disassembled.

12. Device as claimed in any of the foregoing claims, wherein the device comprises control means adapted to control the height of the outflow openings relative to the underwater bottom, wherein the control means comprise a least a computer which controls lifting means for the frame, such as for instance lifting winch(es), on the basis of measurement data and/or on the basis of depths measured by measuring means.

13. Device as claimed in any of the foregoing claims, wherein the device comprises second outflow openings and/or nozzles adapted to emit water jets for the purpose of additionally stabilizing and/or steering the liquid tube.

14. Method for displacing bottom material under water, comprising of coupling a device as claimed in any of the foregoing claims to a vessel and displacing the device under water, wherein liquid is supplied from a source under pressure to a tubular liquid container of the device and injected under pressure out of the outflow openings into or against the bottom, wherein the density of a treated mass of bottom material is reduced and this mass is displaced relative to the surrounding water.

15. Method as claimed in claim 14, wherein the supply of the liquid is interrupted and a mass of bottom material is displaced by means of contact with the pusher member.

16. Method as claimed in claim 14 or 15, wherein the device suctions in surrounding water with the suction means via an inlet provided on the suction side and the surrounding water is suctioned in at a height lying between 2-5 m higher than the outflow openings of the container.

17. Method as claimed in any of the claims 14-16, wherein the liquid is injected at a liquid pressure of between 1 and 2 bar and at a liquid flow rate of between 1500 and 15000 m^3/hour through the outflow openings.

18. Method as claimed in any of the claims 14-17, comprising of controlling the height of the outflow openings relative to the underwater bottom by controlling lifting means for the frame by means of a computer on the basis of depth information and/or by measuring depths.

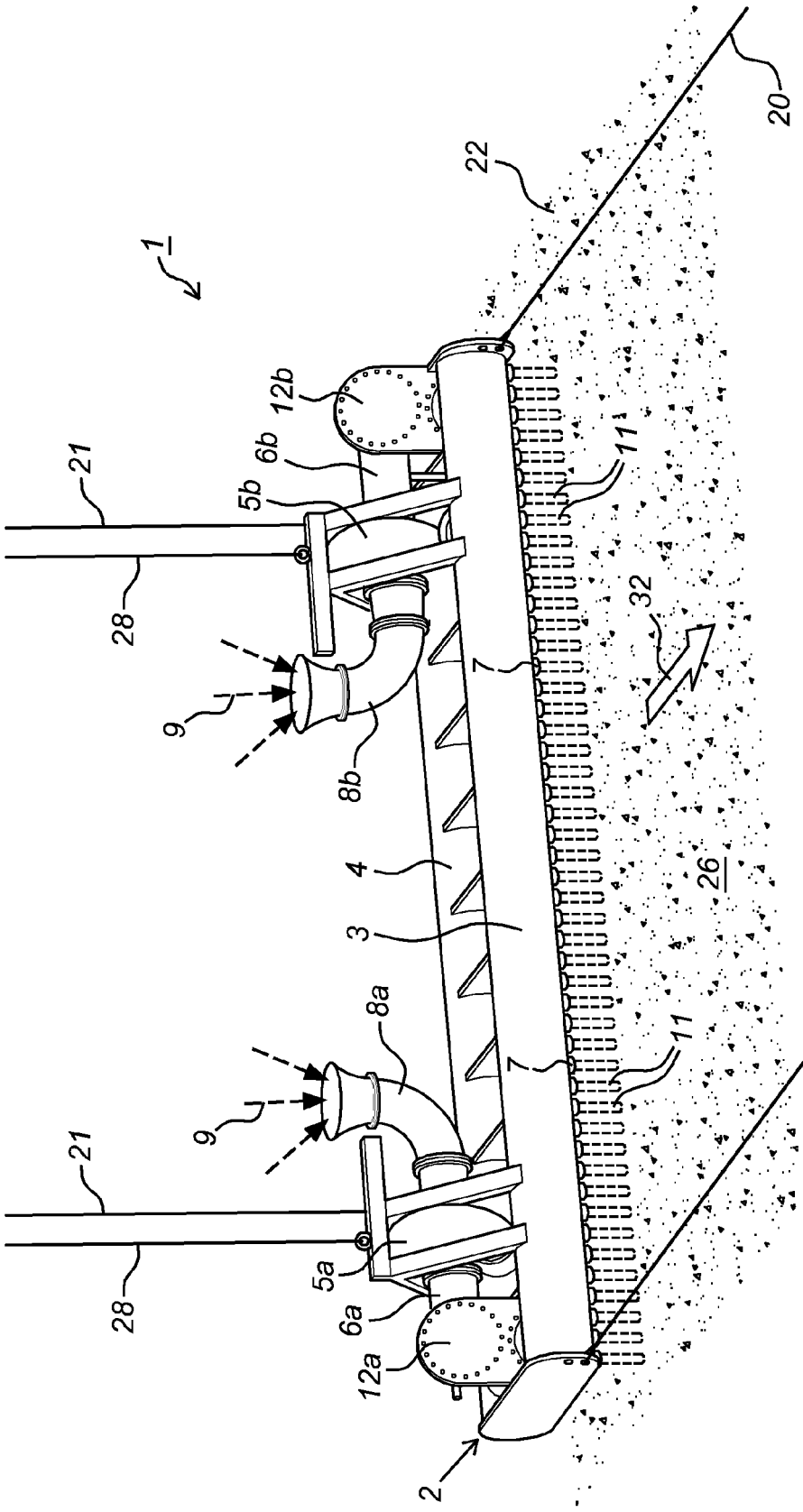

Fig. 1

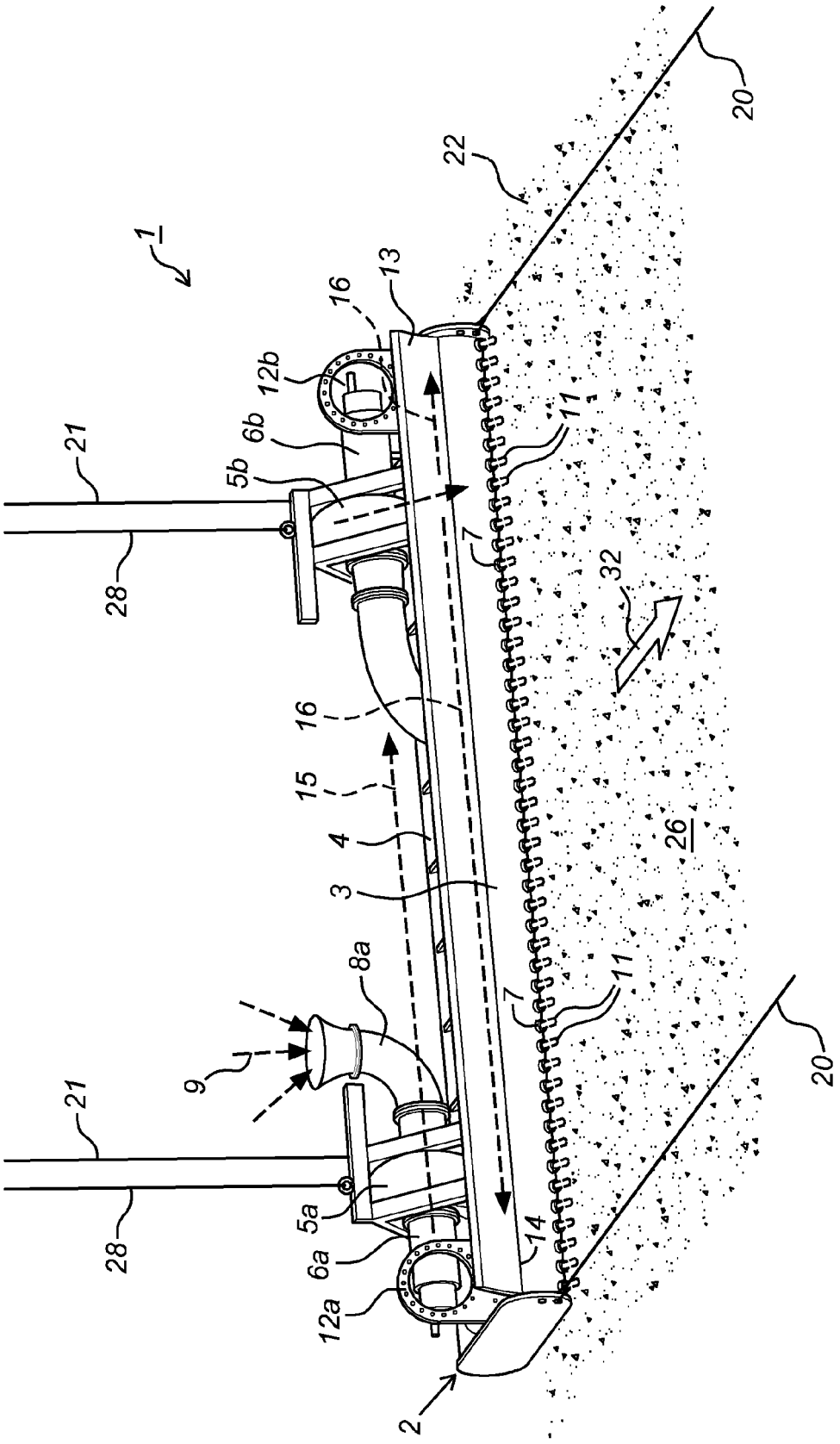

Fig. 2

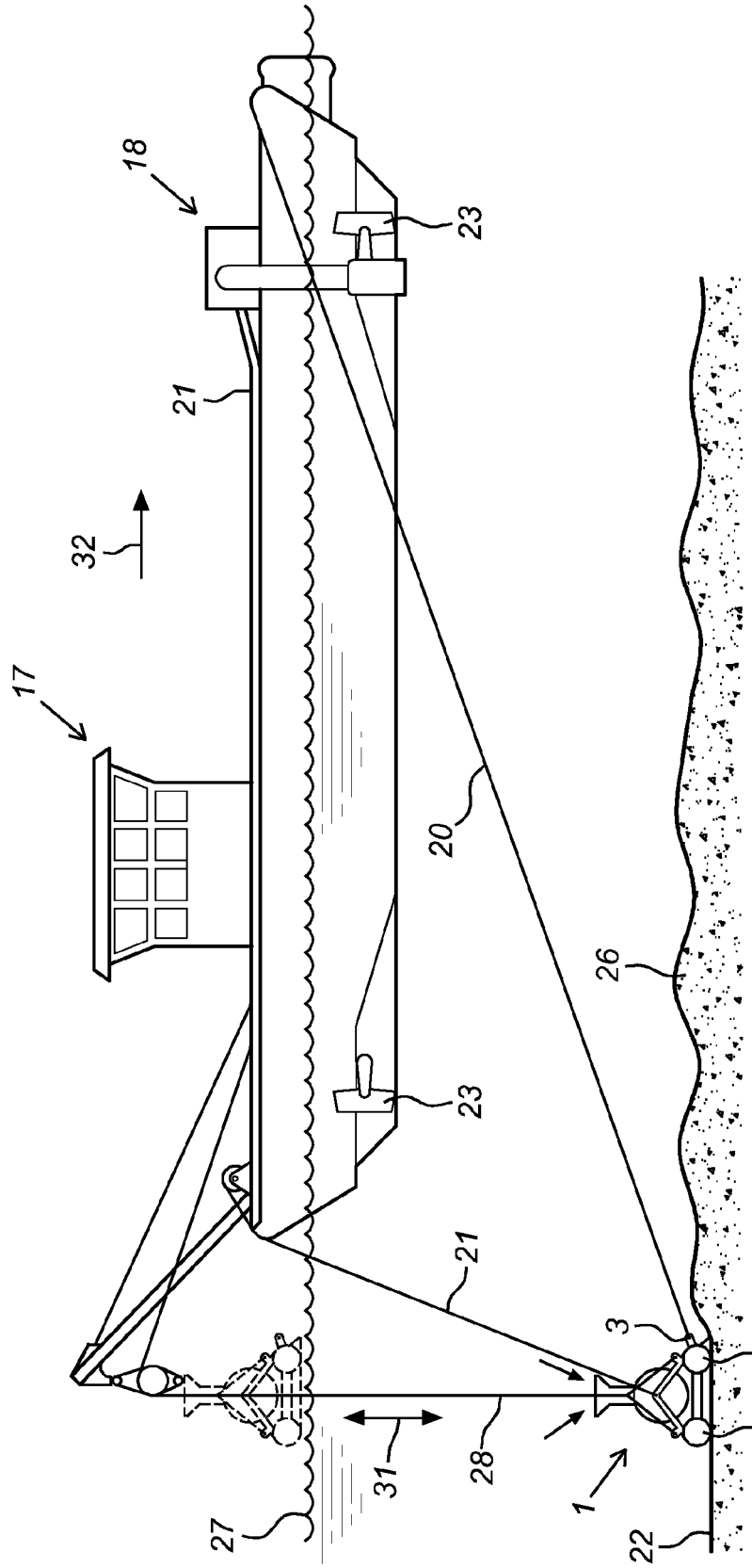

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 12 17 5117

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Y	WO 02/090667 A1 (PROGENITIVE SERVICES LTD [GB]; BROWN PHILIP GWYN [GB]) 14 November 2002 (2002-11-14) * figures 1a, 1b, 2, 8 * * page 18, line 13 - page 19, line 6 * * page 29, line 10 - line 18 * -----	8	
Y	WO 95/27832 A1 (HOLLANDSCHE BETONGROEP NV [NL]; SMIT PAUL [NL]; SCHUIT ADRIANUS JACOBU) 19 October 1995 (1995-10-19) * figure 2; examples 2, 3, 10 * -----	9,10,17	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 November 2012	Bultot, Coralie

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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