

Dredging head of a trailing hopper dredger and method for dredging by means of said dredging head

The invention relates to a dredging head of a trailing hopper dredger which is configured to move in a direction of movement, in which the dredging head comprises a tubular construction which can be attached to a suction line and a visor which is rotatable with respect to the tubular construction and has a suction opening which is directed to the bottom for sucking in the bed material. The invention also relates to a dredging device which comprises the dredging head, and to a method for underwater dredging of bed material using the dredging head.

A known dredging head is known from EP-A-0892116 which discloses a dredging head consisting of a visor which is attached to a suction line. The visor usually has an upper wall and two side walls and is open on the bottom side, as a result of which a suction opening is created for discharging soil. The combination is attached to the trailing hopper dredger by means of a drag pipe. In order to be able to dredge soil underwater, the dredging head with drag pipe and suction line is lowered into the water until it hits the bottom on account of its own weight. Due to the direction of travel of the trailing hopper dredger, the dredging head is dragged across the bottom to be dredged, in which case the soil is loosened and is sucked up via the suction line together with water. To this end, the trailing hopper dredger is provided with a dredger pump. Loosening the soil is facilitated in the known dredging head by providing the visor with a series of teeth which are usually fitted at right angles to the direction of movement, on a so-called tooth bar, and which partly penetrate into the soil during dredging. It is also customary to inject pressurized water into the soil in order to fluidize the latter. All these measures are aimed at increasing the dredging efficiency which, in the context of the present application, means the volume of dredged soil per unit time.

Dredging of bottoms which contain rocks, boulders and other large obstacles is becoming increasingly common, for example in ore mining. In this case, dredging is frequently carried out on bottoms containing relatively large stones, rocks and other objects which may block the suction line during dredging or may damage or inactivate the suction pump during dredging. In order to prevent such undesirable objects from causing problems, the known dredging head is sometimes provided with a retaining structure, such as a grate. However, it has been found that this may compromise the dredging efficiency. A reduction in the dredging efficiency is inter alia caused by the fact that a part of the suction opening of the visor is

blocked by undesirable objects, resulting in less soil being sucked up. The dredging head then has to be hauled up and cleaned, which takes considerable time, in particular if dredging takes place at great depth.

- 5 It is an object of the present invention to provide a dredging head for a trailing hopper dredger which offers adequate protection against undesirable objects being sucked up without compromising the dredging efficiency.

To this end, the dredging head according to the invention comprises a tubular construction
10 which can be attached to a suction line and has a visor which is rotatable with respect to the tubular construction and has a suction opening which is directed towards the bottom for sucking up bed material, in which the dredging head comprises a crushing device for crushing material which is present in the dredging head, such as for example rock-like bed material and/or objects. Instead of retaining this material by means of a grate, which could result in a
15 blockage, it is sucked up through the teeth of the trailing hopper dredger and comminuted by the crushing device to such an extent that the material can pass through the dredging head, the suction line and/or the dredger pump substantially unimpeded. This results in the parts of the dredging head, suction line and/or dredger pump becoming blocked or inactivated less quickly, if at all.

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In an embodiment of the invention, a dredging head is provided in which the crushing device comprises spaced-apart pressure plates situated opposite one another, at least one of which is movable towards the opposite pressure plate. In the present embodiment, the material is crushed as a result of the fact that it ends up between the pressure plates, the at least one
25 pressure plate moving towards the opposite pressure plate in a pressurized manner, as a result of which parts of the material come into contact with the pressure plates, and the material breaks.

A preferred embodiment of the dredging head according to the invention is characterized by
30 the fact that a movable pressure plate is connected to an upper wall of the visor. In this embodiment, a separate drive for the movable pressure plate is superfluous as it is driven by the drive of the visor which is already present. The drive of the visor usually comprises cams on the tubular construction which are connected to cams on (the upper wall of) the visor by means of remotely operable hydraulic pistons. By providing the hydraulic pistons with some
35 travel, the distance between the cams of the tubular construction and those of the visor is

increased, as a result of which the visor rotates about a shaft which runs at right angles to the direction of movement and by means of which the visor is connected to the tubular construction. This embodiment has the additional advantage that the drive (at a distance) of (the hydraulic pistons of) the visor can remain unchanged with respect to the known dredging head, and that no separate drive is required for the crushing device.

In order to be able to supply the (considerable) forces required for crushing, the hydraulic pistons and cams in this embodiment are preferably designed to be stronger than is the case with the known dredging head. A preferred embodiment of the invention comprises a dredging head, of which the force exerted by the crushing device thereof on the material to be crushed is adjustable. In another preferred embodiment, the force applied by the drive of the visor to the material to be crushed is adjustable. As a result thereof, the crushing device can be adjusted to the circumstances and, more particularly to the properties of the material to be crushed, such as for example the hardness, the size and shape and the like.

In this case, a suitable embodiment comprises visor cams with connecting means engaging at different heights for the hydraulic pistons. When the hydraulic pistons are connected to the visor cams at a high level, the angular displacement of the visor upon completed travel of the pistons will be relatively small, but due to the large moment arm, the force exerted on the material is relatively large, for example somewhere between 500 and 750 tonnes or more, all this depending on the position of the visor between a closed and a completely open position. Such a setting of the drive is suitable for dredging bottoms, which comprise rocks and/or boulders, with the rocks and/or boulders having a relatively high hardness. When the hydraulic pistons are connected to the visor cams at a low level, the angular displacement of the visor upon completed travel of the pistons will be relatively great, but due to the small moment arm, the force exerted on the material is relatively small, for example somewhere between 250 and 350 tonnes. Such a setting of the drive is more suitable for dredging bottoms with rocks and/or boulders, in which the rocks and/or boulders have a relatively low hardness. In an intermediate position, the force exerted on the material will, on average, be for example somewhere between 350 and 600 tonnes.

Another practical embodiment of the dredging head according to the invention is characterized by the fact that a stationary pressure plate is connected to a bottom wall of the visor and/or the tubular construction. Good results are achieved when the dredging head

comprises a heel plate and the stationary pressure plate is connected to the top side of the heel plate.

In order to successively comminute the material, it is advantageous if the dredging head
5 according to the invention is characterized by the fact that the distance between the pressure plates varies, and preferably decreases, from an entry side to an exit side, at least when the visor is in a lifted position. In this variant, the entry side is preferably situated on the side downstream of the exit side, and therefore behind the exit side, viewed in the direction of movement. In this embodiment, the material to be crushed is sucked into the crushing device
10 by the suction force of the dredger pump and comminuted in stages.

In this case, the visor is preferably partly closed and opened again in an oscillating manner. This may be effected, for example, by actuating the hydraulic pistons in this manner. It is, for example, also possible to use a cam/push rod mechanism. The oscillation frequency can be
15 chosen within a wide range, for example in the range from 0.05 - 1 Hz, but frequencies outside this range are likewise possible. In another embodiment, the oscillating movements of the visor are not driven by the hydraulic pistons of the visor, but by a separate drive which is specifically configured to control the rapid oscillating movements. The movement of the pressure plate (and the visor) may be relatively small, because breaking and crushing do not
20 have to be carried out in one single stroke.

In order to further increase the point load onto the material to be crushed, an embodiment of the invention provides a dredging head in which the pressure plates comprise a ribbed surface. As a result thereof, the material is broken rather than crushed, thus requiring forces which are
25 less large. The efficiency of crushing appears to improve when the ribs of the ribbed surface extend in a direction parallel to the direction of movement.

Although the distance between the pressure plates at the location of the exit side can be chosen within a wide range, in one embodiment of the dredging head, the distance between
30 the pressure plates at the location of the exit side is chosen to be at most 450 mm, and more preferably at most 350 mm. Such a distance ensures that emerging material particles which will essentially not exceed said distance, thus reducing the risk of blockage and/or damage to the dredger pump, for example.

An embodiment according to the invention having an efficiency which is improved still further comprises a dredging head in which the crushing device extends in a direction at right angles to the direction of movement P along substantially the entire width of the dredging head.

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The dredging head according to the invention preferably comprises a visor which is provided with a series of teeth which are fitted at right angles to the direction of movement and which may partly penetrate into the soil during dredging. Such a series of teeth is able to detain large chunks of material, in which case the intermediate distance between the teeth may, if desired, be adapted to the dimensions and properties of the crushing device.

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In yet another embodiment of the dredging head according to the invention, the dredging head is provided with a series of nozzles for emitting a pressurized medium, preferably water, in order to remove any accumulation of material, in particular of clay-containing bed material, in the dredging head. The nozzles are preferably directed towards the interior of the visor, more preferably to the pressure plates, and most preferably to the stationary pressure plate or pressure plates.

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The invention also relates to a method for underwater dredging of bed material using a dredging vessel provided with a dredging head according to the invention. In this case, the dredging head is dragged across a bottom to be dredged in a direction of movement and in such a way that the cutting tools contact the bottom, and material present in the dredging head is crushed by the crushing device. Due to the ingenious construction of the dredging head, the dredging head has to be brought to the surface less often in case of blockage or damage to parts, thus resulting in a saving in time and money.

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In an embodiment of the method in which the crushing device comprises spaced-apart pressure plates which are arranged opposite one another, at least one of which can be moved towards the opposite pressure plate, the material is crushed by moving the pressure plates towards one another.

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In another embodiment, a method is provided in which a movable pressure plate is connected to an upper wall of the visor and the pressure plates are moved towards each other by operating the visor, preferably in an oscillating manner.

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The method according to the invention is particularly suitable for dredging bed material containing rocks.

The invention will now be explained in more detail by means of the following figures and the description of a preferred embodiment, without the invention being limited thereto, however.

In the figures:

Figure 1 shows a diagrammatic side view of a dredging device according to the invention;

Figure 2 shows a diagrammatic perspective rear view of an embodiment of a dredging head according to the invention;

Figure 3A shows a diagrammatic side view of the dredging head according to the invention shown in Figure 2;

Figure 3B shows a diagrammatic perspective bottom view of the dredging head according to the invention shown in Figure 2;

Figure 4A shows a diagrammatic side view of a dredging head according to the invention with the visor in an open position;

Figure 4B shows a diagrammatic side view of the dredging head shown in Figure 4A with the visor in a closed position;

Figure 5A shows a diagrammatic perspective rear view of a dredging head according to the invention with the visor in an open position, and finally

Figure 5B shows a diagrammatic perspective rear view of the dredging head shown in Figure 5A with the visor in a closed position.

Figure 1 shows a dredging vessel 1 which is provided with an engine (not shown in the drawing) for driving a propelling screw 2 for propelling the dredging vessel 1 via a propeller shaft. In addition, devices (not shown in the drawings) for steering the dredging vessel 1 are present, such as a rudder and transversely positioned propeller screws to facilitate manoeuvring.

The dredging vessel 1 is provided with a dredger pump (not shown in the drawings). A suction line 3 is fitted against a side wall of the dredging vessel, one end of which is connected with the suction connection of the dredger pump. In the present example, the suction line 3 comprises two sections 3a and 3b which are connected to each other by means of a coupling which allows a certain degree of mutual angular displacement. The connection between the upper section 3a of the suction line 3 and the vessel also allows angular displacement in the vertical plane and about the axis. In order to support the movable end of

the upper section 3a of the suction line 3, said section is connected to a cable 4a, the other end of which is connected to a winch 5a. Similarly, in order to support the movable end of the lower section 3b of the suction line 3, said section is connected to a cable 4b, the other end of which is connected to a winch 5b. By means of winches 5a, 5b, it is thus possible to vary the height of the suction line 3. It will be clear that, partly depending on the depth of the bed to be dredged, the number of sections of the suction line 3 can be increased or decreased, in combination with a corresponding adjustment in the number of cables 4 and winches 5. A dredging head 6 according to the invention is fitted at the free end of the second section 3b of the suction line 3.

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In Figure 2, an embodiment of the dredging head 6 is shown. The dredging head 6 comprises a tubular construction 7 which can be connected to the suction line 3 and a visor 9 which is rotatable about a shaft 8 which runs at right angles to the direction of movement P with respect to the tubular construction 7 and has a suction opening 10 which is directed to the sea (bed) for sucking up bed material. The visor 9 of the dredging head 6 is provided with a series of teeth 10 which are attached to a tooth bar 11 which extends at right angles to the direction of movement P, and which may partly penetrate into the sea (bed) during dredging. The intermediate distance between the teeth 10 may optionally be chosen such that material which is too large for the crushing device described below can be retained.

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The dredging head 6 comprises a crushing device in the form of spaced-apart pressure plates (12a, 12b) which are situated opposite one another and of which a movable pressure plate 12a is connected to an upper wall 13 of the visor 9. The pressure plates (12a, 12b) extend in a direction at right angles to the direction of movement P along substantially the entire width of the dredging head 6. In the illustrated embodiment, the pressure plates (12a, 12b) furthermore have a ribbed surface due to the fact that they are provided with ribs 14 which extend in a direction parallel to the direction of movement P. The ribs 14 may comprise, for example, steel rods which are fitted to or partly in the surface of the pressure plates (12a, 12b), for example fastened. The stationary pressure plate 12b is connected to a bottom wall 15 of the tubular construction 7, for example a heel plate.

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The movable pressure plate 12a is driven by the drive of the visor 9 itself which, in the illustrated embodiment, comprises cams 16 which are fitted to the upper wall of the visor 9. By means of hydraulic pistons 17 which can be operated remotely, the visor cams 16 are connected to tube cams 18 which are attached to the tubular construction 7. By giving the

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hydraulic pistons 17 a degree of travel, as is illustrated in Figures 4B and 5B, the distance between the cams 18 of the tubular construction 7 and the cams 16 of the visor 9 is increased, as a result of which the visor 9 rotates about the shaft 8 which runs at right angles to the direction of movement P and by means of which visor 9 and tubular construction 7 are
5 connected to each other.

The force exerted by the drive (16, 17, 18) of the visor 9 on the material to be crushed can be made adjustable by providing the cams 16 with connecting means which are fitted at different levels, in this case pin-hole joints 19, for the hydraulic pistons 17.

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In the virtually completely lifted or open position of the visor 9 shown in Figures 4A and 5A, the distance between the pressure plates (12a, 12b) varies and in such a way that it decreases from an entry side which is situated downstream of the exit side (and is therefore behind the exit side, viewed in the direction of movement P). In this embodiment, due to the suction
15 force of the dredger pump, the material to be crushed is sucked in between the pressure plates (12a, 12b) in the direction of movement P and comminuted in stages. In this case, the visor 9 can be brought from the (partly) open position shown in Figures 4A and 4B to the (partly) closed position shown in Figures 5A and 5B and vice versa by driving the hydraulic pistons 17 in an oscillating manner. The amplitude of this movement may in this case be relatively
20 small, for example a few millimetres.

The distance 20 between the pressure plates (12a, 12b) at the location of the entry side may vary greatly, but is, for example, 1200 mm where the distance 21 between the pressure plates (12a, 12b) at the location of the exit side is, for example, 320 mm. The distance 21 is
25 preferably chosen as a function of the dimensions of the suction line 3 and of the impeller of the dredger pump, for example.

In order to prevent or reduce the amount of clay or the like which attaches itself to the crushing device, the dredging head 6 is provided with a series of nozzles (not shown) in order
30 to expel pressurized water. The nozzles are supplied with pressurized water via lines 22 and a water chamber from where the nozzles send jets of water which are directed towards the interior of the visor 9, in particular to the pressure plates (12a, 12b).

By means of the dredging head of the invention, underwater dredging of bed material can be
35 carried out, in which case the dredging head 6 is dragged across a bottom to be dredged in the

direction of movement P and in such a manner that the cutting tools 10 contact the bottom. According to the invention, any material which cannot be sucked into the dredging head 6 in a satisfactory manner is crushed by means of the crushing device (12a, 12b, 16, 17, 18). The method according to the invention is particularly suitable for dredging bed material which
5 contains rocks.

The invention is not limited to the above-described embodiments and also comprises modifications thereto in so far as these are within the scope of the attached claims.

Claims (as amended with letter of 25 March, 2014)

1. Dredging head (6) of a trailing hopper dredger (1) which is configured to move in a direction of movement P, the dredging head (6) comprising a tubular construction (7) which
5 can be attached to a suction line (3) and a visor (9) which is rotatable with respect to the tubular construction (7) and has a suction opening which is directed to the bottom for sucking in bed material, in which the dredging head (6) comprises a crushing device (12a, 12b, 16, 17, 18) for crushing material which is present in the dredging head (6), the crushing device comprising spaced-apart pressure plates (12a, 12b) situated opposite one another, at least one
10 of which is movable towards the opposite pressure plate by being connected to an upper wall of the visor.
2. Dredging head according to claim 1, in which a stationary pressure plate is connected to a bottom wall of the visor and/or the tubular construction.
- 15 3. Dredging head according to claim 2, in which the dredging head comprises a heel plate and the stationary pressure plate is connected to the top side of the heel plate.
4. Dredging head according to claim 2 or 3, in which the distance between the pressure
20 plates varies from an entry side to an exit side, at least when the visor is in a lifted position.
5. Dredging head according to claim 4, in which the distance between the pressure plates decreases from the entry side to the exit side.
- 25 6. Dredging head according to any one of the preceding claims, in which the pressure plates comprise a ribbed surface.
7. Dredging head according to claim 6, in which the ribs of the ribbed surface extend in a direction parallel to the direction of movement P.
- 30 8. Dredging head according to any one of claims 1-7, in which the distance between the pressure plates at the location of the exit side is at most 450 mm, and more preferably at most 350 mm.

9. Dredging head according to any one of the preceding claims, in which the crushing device extends in a direction at right angles to the direction of movement P along substantially the entire width of the dredging head.
- 5 10. Dredging head according to any one of the preceding claims, in which the force exerted by the crushing device on the material to be crushed is adjustable.
11. Dredging device, comprising a dredging vessel which is configured to move in a direction of movement P and a dredging head according to any one of claims 1-10 connected
10 to the dredging vessel.
12. Method for underwater dredging of bed material using a dredging vessel, equipped with a dredging head according to any one of claims 1-10, in which the dredging head is dragged across a bed to be dredged in a direction of movement and such that the cutting tools
15 contact the bed, and in which the crushing device crushes material present in the dredging head by operating the visor.
13. Method according to claim 12, in which the bed material contains rocks.