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NEW AMENDED TEXT

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METHOD FOR WORKING THROUGH GROUND AND ROCK LAYERS
WITH DREDGERS OR EXCAVATORS AND APPARATUSES
OPERATING ACCORDING TO THIS METHOD

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This invention relates to a method for dredging under water ground layers as described in the preamble of the first claim.

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In DE-A-3521560, a method is disclosed for digging dry ground layers with a firm hardness such as for example rocks, by means of an excavator comprising teeth for excavating the ground layers. In the method disclosed in DE-A-3521560 use is made of the impact of high pressure water jets on the ground layer that needs to be digged. As the high pressure water jets impact the ground layer, a cutting action is imparted to the ground layer, thus involving the formation of fissures and cracks which can then be easily split by the teeth of the excavator. Simultaneously, the size of the parts resulting from the digged grounds is reduced, so that the reduced rocks need not be transported and can be left at the digged location. The pressure of the water jets is mostly between 40 and 400 Mpa.

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The method disclosed in DE-A-3521560 however concerns the excavation of dry grounds, which cannot be applied to under water dredging just like that. Namely, the impact of high pressure water jets after displacement through water, will be significantly lower than the impact of a high pressure water jet on a dry ground after displacement through the environmental air. In addition to this, even if the impact of a high pressure water jet on a dry ground is known, its impact to an under water ground layer cannot be predicted just like that, as it will a.o. strongly vary with the pressure of the water jet

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and the propagation distance through the water.

It has been known for some time to inject water jets, mixed with air or not, under pressure into an area in front of the cutting or excavating component in dredging operations with dredgers or excavators of different types, in particular with suction hopper dredgers when dredging sandy grounds. The main purpose of injecting water jets is to cause the sandy grounds to fluidize through addition of water. In that way the cutting, suction and pumping process are enhanced and in sludge-like grounds a stirring-up of the sludge particles in the water is caused so that the particles can be displaced by the ambient natural water currents. The pressures used in this technique lie in the order of magnitude of 10 bar with a tendency to increase the pressure to about 15-20 bar.

The invention now has different purposes which can be summarized as follows:

- 1) to reduce the mechanical cutting forces so that
 - a) harder ground types can be dredged with a similar or lower power of the machines;
 - b) a higher cutting, suction and pressing production can be attained in identical ground types .
- 2) to reduce the wear on the cutting or excavating components including the teeth thereof.
- 3) to obtain an improved fluidization of the sandy materials, which will improve the pump efficiency.

This is achieved in the present invention with the technical features of the characterising part of the first claim.

In the method of this invention, the dredging action of the dredging component and the injection of the water jets in the area where the cutting or excavating component is active are carried

out simultaneously.

The water jets are preferably injected at a pressure of at least 20 bar at the position of, through and/or behind the mechanical dredging component and at a pressure of at least 50 bar in front of the mechanical dredging component. It has now been found that these water pressures are sufficiently high to enhance the hydraulic fracturing in the non-crushed material in the immediate vicinity of the crushed material, to cut open ground layers such as clay layers and/or fluidise ground layers such as sand layers in the vicinity of the cutting or excavating component. It further appeared that with the high pressure water jets of this invention, broken-off and crushed materials can be immediately removed from the location where the mechanical cutting or excavating component is active in case the ground layers contain rock-like materials or consist virtually or exclusively of rock-like materials such as rock layers.

In the method of this invention, ground layers are understood to include gravel, sand and clay layers or ground layers containing rock-like materials or consisting virtually exclusively of rock masses such as rock layers. Examples of dredging devices suitable for use in the method of this invention include suction hopper dredgers, suction cutter dredgers, bucket dredgers, grab dredgers, pull shovel pontoons or the like. Each of these devices comprises a mechanical cutting or excavating component part of which comes into contact with the ground and/or rock layers for excavating.

In determined conditions, when the ground layers contain rock-like materials or consist solely of rock-like materials, water jets are injected at pressures of preferably at least 100 bar up to pressures of even at least 2000 bar in accordance with the requirement necessary to achieve the intended purpose.

Other details and advantages of the invention will become apparent from the following description of a method for working through ground and rock layers with dredgers or excavators and of the apparatuses operating according to this method.

5 This description is given solely by way of example and does not limit the invention. The reference numerals relate to the figures annexed hereto.

Figure 1 is a schematic view of the principle on which the method according to the invention is based in the case of a
10 tooth as mechanical cutting or excavating component.

Figures 2 and 3 are schematic representations in side view of the head of a suction hopper dredger during application of the method according to the invention.

Figure 4 is a side view of a tooth with adapter in a possible embodiment according to the invention, i.e. with at least
15 one water jet under high pressure through the tooth.

Figure 4A is a side view of an adapter as according to a variant.

Figure 5 shows a cross-section along the line
20 v-v of figure 4.

Figure 5A shows a longitudinal section along the same line of an adapter as according to figure 4A.

Figure 6 is a perspective view of an adapter with tooth mounted thereon in an embodiment according to the
25 invention.

Figure 7 shows in perspective view a variant of the embodiment of figure 6.

Figure 8 illustrates schematically the operation of the teeth on a suction cutter dredger.

The method illustrated by the above stated figures is based on an optimal co-action of the mechanical cutting or excavating component of the dredger or excavator and the water jets injected under pressure as hydraulic cutting or excavating component, and on the strength of said pressure enabling it to fulfil its function satisfactory.

Figure 1 is a very schematic view which serves to elucidate the method according to the invention. If reference is made with 1 to for instance a stone-like ground mass and with 2 to a tooth as the active part of a cutting or excavating component, it is then essential that the tooth structure (in a suction cutter dredger for instance) be disposed such that during cutting of the ground the impact point 3 of the tooth and the water jet 4 practically coincide.

Due to the action of the mechanical cutting implement on the ground (this concept also includes stone-like ground masses) there results a first fracture zone 5 in the ground mass round the position where the mechanical cutting implement is active. In figure 1 the cutting implement is represented by a tooth 2, a water jet under high pressure is designated with 4, the fracture zone where the mechanical cutting implement has been active is designated 5 and the hydraulic fracture zone where water jet 4 injected under high to very high pressure has likewise been active is designated with 5'. It is essential to note herein that the water jet 4 injected under high to very high pressure must be directed precisely at the impact point 3 of tooth 2 because then the crushed stone-like materials are integrally removed from fracture zone 5. The tooth hereby has an improved efficiency and is less subject to wear. The hydraulic fracturing in fracturing zone 5' is also enhanced so that an improved break-away pattern of the material is formed.

When the pressure of the water jet covering this fracture zone is sufficiently high, for instance amounts to at least 100 bar, this fracture zone will then initiate further cracking, which results in hydraulic fracturing, and breakage remnants will be removed from the fracture zone. As a consequence hereof a lower cutting power will be noted and thus less wear because a large part of the broken-off materials associated with this fracture zone are removed by the water jet.

In order to realize an optimal co-action between the tooth and the high pressure water jet, the nozzle through which water jet 4 is injected can be situated just behind tooth 2 (figure 2) while in the embodiment of figure 3 the tooth 2' is designed such that water jet 4' is injected through the tooth.

Because the teeth of dredgers wear exceptionally rapidly, particularly when work is being carried out in rock-like ground masses, a tooth structure is designed according to the invention which, referring to figures 4, 4A, 5, 5A and 6, have the following features.

Tooth 2' is mounted, as is usual, on an adapter 6 which for instance forms part of the rotating cutter or is fixed onto a transverse beam of the draghead.

In the embodiment according to figures 4, 4A, 5, 5A, 6 and 7, at least one high pressure conduit 7 is provided through adapter 6. This high pressure conduit 7 ends in a short nozzle 8 or an extended nozzle 8' which, when tooth 2' is mounted on adapter 6, comes to lie in the line of the bore 9 running through tooth 2'.

This tooth structure results in a maximum co-action between tooth and high pressure water jet, which results in a considerable reduction in the wear of the tooth. When dredging is

carried out in rock-like ground masses or rocks, the broken-off materials will be removed by the high pressure water jets so that the teeth will operate in the most favourable conditions.

5 A variant of the embodiment described by figure 6 consists of providing two bores 9' through tooth 2' and providing the adapter with two nozzles 8 or 8'. Both bores 9' must be directed such that, as the outer end of tooth 2' wears, an injection by both water jets under high pressure is the impact point of the tooth continues to take place which becomes wider as the tooth wears.

10 Figure 8 shows very clearly the method according to the invention for a suction cutter dredger. The same figure shows schematically the operation of teeth 2 or 2' in the ground or rock mass 10 for the same rotation direction and two opposed swinging movements of the suction cutter dredger. The rotation direction is indicated with arrows 11, the swinging movements with arrows 12 and
15 13.

It is noticeable that the water jets under high pressure are injected at least for a duration which corresponds with the time for which the teeth 2 or 2' are active, i.e. remain in contact with the
20 ground mass for excavating or dredging. Due to the action of the high-pressure water jets the broken materials are removed so that they do not obstruct the optimal operation of the teeth and ensure the increased life-span of the teeth. The action of the high pressure water jets also initiates and enhances the hydraulic fracturing.

25 It is therefore necessary in this option to ensure by means of valves the water flow rate under high pressure to at least the "active" or operational teeth.

When the invention is applied on suction hopper dredgers, a plurality of dispositions of the high pressure water

jets can be devised. Reference is made once again to figures 2 and 3 as an example of suction hopper dredgers. The nozzles for high pressure water jets 4 of at least 50 bar are mounted on the heel plate 14 of draghead 15 and provide a first hydraulic working of the ground.

5 A second row of nozzles is arranged behind teeth 2, this such that water jets 4' of at least 20 bar are directed toward the outer end of teeth 2, with a second row of nozzles for injecting water jets 4" of at least 20 bar toward the interior of the draghead 15 to cause the already cut material to undergo an additional cutting operation. In such a

10 suction hopper dredger use can also be made of the above described tooth structure which enables injection of the water jets through tooth 21 with its adapter 6. If water jets 4 are caused to act from the heel plate 14 of draghead 15 in one line between respective teeth 2 or 2', these water jets then provide an initially vertical cutting or fracture plane

15 in one line between teeth 2 or 2', while water jets 4' and 4" with the teeth 2 or 2' co-acting therewith cause further fracture of the intermediate ground material of these vertical planes.

In firm clay layers and harder sand layers the above described arrangement offers very great advantages, since with

20 the currently applied techniques it is only possible to dredge with suction hoppers with a great propulsion power or with a stationary suction cutter dredger. In dredging with an apparatus according to the invention in said harder sand layers or firm clay layers the efficiency increases because the ground layers are already partly broken,

25 simultaneously or not, by the action of the high pressure water jets.

CLAIMS

1. A method for dredging under water ground layers using a dredging device with a mechanical dredging component, wherein a part of the mechanical dredging component is brought into
5 contact with the ground layers to exert a dredging action to the ground layers and water jets are injected in the area where the mechanical dredging component is active, characterized in that the dredging action of the dredging component and the injection of the water jets are carried out simultaneously and the water jets are injected at a pressure
10 of at least 20 bar at the position of, through and/or behind the mechanical dredging component and at a pressure of at least 50 bar in front of the mechanical dredging component.

2. A method as claimed in claim 1, characterized in that water jets are injected at a pressure of at least 100
15 bar, preferably at least 2000 bar.

3. A method as claimed in claim 1, characterized in that use is made of a suction hopper dredger with a draghead equipped with teeth which extend in line in transverse
direction of the displacement direction of the draghead, and in that
20 water jets are injected at a pressure of at least 50 bar in front of said teeth taken in the direction of movement of the draghead.

4. A method as claimed in claim 3, characterized in that water jets are injected at a pressure of at least 20
bar behind said teeth taken in the direction of movement of the teeth,
25 and in front of the suction hoppers of the draghead.

5. A method as claimed in claim 3, characterized in that water jets are injected at a pressure of at least 20
bar between said teeth taken in the direction of movement of the teeth.

6. A method as claimed in claim 3,

characterized in that water jets are injected at a pressure of at least 20 bar through said teeth taken in the direction of movement of the teeth.

5 7. A method as claimed in claim 3, characterized in that at the position of said teeth water jets are injected at a pressure of at least 20 bar in the direction of the inside of the draghead.

8. A method as claimed in claim 1 or 2, characterized in that as a dredging device, use is made of a suction cutter dredger.

10 9. A method as claimed in claim 1 or 2, characterized in that as a dredging device, use is made of a bucket dredger.

15 10. A method as claimed in claim 1, characterized in that as a dredging device, use is made of a pull shovel pontoon and a grab dredger.

11. A method as claimed in claim 8-10, characterized in that the high pressure water is injected exclusively during the effective operation of the dredging component of the dredging device.

20 12. A device for dredging under water ground layers, the dredging device comprising a dredging component with a part for dredging the ground layers and means for ejecting a high pressure water jet to the ground layer in the area where the part of the dredging component is active, characterized in that the part of the
25 dredging component contacting the ground layer comprises high pressure water injection nozzles for injecting water into the ground layer at a pressure of at least 20 bar at the position of, through, between and/or behind the mechanical dredging component, and at a pressure of at least 50 bar in front of the dredging component.

13. A device as claimed in claim 12, characterized in that the dredging component comprises high pressure water injection nozzles for injecting water at a pressure of at least 100 bar, preferably at least 2000 bar.

5 14. A device as claimed in claim 12 or 13, characterized in that the device is a suction hopper dredger, the draghead of which is equipped with teeth which extend in a line transversely of the displacement direction of the draghead and in that high pressure water injection nozzles are provided between said teeth.

10 15. A device as claimed in claim 12 or 13, characterized in that the device is a suction hopper dredger, the draghead of which is equipped with teeth which extend in a line transversely of the displacement direction of the draghead, behind which teeth high pressure water injection nozzles are mounted for
15 injecting high pressure water jets under the tooth in the direction of the outer end thereof.

16. A device as claimed in claim 12 or 13, characterized in that the dredging device is a suction hopper dredger, the draghead of which is equipped with teeth which extend in a line
20 transversely of the displacement direction of the draghead, the draghead comprising nozzles for injecting high pressure water jets in the direction of the interior of the draghead.

17. A device as claimed in claim 12 or 13, characterized in that the dredging device is a suction hopper dredger
25 with a heel plate.

18. A device as claimed in claim 12 or 13, characterized in that the dredging device is a cutter suction dredger with a cutter head the arms of which are equipped with teeth mounted on so-called adapters, the teeth being provided with nozzles for

injecting high pressure jets towards the impact point of the teeth.

19. A device as claimed in claim 12 or 13, characterized in that the dredging device is a bucket dredger, each bucket comprising an edge provided to contact the ground in the course of the dredging action, the edge of the bucket comprising high pressure water injection nozzles.

20. A device as claimed in claim 12 or 13, characterized in that the dredging device is a pull shovel pontoon, the shovel comprising an edge for contacting the ground layer in the course of the dredging action, the edge being provided with high pressure water injecting nozzles.

21. A tooth with adapter for use in a device as claimed in any of the claims 13-20, characterized in that both the tooth and the adapter on which it is mounted have at least one axial bore for injecting high pressure water jets in the direction of the position where the tooth contacts the ground layer or rock.