

Device and method for arranging a layer of material of predetermined height level on an underwater bottom

The invention relates to a device for arranging a layer of material of predetermined
5 height level on an underwater bottom. The invention likewise relates to an assembly of
the device and a floating structure, and a method for arranging a layer of material on an
underwater bottom making use of the invented device.

Arranging a layer of material under water may for instance be necessary in the context
10 of laying a foundation for a construction to be placed on an underwater bottom. A non-
limitative example is for instance a foundation for tunnel elements. During placing of a
tunnel under water a number of tunnel elements are placed joined together on a
foundation layer. Among other materials, the foundation layer comprises stony
materials such as for instance gravel. The height level of such a foundation layer has to
15 be precisely determined along the length and width thereof. Among other reasons, this
is necessary in order to have the tunnel elements fit together properly and to provide
sufficient support to the tunnel elements.

In a known method a quantity of material is poured onto the underwater bottom and
20 subsequently smoothed out with a levelling element. Such a method does not however
have the desired effect, and particularly not when a material layer has to be arranged
with a height level which may only vary to a limited extent from a design height level.
It is thus important for a foundation of tunnel elements that the variations in arranged
height level preferably do not exceed ± 25 mm relative to the design height level, and
25 this over the whole width and length of the foundation. In view of the relatively large
dimensions of a tunnel foundation, for instance 50 m wide and tens of kilometres in
length, this is no easy task, all the more so as the foundation layer must be arranged
underwater. The greater the depth of the underwater bottom, for instance 20 m and
more, the more difficult the task becomes.

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The invention has for its object to provide an improved device and method for arranging
a layer of material on an underwater bottom.

- Provided for this purpose is a device according to claim 1. Particularly provided is a device which comprises a bearing frame provided with buoyancy regulating means configured to carry the bearing frame under water; with support means configured to place the bearing frame on an underwater bottom; and with a throughfeed unit for the material, wherein the throughfeed unit comprises an inlet along which the material is received and an outlet along which the material is deposited onto the underwater bottom, wherein the outlet of the throughfeed unit is movable relative to the bearing frame.
- 10 In a method according to the invention a layer of material of predetermined height level is arranged on an underwater bottom by providing an embodiment of the invented device; carrying the bearing frame under water and placing it on the underwater bottom; feeding material via the inlet to the throughfeed unit; moving the outlet of the throughfeed unit relative to the bearing frame placed on the underwater bottom; and
- 15 depositing the material via the outlet of the throughfeed unit onto the underwater bottom, wherein the throughfeed unit remains at least partially filled. Because the bearing frame is placed on the underwater bottom and hereby hardly moves, or moves to known extent, and the outlet of the throughfeed unit moves in known manner relative to the bearing frame, the outlet of the throughfeed unit will move in accurate and known
- 20 manner relative to the underwater bottom. The device according to the invention allows the position, in particular the height position, of the throughfeed unit, in particular the outlet of the throughfeed unit, to be adjusted and determined relative to the bottom surface. By holding the throughfeed unit at the desired height relative to the bottom surface and keeping the throughfeed unit at least partially filled it is possible to arrange
- 25 a layer of material of precisely determined height level, preferably with a variation of a maximum of ± 25 mm relative to a design height level, this over the whole width and length of the arranged layer. A layer of material smoothed to the design height level can be obtained by moving the throughfeed unit.
- 30 Using the device and method according to the invention the thickness of a foundation layer can be precisely adjusted and determined over the length and width thereof. Tunnel elements placed on the foundation layer hereby fit together properly. The foundation layer precisely deposited on the bottom moreover imparts a good support to

the tunnel elements such that they require less reinforcement and can thereby be given a lighter form.

Although the device according to the invention is particularly suitable for laying a
5 foundation layer under water, it can also be advantageously applied in other
circumstances. It is thus possible for instance to apply the device and method for the
purpose of providing underwater pipelines and other structures with a protective layer.
In the context of the present invention the term 'underwater bottom' thus also includes
'structures arranged on or in the underwater bottom'. The material for arranging on the
10 underwater bottom or other structure located underwater can comprise any material that
is usually applied, such as for instance sand, grit, clay, rocks, pieces of concrete or
cement and the like.

The invention also has particular advantages for arranging a layer of material at great
15 depth on an underwater bottom. Depths can vary here from several metres to 600 m and
more.

Provided in an embodiment of the invention is a device, the support means of which are
configured to immobilize the bearing frame relative to the underwater bottom. This can
20 for instance take place with support means in the form of pins to be driven into the
ground. A further increased accuracy in the arranging of the material can be achieved by
immobilizing the bearing frame in the plane of the underwater bottom and, if desired,
also perpendicularly thereof (in the height).

25 Another embodiment of the invention relates to a device in which the support means are
configured to adjust the height of the outlet of the throughfeed unit relative to the
underwater bottom. In a suitable embodiment the support means comprise hydraulic or
gear rack jacks with which the height of the bearing frame can be set relative to the
underwater bottom. The height of the outlet of the throughfeed unit is hereby also set
30 relative to the underwater bottom. In another suitable embodiment the device comprises
second means configured to adjust the height of the outlet of the throughfeed unit
relative to the underwater bottom. This can for instance be achieved by connecting the
throughfeed unit to the bearing frame via hydraulic or gear rack jacks.

The bearing frame has to be carried under water during use. In an embodiment of the device according to the invention this is achieved in that the bearing frame comprises frame parts provided with buoyancy regulating means. Suitable buoyancy regulating means comprise chambers or containers into which a liquid, preferably water, and/or a gas, preferably air, can be admitted and from which it can be drained. A particularly suitable embodiment comprises a bearing frame with frame parts in the form of box girders, an internal cavity of which serves as chamber or container for the liquid and/or the gas. Admitting the liquid and/or the gas into and allowing it to escape from a chamber or container can be performed with known means, for instance by providing the chamber or container with valves to which pressure hoses are connected.

It is advantageous in an embodiment to exchange liquid ballast using a ballast pump so that the gas volume to be supplied remains limited.

In order to further increase the precision with which the material is arranged it is advantageous to characterize the device according to an embodiment in that the frame parts span a distance and the buoyancy regulating means are positioned at the location of the centre of the span. Frame parts spanning a distance comprise for instance elongate beams which have a tendency to bend. This does not improve the accuracy of the height level of the arranged material. This bending can be reduced by now providing the beams along preferably their whole length with buoyancy regulating means. For instance in the case the beams bend in the direction of the bottom surface, gas-filled chambers of box girders or gas-filled containers arranged on the beams will exert an upward force, whereby the bending is at least partially eliminated.

A practical embodiment of the device according to the invention comprises a bearing frame which extends substantially in a plane and wherein the outlet of the throughfeed unit is movable in the plane within contours of the bearing frame. The plane of the bearing frame preferably runs substantially parallel to the bottom surface during use. The contours of the bearing frame are preferably formed in this embodiment by outer frame parts of the bearing frame. The dimensions of the bearing frame can be selected within broad limits, and depend on, among other factors, the dimensions of the material layer to be arranged. The selected longitudinal and transverse dimensions of a planar

bearing frame can for instance lie between 1 and 100 m, preferably between 5 and 80 m and most preferably between 20 and 50 m.

According to the invention the outlet of the throughfeed unit is movable relative to the bearing frame, and therefore also relative to an underwater bottom on which the bearing frame has been placed or immobilized. The throughfeed unit can if desired take a (partially) flexible form between the inlet and the outlet, for instance comprise a flexible tube. In such an embodiment it is possible to hold the inlet of the throughfeed unit at a fixed position and to move only the outlet or a part of the throughfeed unit located close to the outlet.

The movement of the outlet of the throughfeed unit can take place in any manner known to the skilled person. It is thus possible for instance to attach at least the outlet or a part of the throughfeed unit located close to the outlet to a frame part movable relative to other frame parts. In an embodiment in which the bearing frame extends substantially in a plane and is formed by a rectangular framework of for instance longitudinally and transversely running frame parts, the outlet or a part of the throughfeed unit located close to the outlet can be attached to a transverse frame part which can travel on longitudinally running frame parts. The movable frame part can be provided for this purpose with a gear rack drive or can be moved by cables running over winches.

In an embodiment the throughfeed unit of the invented device comprises a pipe part and/or an elongate holder. The height of the pipe part or the holder can be selected within broad limits but is preferably relatively low. The throughfeed unit can hereby be moved relatively easily and with a force which is not very great. An elongate holder can increase the production speed, particularly when the longitudinal direction of the holder extends transversely of the direction of movement of the holder.

In order to obtain a flat layer with an even more precisely determined height level, an embodiment of the invention comprises a device in which an edge of the outlet of the throughfeed unit comprises a skimming element, preferably a skimming edge.

In a simple embodiment of the device according to the invention the throughfeed unit is movable in its entirety relative to the bearing frame. The throughfeed unit preferably forms a rigid body in such an embodiment.

- 5 During the movement of the outlet of the throughfeed unit over the bottom surface, according to the invention this throughfeed unit is preferably also filled with material to be arranged. In order to facilitate receiving of material via the inlet, in an embodiment the throughfeed unit comprises on its inlet side a funnel-like receiving device for receiving the material. It is in this way possible to bridge positional differences between
10 the inlet of the throughfeed unit and a feed means for the material.

- According to the invention the bearing frame is placed on an underwater bottom. The bearing frame can for instance be lowered by means of cables from a floating structure. In order to carry the bearing frame to a desired position the bearing frame is provided in
15 an embodiment with drive means configured to displace the bearing frame relative to the underwater bottom. Suitable drive means comprise for instance thrusters or jet nozzles which can drive the bearing frame in directions parallel to the bottom surface (horizontally) as well as perpendicularly thereof (vertically).

- 20 It is important in an embodiment to ensure that the throughfeed unit remains at least partially filled with material during movement thereof over the underwater bottom. An embodiment suitable for this purpose comprises a device provided with measuring means configured to determine the quantity of material present in the throughfeed unit. In a practical embodiment the measuring means comprise weighing means. It is also
25 possible to apply volume measuring means. Provided in another embodiment are means for controlling the flow rate of the material supplied to the inlet of the throughfeed unit as a function of the quantity of material present in the throughfeed unit. A suitable flow rate controller comprises a vibrating plate onto which the material is poured before it is carried to the inlet of the throughfeed unit. The flow rate can be controlled by adjusting
30 the frequency of the vibrating plate, wherein a higher frequency generally produces a higher flow rate, and vice versa. The flow rate can (optionally in addition) also be controlled by varying the displacement speed of the conveyor belt, wherein a higher displacement speed generally produces a higher flow rate, and vice versa.

Yet another embodiment of the invention provides a device which comprises measuring means configured to determine the quantity of material arranged on the underwater bottom and/or the position of the device relative to the bottom. Suitable measuring means comprise an ultrasonic and/or optical camera and/or a global positioning system (GPS) and/or pressure sensors (depth determination).

In a preferred embodiment the measuring means configured to determine the position of the device relative to the bottom comprise a transponder and/or a transceiver. It has been found that, by arranging a number of transponders on the bearing frame and the surrounding area and attaching a transceiver to the bearing frame, an accurate determination of the position of the bearing frame relative to the surrounding area becomes possible, even at great depths.

Another aspect of the invention relates to an assembly of a device according to the invention and a floating structure which is provided with feed means which are configured to carry the material for arranging on the underwater bottom to the inlet of the throughfeed unit. The floating structure applied in the assembly according to the invention can be any structure suitable for arranging material underwater. Examples of suitable structures comprise pontoons, vessels, platforms and the like. Use can if desired be made of vessels equipped with per se known positioning systems, such as for instance so-called Dynamic Positioning/Dynamic Tracking (DP/DT) vessels.

The material to be arranged on the underwater bottom can be supplied to the throughfeed unit in any manner. It is thus possible to pour the material freely from the floating structure into the throughfeed unit using cranes, excavators, optionally provided with caterpillar tracks, and other structures, if desired via conveyor belts.

In an embodiment the assembly has the feature that the feed means comprise a fall pipe, a lower outer end of which is connected to the inlet of the throughfeed unit. Such a fall pipe generally comprises an elongate tubular construction which can be carried underwater from a fall pipe tower present on the deck of the floating structure, optionally at an angle varying from zero with the vertical direction. The material is then fed for instance via conveyor belts to an inlet of the fall pipe and carried through the fall pipe to the inlet of the throughfeed unit. This has the advantage that little or no material

is lost. In order to reach greater depths and to compensate the effects of swell on the floating structure and the fall pipe, in an embodiment the fall pipe comprises telescopically disposed fall pipe segments.

5 It can also be advantageous to connect the fall pipe to the floating structure by means of a pivoting connection, preferably pivoting around two horizontal axes.

In an embodiment of the invention the lower outer end of the fall pipe and the inlet of the throughfeed unit are freely movable relative to each other. This has the advantage that the fall pipe and other components are not loaded unnecessarily by forces resulting
10 from for instance swell or a difference in position between the floating structure and the device which has been carried under water.

In another embodiment the connection between the fall pipe and the throughfeed unit comprises a flexible closure, such as for instance a sleeve of rubber, plastic or other
15 material.

According to an embodiment of the invention the throughfeed unit is at least partially filled during depositing of the material via the outlet of the throughfeed unit onto the underwater bottom. This can for instance be achieved by incorporating in the assembly
20 means for controlling the flow rate of the material supplied by the feed means to the throughfeed unit as a function of the quantity of the material present in the throughfeed unit, as has already described above.

Another embodiment comprises an assembly in which the lower outer end of the fall
25 pipe comprises a remote operated vehicle (ROV). Such a remotely controlled ROV can be attached to the floating structure at the position of the lowermost part of the fall pipe, for instance with cables. If desired, the ROV can comprise outward foldable carrier arms which are provided with for instance thrust motors for the purpose of controlling the ROV.

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It is also advantageous to provide an embodiment of the assembly which comprises means for adapting the movement of the floating structure to the movement of the throughfeed unit. Such a master/slave connection between the floating structure and the throughfeed unit can ensure that the supply of material from the floating structure to the

inlet of the throughfeed unit proceeds more efficiently, particularly also when the throughfeed unit is moved over relatively great distances.

5 Provided in another embodiment is an assembly in which the bearing frame is connected by means of hoisting cables to the floating structure, and the floating structure comprises drive means configured to displace the bearing frame relative to the underwater bottom. In this embodiment the bearing frame can be displaced in both horizontal and vertical direction under water by displacing the floating structure and, if desired, drawing in or paying out the hoisting cables by means of hoisting winches
10 present on the floating structure.

A method for arranging a layer of material of predetermined height level on an underwater bottom can be performed with the invented device and assembly. The method according to the invention comprises, among other actions, of carrying the bearing frame under water and placing the bearing frame on the underwater bottom;
15 feeding material via the inlet to the throughfeed unit; moving the outlet of the throughfeed unit over the underwater bottom relative to the bearing frame placed on the underwater bottom, and depositing the material via the outlet of the throughfeed unit onto the underwater bottom, wherein the throughfeed unit remains at least partially filled. The bearing frame is preferably immobilized here relative to the underwater
20 bottom.

Other preferred methods comprise embodiments which can if desired be combined in any manner and in which the height of the outlet of the throughfeed unit is held at a constant value relative to the underwater bottom, wherein the device is carried under
25 water by activating buoyancy regulating means arranged in the frame parts, wherein the frame parts span a distance and the buoyancy of the frame parts is reduced around or in the centre of the span relative to the buoyancy of the frame parts at their outer ends, wherein the throughfeed unit comprises a pipe part and/or an elongate holder, wherein
30 an edge of the outlet of the throughfeed unit comprises a skimming element, wherein the throughfeed unit is moved relative to the bearing frame, wherein the material is received by the throughfeed unit at its inlet side by means of a funnel-like receiving unit, wherein the bearing frame comprises a planar frame and the outlet of the throughfeed unit is moved in the plane of the frame within the contours of the frame,

wherein the bearing frame is displaced autonomously relative to the underwater bottom, wherein the quantity of material present in the throughfeed unit is determined, wherein the quantity of material present in the throughfeed unit is determined by weighing, wherein the quantity of material arranged on the underwater bottom and/or the position of the device relative to the bottom is determined, wherein the quantity of material arranged on the underwater bottom and/or the position of the device relative to the bottom is determined by an ultrasonic and/or optical camera and/or a global positioning system (GPS), wherein the position of the device relative to the bottom is determined by a transponder and/or a transceiver, wherein the material to be arranged on the underwater bottom is carried to the inlet of the throughfeed unit by feed means arranged on the floating structure, wherein the feed means comprise a fall pipe, a lower outer end of which is connected to the inlet of the throughfeed unit, wherein a fall pipe length is adjusted by adapting telescopically disposed fall pipe segments, wherein the fall pipe can pivot relative to the floating structure, wherein the lower outer end of the fall pipe and the inlet of the throughfeed unit move freely relative to each other, wherein the connection between the fall pipe and the throughfeed unit comprises a flexible closure, wherein the flow rate of the material supplied by the feed means to the throughfeed unit is adjusted as a function of the quantity of the material present in the throughfeed unit, wherein the movement of the lower outer end of the fall pipe is controlled by a remote operated vehicle (ROV), wherein the movement of the floating structure is adapted to the movement of the throughfeed unit, and wherein the floating structure substantially follows the movement of the throughfeed unit.

The invention will now be further elucidated on the basis of the description of the accompanying figures, without otherwise being limited thereto. In the figures:

Figure 1 is a schematic cross-section of a tunnel element on a foundation layer arranged with an embodiment according to the invention;

Figure 2 is a schematic side view of an embodiment of an assembly according to the invention;

Figure 3 is a schematic top view of the embodiment of an assembly according to the invention shown in figure 2;

Figure 4 is a schematic top view of an embodiment of the device according to the invention; and

Figure 5 is a schematic top view of an embodiment of the device according to the invention, wherein buoyancy regulating means are shown.

Referring to figure 1, a cross-section is shown of a number of tunnel elements 30 placed
5 adjacently on a foundation layer 40. The shown tunnel elements 30 have a width 31 in a
transverse direction 32 of about 45 m and a height 33 of about 9 m. The length in a
longitudinal direction 36 is not visible but can amount to tens of kilometres. Tunnel
elements 30 can be provided with a plurality of compartments and are placed separately
or in their entirety on a foundation layer 40 under water level 34. A tunnel trench 23 can
10 be excavated or dredged beforehand for this purpose. Foundation layer 40 comprises,
among others, stony materials such as for instance gravel, and is arranged on a generally
existing underwater bottom or seabed 41. Once foundation layer 40 has been arranged
and tunnel elements 30 placed, the space adjacently of tunnel elements 30 can if desired
be filled with materials such as a gravel layer 42, a sand layer 43, and a rock layer 44,
15 on top of which a new seabed 45 can form or be formed.

In order to enable good connection of tunnel elements 30 and sufficient support thereof
it is highly important to be able to arrange a foundation layer 40 with a height level 46
which is precisely determined along the length and width thereof and which has no
20 great variation relative to an average (design) level.

Provided for this purpose is an assembly (1, 17) of a device 1 and a floating structure in
the form of a pontoon 17, an embodiment of which assembly is shown in figures 2 and
3. Pontoon 17 is provided with feed means in the form of a fall pipe 14, a lower outer
25 end 141 of which is connected to an inlet 24 of a throughfeed unit 2, which will be
further discussed below. Fall pipe 14 is configured in this manner to carry material 40 to
be arranged on underwater bottom 41 to the inlet 24 of throughfeed unit 2. The material,
such as gravel, sand or rocks, to be arranged as foundation layer 40 can be stored in
holds 18 available on or in pontoon 17. As shown in figure 3, the material is transferred
30 from a hold 18 to a smaller buffer hold 21 using statically disposed or mobile excavator
cranes 19, and transported therefrom via a conveyor belt 20 to inlet 142 of fall pipe 14.
Pontoon 17 is meanwhile held in place by means of anchor lines 22. A hold 18 can if
desired be replenished with material from an auxiliary pontoon 25 moored against
pontoon 17.

In the shown embodiment fall pipe 14 comprises telescopically retractable and extendable fall pipe segments 140 with which the length of fall pipe 14 can be adjusted as a function of the water depth 35. Fall pipe 14 is further connected with an upper
5 segment 140 thereof to pontoon 17 by means of a fall pipe tower 16 and via a pivoting connection 15 which allows at least rotations around an axis or axes running substantially parallel to water surface 34. The lower outer end 141 of fall pipe 14 and inlet 24 of throughfeed unit 20 are freely movable relative to each other. It is also possible to embody the connection between fall pipe 14 and throughfeed unit 2 by
10 means of a flexible closure, such as for instance a flexible sleeve or cap (not shown).

Referring to figures 2 and 4, a possible embodiment of a device 1 according to the invention is shown in more detail. Device 1 is configured to arrange a material layer 40 of a precisely determined height level 46 on an underwater bottom 41. The shown
15 device 1 comprises a substantially rectangular, planar bearing frame 100 of frame parts in the form of box girders 5, 50 connected rigidly to each other. The main box girders 5 span a distance in transverse direction 32 roughly corresponding to the width 31 of the tunnel elements 30 for placing. The side box girders 50 running in the longitudinal direction 36 of the tunnel (and foundation 40) span a distance which can in principle be
20 freely chosen. Bearing frame 100 extends during use in a plane 101 running substantially parallel to the bottom surface.

Bearing frame 100 is further provided with buoyancy regulating means configured to carry bearing frame 100 under water. In the shown embodiment the buoyancy
25 regulating means are arranged partially in or on box girders 5, 50, as will be further elucidated below in the description of figure 5. Suitable buoyancy regulating means comprise chambers in the box girders or containers 6 which are attached to the box girders and into which preferably water and/or air can be admitted and/or from which it can be drained. The water and/or the air can be carried into or out of a chamber or
30 container 6 with means available to the skilled person, such as for instance via valves arranged on chamber or container 6 and/or via pumps.

Bearing frame 100 is further provided with support means in the form of height-adjustable support feet or spuds 11. Bearing frame 100 can be placed with support feet

11 on underwater bottom 41 and be anchored therein so that bearing frame 100 is immobilized relative to underwater bottom 41. Support feet 11 can be adjusted in the height in height direction 37 by means of for instance hydraulic cylinders (not shown) in order to place bearing frame 100 in for instance a level position and/or to adjust the height of an outlet 26 of throughfeed unit 2 relative to underwater bottom 41. The support feet can if desired also be adjustable in the longitudinal direction by means of a hydraulic cylinder drive (not shown).

Also incorporated in bearing frame 100 is a throughfeed unit 2 for the material supplied via fall pipe 14. In the shown embodiment throughfeed unit 2 comprises a pipe part 27 of relatively limited height (lying for instance between 0.1 and 10 m) with an inlet 24 along which the material is received and an outlet 26 along which the material can be deposited onto underwater bottom 41. Pipe part 27 is arranged in bearing frame 100 for movement relative to bearing frame 100. Pipe part 27 can further comprise on the side of inlet 24 a funnel-like receptacle 13 for receiving the material exiting fall pipe 14 with less loss. An edge of outlet 26 of throughfeed unit 2 can also comprise a skimming element which in the shown embodiment forms a skirt on the underside of pipe part 27.

Throughfeed unit 2 is movable in the plane 101 of bearing frame 100 within the contours of bearing frame 100, these contours being defined by box girders 5, 50. It is in principle also possible in an embodiment of the device for throughfeed unit 2 to optionally be able to move outside the contours of bearing frame 100. The movement of throughfeed unit 2 can take place in any manner known to the skilled person. In the embodiment shown in figure 4 throughfeed unit 2 is mounted on a gantry 4 movable relative to box girders 5, 50. Gantry 4 extends from a main box girder 5 to an opposite main box girder 5 and can slide, for instance travel on or along the main box girders 5 in transverse direction 32. Gantry 4 is further provided with a trolley 3 which can travel in longitudinal direction 36 on or along beams of gantry 4. The movements of gantry 4 and trolley 3 can be performed in known manner, for instance by means of gear rack drives or by cables running over winches. Throughfeed unit 2 can in this way be carried precisely to substantially any desired position within the contours of bearing frame 100. In order to enable still more accurate adjustment of the height position of outlet 26 of throughfeed unit 2 (in addition to the height adjustment of support feet 11), the underside of throughfeed unit 2 (or of pipe part 27 in the shown embodiment) is

provided at the position of outlet 26 with a height-adjustable mouthpiece 12.

Mouthpiece 12 can for instance be adjustable in the height by means of hydraulic cylinders.

- 5 In order to enable simple and if desired autonomous underwater positioning of device 100, bearing frame 100 comprises drive means in the form of motor-driven thrusters (7, 8, 9). Thrusters 7 are configured to displace bearing frame 100 in longitudinal direction 36 relative to underwater bottom 41, while thrusters 8 are configured to displace bearing frame 100 in the transverse direction 32. Thrusters 9 are further configured to displace
10 bearing frame 100 in depth direction 37.

- During depositing of the material onto underwater bottom 41 it can be important to keep throughfeed unit 2 filled with material. Device 1 comprises for this purpose measuring means in the form of weighing means (not shown). These are configured to determine
15 the weight and/or the volume (and therefore also the quantity) of material present in throughfeed unit 2, and are preferably used in combination with means present for instance on pontoon 17 for controlling the flow rate of the material supplied by conveyor belt 20 via fall pipe 14 to throughfeed unit 2 as a function of the quantity of material present in throughfeed unit 2. A suitable flow rate controller comprises a
20 vibrating plate (not shown) placed for instance between a discharge side of conveyor belt 20 and the inlet of fall pipe 14.

- During depositing of material onto underwater bottom 41 by throughfeed unit 2 the pontoon 17 will preferably be co-displaced with throughfeed unit 2. It can then be
25 useful to effect a master-slave connection between pontoon 17 and throughfeed unit 2 in order to adapt the movement of pontoon 17 to the movement of throughfeed unit 2 relative to bearing frame 100.

- It may further be useful to provide measuring means (likewise not shown) which can
30 determine the quantity of material arranged on the underwater bottom and/or the position of device 1 (or bearing frame 100) relative to the bottom 41. Means suitable for this purpose comprise a number of transponders and/or transceivers arranged on bearing frame 100 and in a surrounding area with known position, such as for instance pontoon 17 and/or an already placed tunnel element 30. Device 1 is also provided with housings

10 accommodating the equipment required for the operation of the device, such as electrical and electronic components, pumps, measuring means and the like. The signal connection to pontoon 17 is embodied in known manner by power supply and other lines (umbilicals) provided between bearing frame 100 and the pontoon.

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Finally shown in schematic manner with reference to figure 5 is an embodiment of device 1 in which the possible placing of the buoyancy regulating means is shown. The shown buoyancy regulating means comprise chambers 60 arranged in box girders (5, 50) or containers 6 which are attached to the box girders and in which preferably water and/or air can be admitted and/or from which it can be drained. In the shown embodiment bearing frame 100 is provided at the four corner points thereof with containers (6a, 6b, 6c, 6d) attached to side box girders 50. By filling these with water the bearing frame 100 can be pressed firmly, at least at the position of the corner points, onto underwater bottom 41. When bearing frame 100 must be moved or brought above water, containers (6a, 6b, 6c, 6d) can be filled with air, so displacing (some of) the water present in containers (6a, 6b, 6c, 6d). In figure 5 the fillable volume of the containers and chambers is designated schematically with a cross shown in dash-dot lines. Side box girders 50 are further each provided with an internal chamber (60a, 60b). Chambers (60a, 60b) extend over substantially the full height and length of side box girders 50. Finally, the main box girders 5 are each likewise provided with an internal chamber (60c, 60d). Chambers (60c, 60d) extend over substantially the full length of main box girders 5, while in height direction 37 they extend to only half the height of main box girders 5 as shown schematically in the cross-section along line B-B. By filling chambers (60c, 60d) with air the bending of the main box girders can be prevented by the upward directed buoyancy of the enclosed air. This effect is a further enhanced by positioning the chambers (60c, 60d) around or in the centre of the length spanned by main girders 5. The accuracy of the height level of the arranged foundation layer can be further improved by reducing the bending.

30 The invention is not limited to the above described embodiments, and modifications could be made thereto to the extent these fall in self-evident manner within the scope of the appended claims.

Claims

1. Device for arranging a layer of material of predetermined height level on an underwater bottom, comprising a bearing frame provided with buoyancy regulating means configured to carry the bearing frame under water; with support means configured to place the bearing frame on an underwater bottom; and with a throughfeed unit for the material, wherein the throughfeed unit comprises an inlet along which the material is received and an outlet along which the material is deposited onto the underwater bottom, wherein the outlet of the throughfeed unit is movable relative to the bearing frame.
2. Device as claimed in claim 1, wherein the support means are configured to immobilize the bearing frame relative to the underwater bottom.
3. Device as claimed in claim 1 or 2, wherein the support means are configured to adjust the height of the outlet of the throughfeed unit relative to the underwater bottom and/or the position of the outlet of the throughfeed unit in a horizontal plane.
4. Device as claimed in any of the foregoing claims, wherein the throughfeed unit comprises at least one pipe part and/or an elongate holder.
5. Device as claimed in any of the foregoing claims, wherein the bearing frame comprises drive means configured to displace the bearing frame relative to the underwater bottom.
6. Device as claimed in any of the foregoing claims, wherein the device comprises measuring means configured to determine the quantity of material present in the throughfeed unit.
7. Device as claimed in any of the foregoing claims, wherein the device comprises measuring means configured to determine the quantity of material arranged on the underwater bottom and/or the position of the device relative to the bottom.

8. Assembly of a device as claimed in any of the foregoing claims and a floating structure which is provided with feed means which are configured to carry the material for arranging on the underwater bottom to the inlet of the throughfeed unit.
- 5 9. Assembly as claimed in claim 8, wherein the feed means comprise a fall pipe, a lower outer end of which is connected to the inlet of the throughfeed unit.
10. Assembly as claimed in either of the claims 8 or 9, comprising means for controlling the flow rate of the material supplied by the feed means to the throughfeed unit as a function of the quantity of the material present in the throughfeed unit.
- 10 11. Assembly as claimed in claim 8, wherein the feed means comprise an excavator crane, gripping crane, conveyor belt and combinations thereof present on the floating structure for the purpose of pouring the material directly into the throughfeed unit.
- 15 12. Method for arranging a layer of material of predetermined height level on an underwater bottom, the method comprising the steps of:
- providing a device as claimed in any of the claims 1-7 or an assembly as claimed in any of the claims 8-11;
 - 20 -carrying the bearing frame under water and placing the bearing frame on the underwater bottom;
 - feeding material via the inlet to the throughfeed unit;
 - moving the outlet of the throughfeed unit over the underwater bottom relative to the bearing frame placed on the underwater bottom and depositing the material via
 - 25 the outlet of the throughfeed unit onto the underwater bottom, wherein the throughfeed unit remains at least partially filled.
13. Method as claimed in claim 12, wherein the bearing frame is immobilized relative to the underwater bottom.
- 30 14. Method as claimed in claim 12 or 13, wherein the height of the outlet of the throughfeed unit is held at a constant value relative to the underwater bottom.

15. Method as claimed in any of the claims 12-14, wherein the material to be arranged on the underwater bottom is carried to the inlet of the throughfeed unit by feed means arranged on the floating structure.
- 5 16. Method as claimed in claim 15, wherein the feed means comprise a fall pipe, a lower outer end of which is connected to the inlet of the throughfeed unit.
17. Method as claimed in any of the claims 12-16, wherein the connection between the fall pipe and the throughfeed unit comprises a flexible closure.
- 10 18. Method as claimed in any of the claims 12-17, wherein the flow rate of the material supplied by the feed means to the throughfeed unit is adjusted as a function of the quantity of the material present in the throughfeed unit.
- 15 19. Method as claimed in any of the claims 12-18, wherein the floating structure substantially follows the movement of the throughfeed unit.