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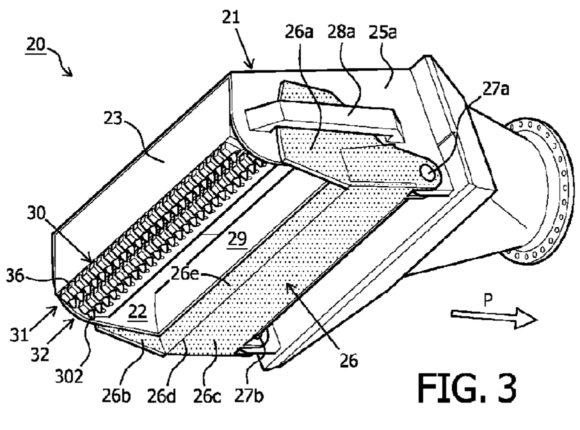

FIG. 3

(57) **Abstract**: The invention relates to a suction head (20) for a dredging vessel (1) that is adapted for movement in a direction of movement P. The suction head (20) comprises a box shaped construction (21) provided at the bottom side with a suction opening (22) with a connection for a suction conduit (3) of the dredging vessel (1), and with a rear wall (23) and a front wall (29,26e), extending substantially transverse to the direction of movement P and side walls (25a, 25b), extending substantially parallel to the direction of movement P, as well as an upper wall (24) provided at the side turned away form the bottom, whereby the rear wall at the bottom side is provided with cutting tools (30) for penetrating in the bottom, and whereby the front wall comprises a fixed wall part (29) and a movable wall part (26e) that moves together with the bottom profile. The suction head can efficiently dredge harder grounds.

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Suction head for a dredging vessel and method for dredging using said suction head

The invention relates to a suction head for a dredging vessel. The invention also relates to a dredging device comprising a dredging vessel, adapted for movement in a movement direction, a dredge pump positioned on the dredging vessel and provided with a suction connection, a suction conduit that connects the suction head with the suction connection of the dredge pump, and, provided between the dredging vessel and the suction head, support means for supporting the suction conduit, which support means are adapted to determine the depth of the suction head. The invention further relates to a method for dredging ground using said suction head.

Such dredging devices are generally known, for instance from EP-A-0892116. The known suction head comprises a box shaped construction that is connectable to a suction conduit of a dredging vessel and is shaped like a closed shaft like construction with sidewalls, an upper wall and a lower wall facing the bottom. At the rear end (the downstream side relative to the movement direction) of the box shaped construction, a visor with an opening at the bottom side thereof is, hingedly around a horizontal axis, attached to the box shaped construction, which visor can in this fashion be rotated up and down, for instance through a hydraulic piston. The visor is further provided with a tooth bar that extends transverse to the direction of movement and is at the bottom side provided with teeth for loosening material to be dredged from the bottom. At the under side (the bottom side) of the box shaped construction, at the height of the connection with the visor, a number of heel wear pads is provided, that together form the heel plate. In use, such a suction head is trailed over or in the bottom to be dredged, whereby the box shaped construction rests on the bottom with the heel plate, and whereby the teeth turn up the bottom and the loosened bottom material is sucked away through the suction conduit, for instance to a bin provided on the dredging vessel. For this reason, such a suction head is also referred to as a trailing suction hopper suction head.

Because the box shaped construction rests on the bottom through the heel plate, the visor can rotate independently of the box shaped construction. When the visor is controlled by the hydraulic piston such that a constant force ensues, the visor will follow the profile of the bottom, whereby the rear wall and the side walls of the visor will more or less penetrate into the bottom, depending on the hardness of the bottom. Due to the sucking action of the suction conduit an underpressure will develop in the suction head, which underpressure among others depends on the extent of sealing of the suction head. The developed underpressure ensures the sucking up of dredged bottom material, whereby water will inevitably also be sucked up from the outside.

The known suction head is only suitable for relatively soft bottoms, which is a disadvantage. Indeed, it has been established that with too hard bottoms the teeth of the known suction head do not penetrate sufficiently in the bottom as a result of which a relatively minor amount of bottom material is loosened.

The present invention aims to provide a suction head for a dredging vessel with which bottoms, in particular harder bottoms, can be dredged, preferably with an improved efficiency relative to the known suction head. With efficiency is understood in the context of the present application the total volume of bottom material that can be dredged per unit of time and per unit of power.

According to the invention, a suction head is provided for a dredging vessel arranged for movement in a direction of movement, which suction head comprises a box shaped construction, at its bottom side provided with a suction opening and having a connection for a suction conduit of the dredging vessel, further having a rear wall and front wall that extend substantially transverse to the direction of movement, and side walls that extend substantially parallel to the direction of movement, as well as an upper wall provided at the side turned away from the bottom, whereby the rear wall at its bottom side is provided with cutting tools for penetrating in the bottom, and whereby the front wall comprises a fixed wall part and a wall part that moves with the bottom profile. The invented suction head has proven to be able to dredge bottoms with an improved efficiency relative to the known dredging head. In particular with relatively hard bottoms, such as for instance rock bottoms, good results are obtained. By providing the suction head at its front side (upstream) of the suction opening with a wall part that moves together with the bottom profile, the suction opening at the upstream side of the cutting tools is substantially at all times closed off so as to minimize or avoid that surrounding water will be sucked in through this (unproductive) side. The bottom material/water mixture that is sucked in at the height of the rear side of the suction head through the spaces in between the cutting tools comprises a relatively large amount of bottom material by the action of the cutting tools on the bottom. In use, the suction head rests at the upstream side of the cutting tools on the bottom with its movable wall part and at the height of the rear side with the cutting tools. As the movable wall part moves together with the bottom, for instance under its (limited) natural weight, substantially the total weight of the suction head and the suction conduit will be transmitted onto the bottom via the cutting tools. This results in larger generated forces in the bottom at the height of the cutting tools than is possible with the known suction head, whereby it becomes possible to break harder bottoms. With the known suction head, an important part of the weight is transmitted to the bottom through the heel plate and the side walls of the visor. With the invented suction head, the visor is in fact obsolete and can be deleted if desired. The movable wall part at the upstream side of the cutting tools and the suction opening therefore takes care of an improved efficiency of the suction head in accordance with the invention in at least two different ways.

According to the invention, a suction head is provided whereby the cutting tools attack the bottom at the upstream side of the movable wall part. This proves to be no disadvantage because of the sucking action of the suction conduit. The cutting tools are, in accordance with the invention, provided at the height of or at the rear wall (the downstream wall) of the suction head. By this measure it is not only achieved that less surrounding water is sucked in but it is also prevented that other wall parts of the suction head can come into contact with the bottom, which results in an even larger part of the weight is deviated to the cutting tools. Since the walls of the box shaped construction are substantially rigidly connected to each other the rear wall, the side walls and the fixed front wall part form a rigid unity. In order to avoid that parts of the suction head, other than the cutting tools and the moving front wall part, come in substantial contact with the bottom, it is important to appropriately select the inclination of the suction head relative to the bottom. It has turned out that a mean inclination angle ranging between 5 en 30°, more preferably between 10 en 20° relative to the horizontal yields good results. In this context it is possible to execute the connection of the suction head with the suction conduit in a rigid fashion. It is also possible to execute the connection in a flexible fashion, for instance through a rubber coupling.

In an embodiment the suction head according to the invention is characterized in that the suction head comprises a close off body, that is hingedly connected to the box shaped construction, and in that the movable wall part comprises a wall part of the close off body. By these measures the close off body can, if desired, rest onto the bottom with an under rim of said wall part during dredging, without however taking away a lot of weight from the cutting tools. The natural weight of a close off body (for instance 3 ton) indeed is substantially lower than the total weight of the suction head and suction conduit, which can surmount 150 ton.

Particularly advantageous is a suction head whereby the wall part of the close off body comprises a rear wall of the close off body which rear wall is hingedly connected with the side walls of the box shaped construction by means of side walls connected thereto, such that the rear wall can be rotated up and down. The side walls of the close off body in this embodiment act as close off means for surrounding water, since the at least partly can close off the opening between the side walls of the box shaped construction and the bottom.

In a further embodiment of the suction head according to the invention it is characterized in that the rear wall of the close off body comprises an upstanding rear wall that partly overlaps with the fixed wall part of the front wall of the box shaped construction. In this way a simple construction of the moving wall part of the front wall is provided, whereby said wall part closes off well and moreover only transmits little force onto the bottom. By rotating the close off body relative to the box shaped construction the rear wall of the close off body will so to speak move along the fixed wall part of the front wall of the box shaped construction. Both wall parts are formed such that said gliding past each other is possible. In order to avoid that the close off body rotates too far away from the fixed wall part of the box shaped construction, whereby an opening could be formed between the lower rim of said fixed wall part and the upper rim of the rear wall of the close off body, the close off body is preferably provided with an end stop to avoid such large rotation. When reaching the end stop it is thus possible that the lower rim of the movable wall part becomes loose from the bottom which causes the suction head to rest on the bottom with the cutting tools only. It is likewise possible to limit the rotation of the close off body in the other direction (towards the box shaped construction) by means of an end stop. When reaching such an end stop unforeseen, the close off body will rest with an increased force on the bottom because its movement is hindered.

The wall part of the front wall of the box shaped construction that is movable with the bottom profile, or the closing off wall part of the close off body may extend transverse to the direction of movement of the suction head over part of the width thereof, but will preferably extend over substantially the whole width thereof. It may hereby have advantages when the wall part of the front wall of the box shaped construction that is movable with the bottom profile, or the closing off wall part of the close off body comprises transverse to the direction of movement of the suction head a number of substantially linked up and mutually independently movable sections. In this way, each section can move up and down independently from another section and thereby follow the bottom profile, which bottom profile indeed may vary in the direction transverse to the direction of movement of the suction head.

Although it is according to the invention possible to provide the suction head with cutting tools in het shape of the known teeth, a preferred embodiment of the suction head according to the invention is characterized in that the cutting tools at least at their free end are rotation symmetric. According to the invention the cutting tools substantially carry the whole weight of the suction head and suction conduit, by which these cutting tools on average carry a higher load than is the case with the known suction head. The cutting tools according to the present embodiment among others have the advantage that they can withstand higher loads than the known teeth.

The cutting tools can in principle be attached to the rear wall of the box shaped construction in any conceivable way. It will be apparent that the rear wall needs to have sufficient thickness to be able to accommodate the cutting tools, and to withstand the large forces generated. The cutting tools may for instance be received in recesses, provided in the rear wall for this reason. It is also possible to provide the rear wall with coupling means such as for instance holders in which at least a part of the cutting tools may be accommodated.

In a preferred embodiment the cutting tools of the suction head according to the invention are connected to the rear wall such that that they can rotate substantially free around their axis of rotation symmetry. With free rotation is meant in this context that the cutting tools may eventually also rotate around their axis of rotation symmetry with some friction, as long as they undergo some rotation in use. The described rotation is made possible because the cutting tools are rotation symmetric. Admitting a free rotation of the cutting tools in the rear wall and/or in the holders decreases the risk for breakage of the cutting tools. Furthermore, the cutting tools are sharpened automatically by friction with the bottom. The duration of use of the cutting tools can herewith be lengthened and time can be saved since on average less broken or blunted cutting tools need to be replaced.

According to another preferred embodiment of the invention the cutting tools are cone shaped or conical, and the cutting tools comprise a substantially cylindrical shaft part with a smaller diameter than the diameter of a conical top part. The cutting tool according to this embodiment is applied with its cylindrical shaft part in coupling means that are provided on the rear wall. The coupling means preferably comprise a block holder with a central bore into which the cylindrical shaft part may be received under a substantially free rotation. In this embodiment the conical top part will extend with an active length out of the block holder, which length is relatively short in comparison to the total length of the cutting tool. This has the advantage that even larger forces may be withstood. The block holder moreover supports in an effective way the cutting tool against flexural deformations. In a preferred embodiment the cutting tools have a length extending out of the holder ranging between 10 and 500 mm, more preferred between 20 and 250 mm, and most preferred between 50 and 150 mm.

The conical top part of the cutting tool is preferably provided with a hardened top at the end that contacts the bottom. The top may for instance be made of carbide.

Partly by applying the rotation symmetric cutting a large pressure is generated locally, which pressure effectively shatters the bottom, in particular a relatively hard bottom, such as a rock bottom. It has turned out that the rotation symmetric cutting tools form furrows in the bottom and that in that part of the bottom between the furrows high stresses are generated to such an extent that this part easily breaks. The chips thus formed may, eventually together with some surrounding water, sucked up well by the suction conduit. The sucking up happens through the rear side of the suction head via the gaps between the cutting tools towards the sucking opening that connects to the suction conduit.

It is advantageous to characterize the suction head according to the invention in that the cutting tools form at least one array, that extends or extend according to a straight line substantially transverse to the direction of movement of the suction head. By positioning the cutting tools along a substantially straight line the chip formation described above is surprisingly enhanced.

The amount of cutting tools of the suction head according to the invention can be chosen within broad limits. In a preferred embodiment of the invented suction head, the amount of cutting tools of the suction head is larger, and more preferably significantly lager than the amount of teeth of the known suction head. A larger amount of cutting tools leads on average to a lower penetration depth of the cutting tools in the bottom. The hereby expected lower efficiency is surprisingly completely compensated by providing a suction head according to the invention whereby substantially the total weight is lead via the cutting tools towards the bottom. Since the forces on the chisels are better distributed is also becomes possible to design the total suction head larger and heavier (for instance a weight above water of 100 ton) than was customary hitherto (as a rule, the known suction head weighs 20-50 ton on shore). A heavier and larger suction head further increases the dredging efficiency. Preferably, the amount of cutting tools in an array comprises at least 10, more preferably at least 15 and most preferably at least 20. The amount of arrays preferably ranges between 1 and 10, more preferably between 1 and 5, and most preferably the amount of arrays is 2. With this preferred embodiment, a good compromise is reached between dredging efficiency and the power needed to trail the suction head in the direction of movement over and/or in the bottom.

The mutual distance between the cutting tools is among others determined by the dimensions of the cutting tools themselves and by the total weight of the suction head and suction conduit parts that are under water, divided by the amount of cutting tools. Also, the pulling force produced by the dredging vessel may be of importance. Besides that, the properties of the bottom to be dredged are important, for instance the compression strength/tensile strength ratio of the bottom.

The cutting tools may in principle be positioned in the longitudinal direction of the suction head (the direction parallel to the direction of movement) in every possible manner. In order to further increase the efficiency of the dredging, it has advantages to position adjacent arrays of cutting tools offset relative to each other. A higher efficiency is hereby achieved.

In another aspect of the invention a suction head is provided comprising at least one series (low pressure) jet pipes for injecting a fluid under pressure, preferably water. The jet pipes preferably work under a pressure of at most 50 bar, more preferably at most 30 bar, and most preferably at most 15 bar. The fluid jets produced by the jet pipes under such pressures are adapted to clean the cutting tools and the space between the cutting tools, in other words clear them from bottom material and other materials The cutting action of the cutting tools is hereby improved and a good sucking in of loosened bottom material is further reached. The jet pipes according to the invention may in principle be positioned before, after, or at the height of the cutting tools. It is also possible to provide the cutting tools themselves with jet pipes, for instance as a central bore. The jet pipes can help to remove already shattered bottom material via the suction conduit, and/or further reduce in size this bottom material.

Besides this, it is also possible to provide (high pressure) jet pipes that can work under substantially higher pressures of 200 to 1000 bar and more. The fluid jets produced by the jet pipes under such high pressures are adapted to help breaking the bottom. These jet pipes also can, according to the invention, in principle be positioned in front of, after, or at the height of the cutting tools. It is also possible to provide the cutting tools themselves with jet pipes, for instance as a central bore. Jet pipes positioned in front of the cutting tools can help in shattering the bottom by providing a furrow in front of the cutting tools causing the cutting tools to penetrate deeper and thereby breaking out more material. Jet pipes positioned at the height of the cutting tools can help in loosening the pieces of rock and thereby letting the cutting tools penetrate further; the loose pieces indeed no longer are able to absorb the energy of the cutting tools as a “cushion”. Jet pipes positioned behind the cutting tools can help in loosening pieces that were not yet loosened and in transporting the already shattered bottom material via the suction conduit. In general, the flow of such high pressure jet pipes will be lower than the flow that is needed for the low pressure jet pipes.

In a preferred embodiment the suction head according to the invention is characterized in that the jet pipes are present between the cutting tools, and this can be between the cutting tools of one array and/or between two or more arrays of cutting tools.

The invention also relates to a method for breaking and/or dredging at least partly hard grounds under water with a dredging vessel, equipped with a suction head according to the invention. The method comprises lowering a suction head according to the invention to the bottom and trailing said suction head over the bottom.

The suction head is hereby trailed over a bottom to be dredged in a direction of movement and such that substantially the cutting tools alone contact the bottom, and whereby the movable wall part of the front wall of the close off body moves along with the bottom profile. The cutting tools will hereby, under the influence of the weight of the suction head and the suction force, penetrate in the bottom and form fissures herein. The broken off bottom chips are sucked up through the suction conduit, whereby the movable wall part of the front wall ensures that substantially no surrounding water is sucked up via that side and that substantially the total weight of the suction head and suction conduit ends up on the cutting tools.

The suction head according to the invention is in particular suitable for dredging bottoms under water having a UCS ('Unconfined Compressive Strength') of at least 5 MPa, preferably at least 20 MPa, and most preferably at least 40 MPa.

The suction head and method according to the invention will now be further described in more detail with the aid of the following description of preferred embodiments and figures, without however limiting the invention thereto. In the figures:
figure 1 shows a schematic cross-sectional view of a dredging device according to the invention;
figure 2 shows a schematic side view of a suction head according to the state of the art;
figure 3 shows a schematic bottom view in perspective of a suction head according to an embodiment of the invention;
figure 4 shows a top view in perspective of the suction head shown in figure 3;

figure 5 shows a schematic cross-sectional view of the suction head shown in figure 3 with suction conduit;
figure 6 shows a bottom view in perspective of a suction head according to another embodiment of the invention; and
figure 7 shows a side view of a detail of a cutting tool according to an embodiment of the invention.

Figure 1 shows a dredging vessel 1, provided with a motor, not shown in the drawing, for driving a screw propeller 2 via a screw axis for propelling the dredging vessel 1. Further, devices not shown in the drawing for steering the dredging vessel 1 are present, such as a rudder and transversely placed screw propellers to ease maneuvering.

In the dredging vessel 1 a dredge pump, not shown in the drawings, is also present. Against a side wall of the dredging vessel a suction conduit 3 is provided, of which one end is connected to the suction connection of the dredge pump. The suction conduit 3 comprises in the present example two members 3a and 3b that are interconnected by means of a coupling, that allows a certain mutual angular rotation. The connection between the upper member 3a of the suction conduit 3 and the ship also allows some angular rotation in the vertical plane and around the axis. To support the movable end of the upper member 3a of the suction conduit 3, this member is connected to a cable 4a, of which the other end is connected to a winch 5a. Also to support the movable end of the lower member 3b of the suction conduit 3, this member is connected to a cable 4b, of which the other end is connected to a winch 5b. The winches 5a, 5b thus allow to vary the height of the suction conduit 3. It will be apparent that, among others dependent on the depth of the basin to be dredged, the number of members of the suction conduit 3 can be enlarged or diminished, together with a respective adjustment of the number of cables 4 and winches 5.

At the free end of the second member 3b of the suction conduit 3, a suction head 6 is provided. With reference to figure 1 a suction head 6 of the known type is shown. The known suction head 6 comprises a box shaped construction 7 that is connectable to the suction conduit 3 and has the shape of a closed shaft construction with side walls 7a, 7b (only 7a is visible), an upper wall 7c and a lower wall 7d, facing the bottom. At the rear side (the upstream side relative to the direction of movement P) of the box shaped construction 7, a visor 8, only open at the bottom side, is provided and hingedly connected around a horizontal axis 9 to the box shaped construction 7, whereby it can be rotated up and down by mean of a hydraulic piston, not shown. The visor 8 is further provided with a tooth bar 10 extending transverse to the direction of movement P and at the bottom side provided with teeth 11 for loosening to be dredged material from the bottom. At the underside of the box shaped construction 7 a series of heel wear pads is provided, together forming a heel plate 12. During dredging, the known suction head 6 rests on the bottom with the heel plate 12, whereby the visor 8 may rotate independently from the box shaped construction 7. The rotation of the visor 8 regulates the desired penetration depth of the teeth 11 in the bottom. The teeth 11 turn up the bottom and the loosened bottom material is sucked away via the suction conduit 3, for instance to a bin, present on the dredging vessel 1. In order to achieve the highest possible production, the visor 8 in the known suction head 6 is positioned independently from the box shaped construction 7 such that the best possible sealing between visor 8 and bottom is achieved. With the known suction head 6, an important part of the weight is transferred on the bottom via the heel plate 12 and the side walls of the visor 8.

With reference to figures 3-6 a number of embodiments of a suction head 20 according to the invention are shown. The suction head 20 comprises a box shaped construction 21 that is connectable to the suction conduit 3 (or at least to part 3b thereof) of the dredging vessel 1. The box shaped construction 21 is at the bottom side provided with a suction opening 22 and further comprises a rear wall 23, an upper wall 24, side walls 25a, 25b, and a front wall, comprising a fixed wall part 29 and a movable wall part 26e. The movable wall part 26e in the embodiment shown is part of a close off body 26. In the embodiment shown, the rear wall 23 of the box shaped construction 21 also acts as a support body extending transverse to the direction of movement P for cutting tools 30 provided at the bottom side. The upper plate 24 is provided with an opening 24a onto which a conduit may be attached along which water can be supplied under (high) pressure for the jet pipes 35, described further hereunder.

The close off body 26 is adapted to, with a wall part 26e thereof, move together with the bottom profile, and such that substantially only the cutting tools 30 contact the bottom. This can for instance be achieved by providing a close off body 26 comprising a sealing plate 26c facing the bottom and to which two side plates 26a, 26b are connected, and an upstanding wall part 26e. As shown in figures 3-6 the side plates 26a, 26b are hingedly suspended to hooks 27a, 27b of the side walls 25a, 25b. The side plates 26a, 26b can freely rotate around the hooks 27a, 27b whereby they move in guides 28a, 28b, that also act as end stop. During dredging the suction head 1 is held in such a position relative to the bottom that the suction head 1 substantially rest with the cutting tools 30 on the bottom, whereby the close off body 26 rests on the bottom with the lower rim 26d. Since the close off body 26 hereby is able to rotate freely around the hooks 27a, 27b the weight of the close off body 26 only is transferred to the bottom via the rim 26d. Hereby, a relatively small amount of weight is actually taken away from the cutting tools 30. The suction opening 22 is formed in the embodiments shown in figures 3-6 between the rear wall 23 and an upstanding fixed wall part 29 of the box shaped construction 21. By rotating the close off body 26 around the hooks 27a, 27b relative to the box shaped construction 21, the rear wall part 26e of the close off body 26 will so to speak move along (and in front of) the fixed wall part 29 of the front wall of the box shaped construction 21. Both wall parts 29, 26e are shaped such that such gliding past each other is possible. To avoid the close off body 26 to rotate too far from the fixed wall part 29 of the box shaped construction 21, whereby an opening could be formed between the lower rim of said fixed wall part 29 and the upper rim of the rear wall part 26e of the close off body 26, the close off body is preferably provided with an end stop 28 that cooperates with a hook (not shown) on side plate 26a.

In the embodiments shown in the figures, the close off body 26, and therefore also wall part 26e that moves together with the bottom profile, extends transverse to the direction of movement of the suction head 1 over substantially the whole width of the suction head. In a preferred embodiment that is not shown, the close off body 26 comprises a number of substantially linked up and mutually independently movable sections that extend transverse to the direction of movement of the suction head 1. Hereby, a better sealing between bottom and close off body 26 is achieved.

The cutting tools 30 in the embodiment shown form two arrays 31, 32, which arrays extend along a straight line, substantially perpendicular to the direction of movement P of the suction head 1. Each array comprises 23 cutting tools 30. In accordance with expectations, such a high number of cutting tools on average leads to a lower penetration depth of the cutting tools 30 in the bottom. As, in accordance with the invention substantially the whole weight of the trailing head and suction conduit is transferred to the bottom via the cutting tools 30, this effect is substantially annihilated. The cutting tools 30 of array 31 are positioned offset relative to the cutting tools 30 of the second array 32.

In the embodiment shown in figure 6, the suction head 1 is provided with two arrays 33, 34 of jet pipes 35 that are adapted to inject a fluid, in particular water, under a low (at most 50 bar) and/or high pressure (of 1000 bar and higher) between the cutting tools 30. The jet pipes 35 are situated in the embodiment shown between the cutting tools 30 but it is also possible to aim the jet pipes 35 towards the bottom, in particular the high pressure jet pipes.

The cutting tools 30 may in principle comprise any cutting tool suitable for dredging bottom material, such as for instance the known teeth. In the preferred embodiments shown, the cutting tools 30 are at least at their free end rotation symmetric, whereby each cutting tool 30 is connected with the rear wall 23 by means of coupling means 36. The cutting tools 30 comprise a substantially cylindrical shaft part 301 with a smaller diameter than the diameter of a conical top part 302. The cutting tool 30 is applied with the cylindrical shaft part 301 in the coupling means 36 provided on the rear wall 23. The coupling means 36 hereto comprise a block holder 361 with a central bore 362 into which the cylindrical shaft part 301 is accepted under substantially free rotation. The conical top part 302 extends over an active length out of the block holder 361, which length is relatively short compared to the total length of the cutting tool 30. This has the advantage of being able to withstand large forces. The block holder 361 moreover supports in an effective way the cutting tool 30 against flexural deformations. The conical top part 302 is provided with a hardened carbide top 303, that comes into contact with the bottom. In the embodiment shown, the cutting tool 30 is inserted in the central bore 362 until the click connection 363 impinges on a correspondingly ring shaped recess 364 of the holder 361. In this state, the cutting tool 30 can rotate substantially free around the axis 37, such that it sharpens itself.

With the suction head described in detail above, an at least partly hard ground may advantageously be broken and/or dredged under water, whereto the suction head is attached to the suction conduit 3 of a dredging vessel 1, lowered onto the bottom and trailed along said bottom in a trailing direction P, and such that substantially only the cutting tools 30 make contact with the bottom. The close off body 26 is hereby positioned such that it rests on the bottom with the rim 26d and can rotate substantially free around the hooks 27a, 27b. Hereby is achieved that substantially the total weight of the suction head 1 and the suction conduit 3 is transferred to the bottom via the cutting tools 30.

The invention is not limited to the exemplary embodiments described herein above and changes may be made as long as they fall within the scope of the attached claims.

Conclusies

1. Suction head (20) for a dredging vessel (1), adapted for movement in a direction of movement P, the suction head (20) comprising a box shaped construction (21), at its bottom side provided with a suction opening (22) and having a connection for a suction conduit (3) of the dredging vessel (1), further having a rear wall (23) and a front wall (29, 26e), extending substantially transverse to the direction of movement P, and side walls (25a, 25b), extending substantially parallel to the direction of movement P, as well as an upper wall (24) provided at the side turned away from the bottom, whereby the rear wall (23) at its bottom side is provided with cutting tools (30) for penetrating in the bottom, and whereby the front wall (29, 26e) comprises a fixed wall part (29) and a movable wall part (26e) that moves together with the bottom profile.

2. Suction head according to claim 1, the suction head comprising a close off body (26) that is hingedly connected to the box shaped construction, the movable wall part comprising a wall part (26e) of the close off body (26).

3. Suction head according to claim 2, whereby the wall part of the close off body comprises a rear wall of the close off body, the rear wall being hingedly connected to the side walls of the box shaped construction by means of side walls connected to the rear wall, such that the rear wall may be rotated up and down.

4. Suction head according to claim 3, whereby the rear wall of the close off body comprises an upstanding rear wall overlapping partly with the fixed wall part of the front wall of the box shaped construction.

5. Suction head according to any one of the preceding claims, whereby the wall part that moves together with the bottom profile extends transverse to the direction of movement of the suction head over substantially the complete width thereof.

6. Suction head according to any one of the preceding claims, whereby the wall part that moves together with the bottom profile comprises a number of substantially linked up and mutually independently movable sections transverse to the direction of movement of the suction head.

7. Suction head according to any one of the preceding claims, whereby the cutting tools at least at their free end are rotation symmetric.

8. Suction head according to claim 7, whereby the cutting tools are connected with the rear wall such that they can rotate substantially free around their axis of rotation symmetry.

9. Suction head according to claim 7 of 8, whereby the cutting tools are cone shaped.

10. Suction head according to any one of the preceding claims, whereby the cutting tools form at least one array, that extends or extend along a straight line (11, 12) substantially transverse to the direction of movement.

11. Suction head according to claim 10, whereby the number of cutting tools in an array is at least 15.

12. Suction head according to claim 10 of 11, whereby the number of arrays is at least 2.

13. Suction head according to any one of the preceding claims, whereby the suction head (1) comprises at least one array of jet pipes for injecting water under pressure.

14. Suction head according to claim 13, whereby the rear wall of the box shaped construction comprises at least one array of jet pipes.

15. Suction head according to claim 13 of 14, whereby the jet pipes are provided between the cutting tools.

16. Dredging device, comprising a dredging vessel adapted for movement in a direction of movement, a suction head according to any of one of claims 1-15, connected to the dredging vessel, a dredge pump with a suction connection provided on the dredging vessel, a suction conduit connecting the suction head to the suction

connection of the dredge pump, and support means provided between the dredging vessel and the suction head for supporting the suction conduit, the support means being adapted for controlling the depth of the suction head.

17. Method for dredging bottom material under water with a dredging vessel, equipped with a suction head according to any one of claims 1 - 15, whereby the suction head is trailed over a bottom to be dredged in a direction of movement and such that substantially only the cutting tools make contact with the bottom, and whereby the movable wall part of the front wall of the close off body moves together with the bottom profile.

18. Method according to claim 17 for dredging bottom under water with an UCS ('Unconfined Compressive Strength') of at least 20 MPa.

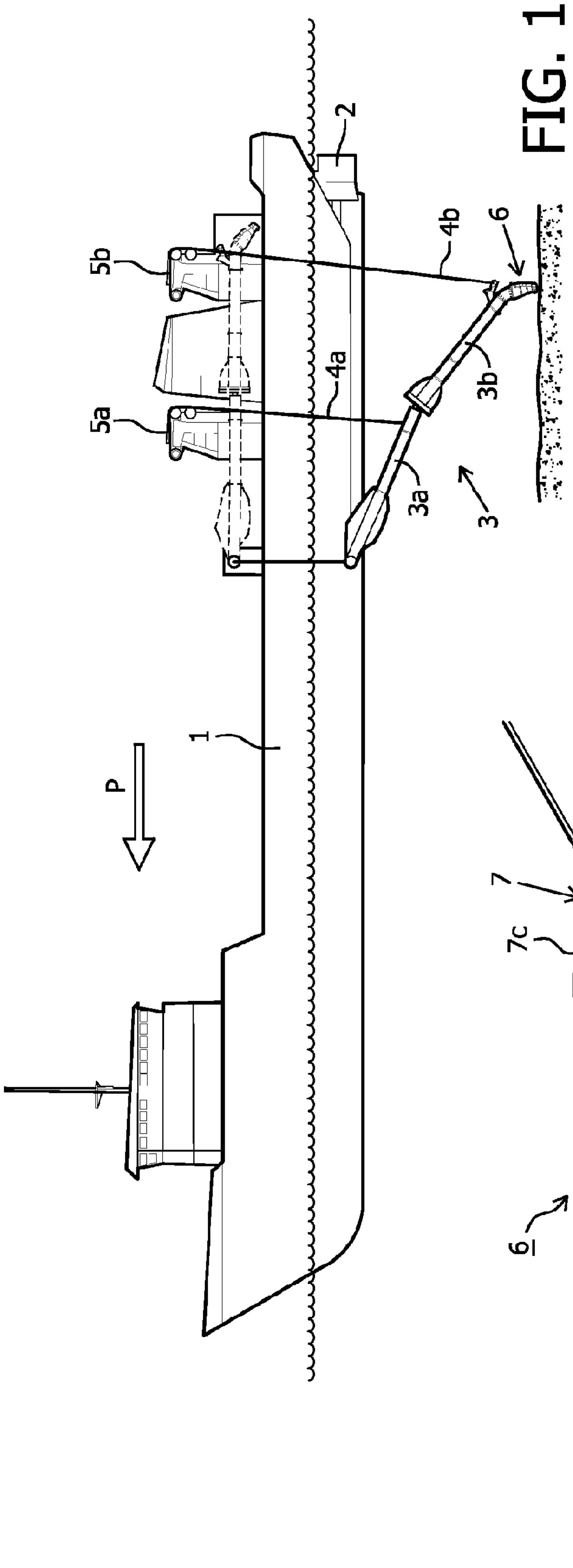


FIG. 1

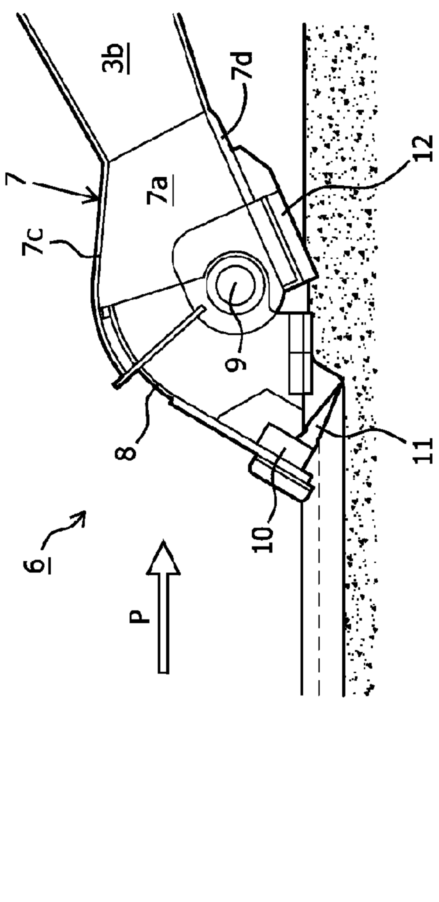
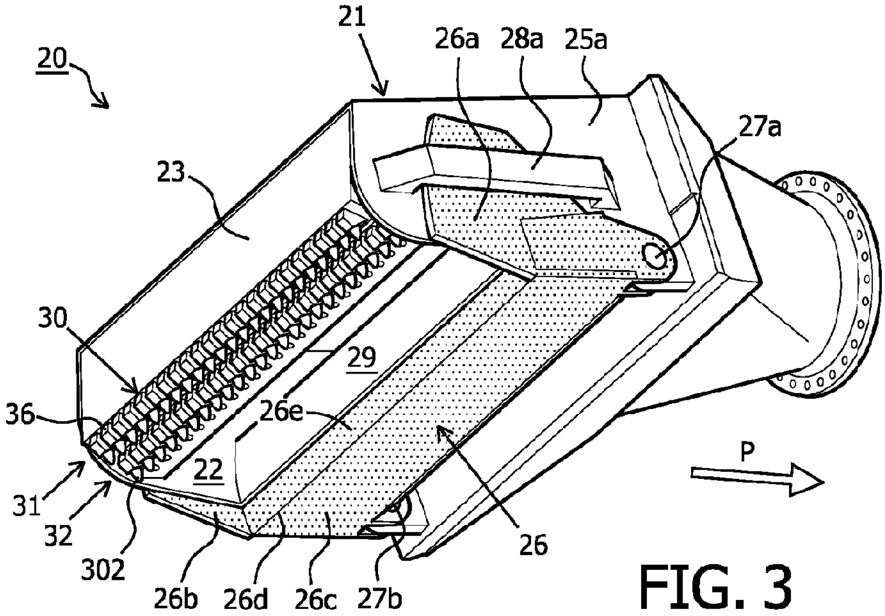


FIG. 2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21
26a
28a
25a
27a
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29
26e
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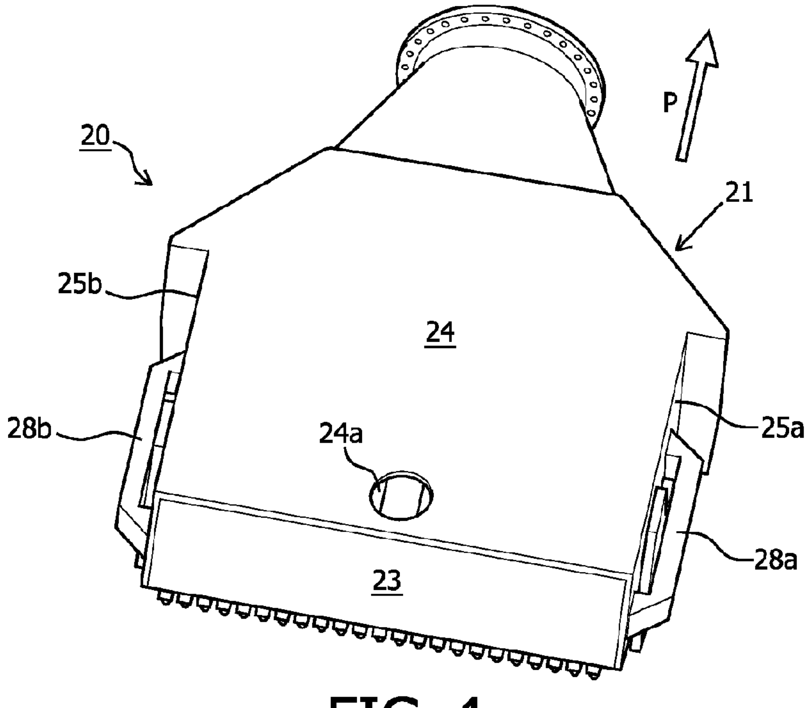
22
31
32
302
26b
26d
26c
27b
26
P

FIG. 3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25b
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24a
25a
23
28a

FIG. 4

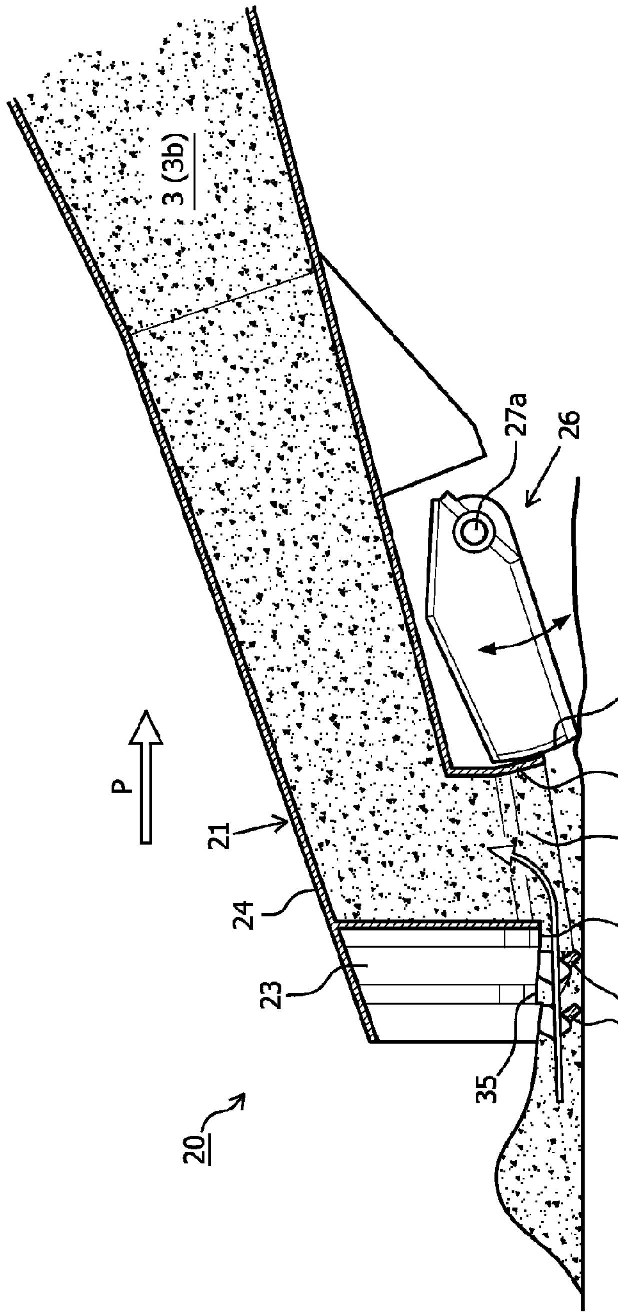
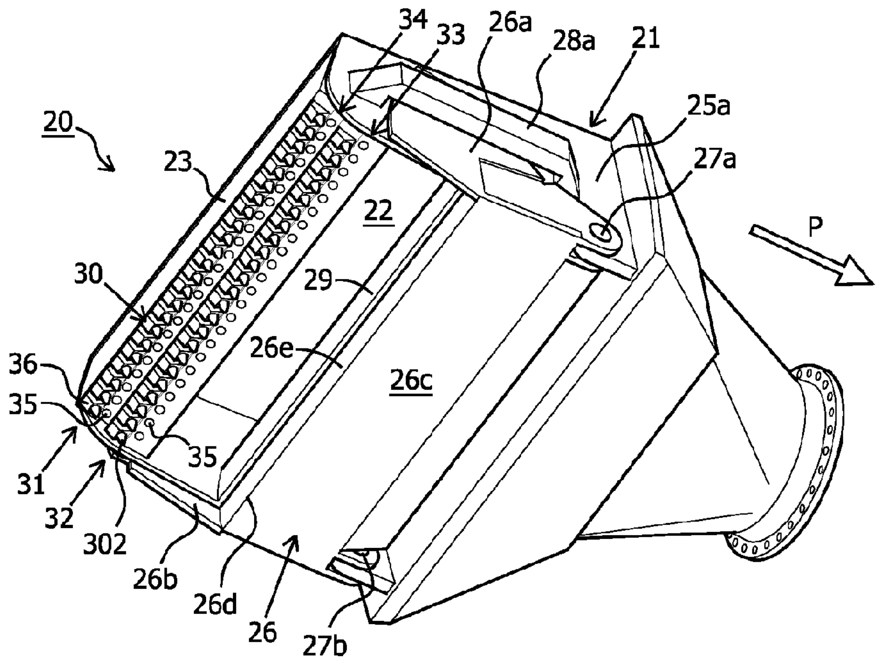


FIG. 5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P
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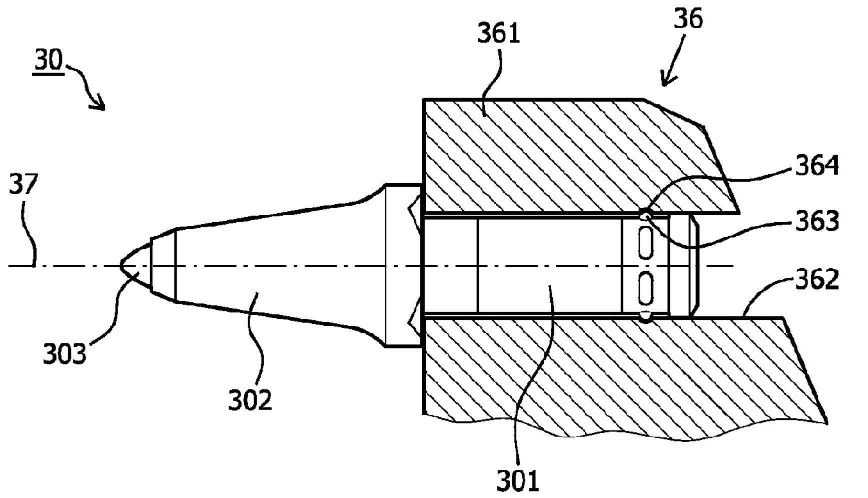
302
26b
26d
26
27b

FIG. 6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363
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301

FIG. 7