

Drag head for a trailing suction hopper dredger and method for dredging using this drag head

The invention relates to a drag head of a trailing suction hopper dredger, comprising a
5 visor which is dragged over the bottom and herein loosens soil, and a suction pipe
which is connected to the visor and which discharges the loosened soil. The invention
also relates to a method for dredging soil using this drag head.

A drag head according to the preamble is known from EP-A-0892116. EP-A-0892116
10 describes a drag head for a trailing suction hopper dredger comprising a visor which is
connected to a suction pipe and is open toward the bottom for dredging. The visor is
fixed to the trailing suction hopper dredger by means of a drag pipe. A series of teeth is
arranged on the visor. During the dredging the drag head with drag pipe and suction
pipe is lowered under water at a generally oblique angle with a winch at the rear of the
15 trailing suction hopper dredger, until the drag head makes contact with the bottom.
During the travel of the trailing suction hopper dredger the drag head is dragged over
the bottom under water, wherein the soil is loosened by the teeth engaging on the
bottom. The loosened soil is suctioned away via the suction pipe, for instance to a
storage space present on the trailing suction hopper dredger. During the dredging the
20 drag head exerts pressure on the bottom due to the relatively high weight of the
components situated under water, and optionally due to the suction force developed by
the suction pipe. The underwater weight of the relevant components corresponds to the
above-water weight thereof minus the weight of the water displaced by said
components. The underwater weight of a steel component thus amounts to about 7/8 of
25 the above-water weight (the relative specific weight of steel being approximately equal
to 8).

Although the known drag head has a reasonable efficiency, there is a great need to
further improve this efficiency. Within the context of this application, efficiency is
30 understood to mean the volume of soil dredged per unit of time.

The present invention has for its object to provide a drag head for a trailing suction
hopper dredger which is able to dredge soil under water with an improved efficiency.

The drag head according to the invention has for this purpose the feature that the visor of the drag head comprises at least two individually movable pressure elements transversely of the dragging direction, wherein a pressure element comprises a number of penetrating bodies which transmit forces to the bottom under the influence of the weight of the pressure element. The individually movable pressure elements running transversely of the dragging direction ensure that the penetrating bodies are better able to maintain contact with the bottom when the bottom is uneven. The existing drag head comprises a relatively large number of penetrating bodies. In the case of uneven bottom conditions it is well possible that only a small number of these penetrating bodies make contact with the bottom, whereby the full weight of the drag head is distributed over a small number of penetrating bodies. The penetrating bodies are hereby subjected to relatively great forces which can easily result in breaking and/or rapid wear of the penetrating bodies. The invented drag head solves this and other problems. Not only will more penetrating bodies on average make contact with the (uneven) bottom, the number of penetrating bodies per pressure element can moreover be readily adjusted without changing the overall number of penetrating bodies. Because the forces on the penetrating bodies are better distributed, it also becomes possible to give the overall drag head a larger and heavier design (for instance an above-water weight of 100 tonnes) than has heretofore been usual (the known drag head generally has an onshore weight of 20-30 tonnes). A heavier and larger drag head will increase the dredging efficiency significantly. In an embodiment of the invented drag head the number of penetrating bodies can, if desired, be greater than in the known drag head. A greater number of penetrating bodies results in an average lower penetration depth into the bottom. Surprisingly, the hereby expected lower efficiency is fully compensated by applying the individually movable pressure elements.

In a preferred embodiment the drag head according to the invention is characterized in that the pressure elements are received in the visor by means of guide means, this such that the pressure elements are translatable in a direction substantially perpendicularly of the bottom. Such a variant has the advantage that substantially the whole weight of each pressure element is utilized. This is because in this embodiment variant each pressure element can move substantially 'freely' (apart from friction forces and the like) in a direction perpendicularly of the bottom.

Yet another preferred embodiment relates to a drag head provided with disc-shaped penetrating bodies which transmit forces to the bottom via their peripheral edge under the influence of the weight of the pressure element in which they are received. Because the disc-shaped penetrating bodies are preferably arranged with their disc plane substantially perpendicularly of the lower surface of the pressure elements, and moreover protrude partially from this lower surface, their peripheral edge comes into contact with the bottom surface. The weight of the associated underwater pressure element of the hopper dredger is thus distributed over the contact surface between penetrating body and bottom surface. A high pressure is hereby developed locally which effectively crushes the bottom, and in particular relatively hard bottom.

It is advantageous to characterize the drag head according to the invention in that the penetrating bodies extend in one line and substantially transversely of the dredging direction. By positioning particularly the disc-shaped penetrating bodies in one line it has been found, surprisingly, that not only is the bottom under the penetrating bodies crushed, but also those parts of the bottom situated between the penetrating bodies.

The number of disc-shaped penetrating bodies per pressure element can be chosen within broad limits. The number of disc-shaped penetrating bodies per pressure element preferably lies between 2 and 20, more preferably between 2 and 10, and most preferably between 3 and 5. A particularly suitable intermediate distance in the transverse direction between two successive penetrating bodies amounts to between 5 and 50 cm, more preferably to between 8 and 35 cm, and most preferably to between 10 and 20 cm. The number of pressure elements in the drag head according to the invention can also be varied within broad limits. A large number of pressure elements has the advantage that the bottom contour can be followed with greater accuracy, although the average force transmitted to the bottom by the penetrating bodies will decrease. A small number of pressure elements results in a simpler construction. A good compromise is obtained when the number of pressure elements lies between 2 and 20, more preferably between 2 and 8, and most preferably between 3 and 5.

The drag head is dragged over the bottom under water, wherein according to the invention it mainly makes contact with the bottom by means of the penetrating bodies, in particular the disc-shaped penetrating bodies. It is therefore advantageous to

characterize the drag head in that the disc-shaped penetrating bodies are received in the pressure elements for rotation around their axis - the axis perpendicularly of the disc plane - wherein the rotation axis is substantially at a right angle to the dragging direction. Hereby achieved is that considerably less power is required to move the
5 trailing suction hopper dredger at the usual speeds.

A further advantage of the drag head according to the invention is that the bottom can be crushed into relatively small soil particles, whereby these latter are suctioned up with a good efficiency. This is understood to mean that the concentration of the relevant
10 particles in the suctioned-up water is relatively high.

In order to protect the disc-shaped penetrating bodies, the pressure elements of the drag head are preferably provided with a series of teeth extending substantially transversely of the dragging direction and engaging on the bottom upstream of the disc-shaped
15 penetrating bodies during use. The teeth break a determined ground portion before the penetrating bodies reach this ground portion. The teeth can also level the bottom, whereby the disc-shaped penetrating bodies can do their work more efficiently. The combination of teeth and disc-shaped penetrating bodies likewise provides for an increased efficiency.

20 A further improved drag head is obtained when the pressure elements are also provided with support means which during use engage on the bottom upstream of the disc-shaped penetrating bodies, and optionally of the teeth. In the case of great unevenness in the bottom these support means ensure that the pressure elements, and possibly even the
25 whole visor, are forced to follow the contour of the bottom. This prevents jamming of and/or damage to the drag head, and in particular the disc-shaped penetrating bodies. In a particularly suitable embodiment the support means comprise a number of slide blocks preferably disposed in the transverse direction. The slide blocks are profiled such that the drag head does not tend to dig itself in but, on the contrary, tends to follow the
30 bottom contour. The slide blocks hereby also have a protective function.

The disc-shaped elements will generally sink a certain penetration depth into the bottom under the weight of the pressure elements. This typical penetration depth can be determined during the design of the disc-shaped penetrating bodies. In an advantageous

embodiment variant the drag head according to the invention is characterized in that the teeth engage on the bottom preferably $\frac{1}{2}$ to 10 times, more preferably $\frac{1}{2}$ to 5 times, and most preferably $\frac{1}{2}$ to $1\frac{1}{2}$ times the penetration depth of the disc-shaped penetrating bodies higher than the disc-shaped penetrating bodies. The teeth hereby have an optimal protective effect, and the highest efficiency is obtained. The teeth also have a penetration depth. The penetration depth of the teeth is preferably limited in order to avoid breaking of the teeth or excessively high cutting forces. It is advantageous here if the underside of the support means is positioned a predetermined, preferably limited distance above the underside of the teeth. The support means are preferably positioned such that they engage on the bottom higher than the teeth, more preferably $\frac{1}{2}$ to $1\frac{1}{2}$ times the penetration depth of the teeth. An even better protective effect is obtained due to this measure, as well as a further improved efficiency.

In a further improved preferred embodiment the drag head according to the invention is provided with closing means for at least partially closing the opening between components, and in particular between visor and bottom. Providing closing means achieves that the suction force supplied through the suction pipe will as it were suction the drag head onto the bottom. The developed suction force ensures sufficient pressure stress under the penetrating bodies in the bottom, so that the bottom breaks, chips or otherwise collapses. The closing of the opening between the visor and the bottom can be embodied in any manner known to the skilled person. The closing means can thus comprise a strip of flexible material, this strip spanning the opening and being fixed to the relevant component on at least one side of the opening.

In respect of the dimensions of the penetrating bodies it can be noted that these are chosen subject to, among other factors, the intended pressure forces and the number of penetrating bodies per pressure element. The diameter of the penetrating bodies can vary from several centimetres to a number of decimetres. Particularly suitable diameters amount to between 2 and 80 cm, more preferably to between 5 and 60 cm, and most preferably to between 10 and 40 cm. Penetrating bodies with such diameters have a good balance between the power required per metre of headway and the dredging efficiency to be achieved, i.e. the number of m^3 of soil dredged per second.

If desired, the drag head according to the invention can be provided with at least one series of jet pipes for injecting water, preferably under high pressure. Usual pressures lie for instance around 10 to 200 bar, although pressures of 2500 bar are also possible. The water jets can be directed into the bottom in front of, on or behind the penetrating
5 bodies in order to improve the efficiency of the dredging.

The invention also relates to a method for breaking and/or dredging of an at least partially hard bottom under water with a trailing suction hopper dredger, equipped with a drag head according to the invention. The method comprises of lowering a drag head
10 according to the invention onto the bottom, after which it is dragged over the bottom. A suction force is herein exerted through the suction pipe on the space at least partially closed off via closing means and enclosed by the visor and the bottom, so that the disc-shaped penetrating bodies penetrate via their peripheral edge into the bottom and cause cracks therein under the influence of the weight of the pressure elements and the suction
15 force. The broken-off soil chips are suctioned up through the suction pipe. According to the invention the pressure elements herein move independently of each other, whereby an improved efficiency is achieved. During the dredging the pressure elements preferably translate independently of each other in a direction substantially perpendicularly of the bottom. In a preferred method the support means of a pressure
20 element engage first on the bottom, wherein the pressure element is forced to follow the contour of the bottom, after which the teeth then engage on the bottom so that the bottom is at least partially levelled, after which the penetrating bodies engage on the bottom.

25 The drag head and method according to the invention will now be further elucidated on the basis of the following description of preferred embodiments and figures, without limiting the invention thereto. In the figures:

figure 1 shows a schematic perspective bottom view of a drag head according to the invention;
30 figure 2 shows a schematic perspective top view of the drag head of figure 1;
figure 3 shows a schematic perspective bottom view of a pressure element of the drag head according to the invention;
figure 4 shows a schematic perspective top view of a support construction in which pressure elements, as shown in figure 3, can be received; and finally

figure 5 shows a schematic view of a drag head according to the invention in operation.

A drag head 1 for a trailing suction hopper dredger is shown with reference to figure 1. Drag head 1 comprises a visor 2 which during use is dragged over bottom 50 in the dragging direction P (see also figure 5) and herein loosens soil, and a suction pipe 3 which connects to visor 2 and discharges the loosened soil. Visor 2 is provided with side walls (84, 85) and a top plate 86 which is connected to suction pipe 3. In the shown embodiment of the drag head according to the invention visor 2 comprises four individually movable pressure elements (21, 22, 23, 24) transversely of the dragging direction P. Pressure elements (21, 22, 23, 24) are received in visor 2 by means of guide means (211, 212, 213, 214, 215, 216, 217, 218) (see figure 3). Visor 2 comprises for this purpose a support structure, shown in figure 4, which in the shown embodiment variant comprises four chambers (25, 26, 27, 28) in which pressure elements (21, 22, 23, 24) are received. The guide means comprise four guide rollers (211, 212, 213, 214) arranged on rear wall 31 of pressure element 21 and four guide rollers (215, 216, 217, 218) arranged on front wall 32, which can be rolled on corresponding rear wall 41 and front wall 42 of chambers (25, 26, 27, 28). In order to avoid pressure elements (21, 22, 23, 24) being able to escape from visor 2, each pressure element is provided with stop edges (33, 34) on respectively rear wall 31 and front wall 32. Pressure elements (21, 22, 23, 24) can hereby translate relatively freely in a direction L running substantially perpendicularly of bottom 50, wherein stop edges (33, 34) rest on the upper edge of chamber 25 in the lowermost position of for instance pressure element 21.

As shown in figure 3 for pressure element 21, each pressure element (21, 22, 23, 24) is provided with four penetrating bodies (51, 52, 53, 54). The penetrating bodies (51, 52, 53, 54) are disc-shaped and transmit forces to bottom 50 via their peripheral edge under the influence of the weight of the pressure element in which they are received, thereby creating cracks in the bottom. In each pressure element the disc-shaped penetrating bodies (51, 52, 53, 54) extend in one line running substantially transversely of the dragging direction P. The penetrating bodies of all pressure elements are preferably arranged such that they together also extend in one line running substantially transversely of the dragging direction P. This configuration is shown in figure 1.

In the shown embodiment the pressure elements (21, 22, 23, 24) of drag head 1 are also provided with a series of teeth (61, 62, 63, 64) which extend substantially transversely of the dragging direction P and which engage on the bottom 50 upstream of the disc-shaped penetrating bodies (51, 52, 53, 54) during use. Pressure elements (21, 22, 23, 24) are further provided with support means (71, 72, 73, 74). These comprise slide blocks, for instance of steel, with a lower surface which runs obliquely from front wall 32 of a relevant pressure element 21 to the disc-shaped penetrating bodies (51, 52, 53, 54) and/or teeth (61, 62, 63, 64). During use the support means (71, 72, 73, 74) engage on the bottom upstream of the disc-shaped penetrating bodies (51, 52, 53, 54) and optionally the teeth (61, 62, 63, 64), whereby they are first to engage on bottom 50. The associated pressure element is therefore forced to follow the contour of bottom 50. In the case of a rise in bottom 50 the relevant pressure element will be pushed upward even before teeth (61, 62, 63, 64) and penetrating bodies (51, 52, 53, 54) can penetrate into the bottom. Support means (71, 72, 73, 74) not only provide a protection for the teeth and disc-shaped penetrating bodies, but also control the desired penetration depth of penetrating bodies (51, 52, 53, 54, 61, 62, 63, 64). Because teeth (61, 62, 63, 64) engage on the bottom upstream of disc-shaped penetrating bodies (51, 52, 53, 54), the teeth likewise provide protection for the disc-shaped penetrating bodies, and also control the desired penetration depth of penetrating bodies (51, 52, 53, 54). The best results are achieved when the underside of the support means is positioned at a predetermined, preferably limited distance above the underside of the teeth. This is for instance the case when the teeth (61, 62, 63, 64) have a penetration depth and the support means engage on bottom 50 $\frac{1}{2}$ to $1\frac{1}{2}$ times the penetration depth of the teeth higher than the teeth, and when the disc-shaped penetrating bodies (51, 52, 53, 54) have a penetration depth and the teeth (61, 62, 63, 64) engage on bottom 50 $\frac{1}{2}$ to $1\frac{1}{2}$ times the penetration depth of the disc-shaped penetrating bodies higher than the disc-shaped penetrating bodies.

Of the embodiment of drag head 1 shown for instance in figure 1, visor 2 is provided with closing means which substantially close the opening between visor 2 and bottom 50 in order to prevent the possibility of supply water being supplied along the relatively unproductive sides of visor 2. The closing means comprise closing plates (81, 82) which are arranged on both side walls (84, 85) and which are slidable in height and, if desired, are provided on the lower edges thereof with a rubber cover layer. On the upstream

underside, visor 2 is provided with a heel plate 83 which provides for sufficient support on bottom 50 and prevents water being drawn in along the upstream side.

During the dredging an underpressure is maintained inside drag head 1 to enable the loosened hard soil particles and other soil particles to be suctioned up via suction pipe 3. Referring to figure 5, the method according to the invention comprises of lowering drag head 1 to the bottom 50 and dragging drag head 1 over bottom 50 in the dragging direction P. A suction force is herein exerted by suction pipe 3 on the space at least partially closed off via closing means (84, 85) and enclosed by visor 2 and bottom 50 so that the disc-shaped penetrating bodies (51, 52, 53, 54) penetrate via their peripheral edge into bottom 50 and cause cracks therein under the influence of the weight of the pressure element in which they are received. By applying a large number of disc-shaped penetrating bodies (51, 52, 53, 54) positioned adjacently of each other it has been found that the bottom between the penetrating bodies is also crushed, whereby the efficiency is considerable. The broken-off bottom chips are suctioned up through suction pipe 3. According to the invention the pressure elements (21, 22, 23, 24) translate here substantially independently of each other in a direction L substantially perpendicularly of bottom 50. A large number of penetrating bodies hereby remains in contact with bottom 50, whereby an increased efficiency is achieved relative to the prior art despite the possible smaller average penetration depth. Support means (71, 72, 73, 74) engage first on bottom 50 and provide for, among other things, protection of the penetrating bodies. A further improved efficiency is achieved by applying a combination of teeth and disc-shaped penetrating bodies, wherein the teeth are first to engage on the bottom to a determined penetration depth so that bottom 50 is at least partially levelled, after which the disc-shaped penetrating bodies engage on bottom 50. It can also be advantageous to provide a drag head in which the disc-shaped penetrating bodies engage first on the bottom to a determined penetration depth so that bottom 50 is at least partially broken up, after which the teeth then engage on bottom 50.

The invention is not limited to the above described exemplary embodiments, and modifications can be made thereto to the extent these fall within the scope of the appended claims.

Claims

1. Drag head (1) of a trailing suction hopper dredger, comprising a visor (2) which is dragged over the bottom (50) and herein loosens soil, and a suction pipe (3) which is connected to the visor (2) and which discharges the loosened soil, **characterized in that** the visor (2) comprises at least two individually movable pressure elements (21, 22, 23, 24) transversely of the dragging direction, wherein a pressure element is provided with a number of penetrating bodies (51, 52, 53, 54, 61, 62, 63, 64) which transmit forces to the bottom (50) under the influence of the weight of the pressure element.
2. Drag head as claimed in claim 1, **characterized in that** the pressure elements (21, 22, 23, 24) are received in the visor (2) by means of guide means (211, 212, 213, 214), this such that the pressure elements (21, 22, 23, 24) are translatable in a direction substantially perpendicularly of the bottom (50).
3. Drag head as claimed in claim 1 or 2, **characterized in that** the penetrating bodies comprise disc-shaped penetrating bodies (51, 52, 53, 54) which transmit forces to the bottom (50) via their peripheral edge (23) under the influence of the weight of the pressure element.
4. Drag head as claimed in claim 3, **characterized in that** the disc-shaped penetrating bodies (51, 52, 53, 54) extend in one line and substantially transversely of the dredging direction.
5. Drag head as claimed in any of the foregoing claims, **characterized in that** the number of disc-shaped penetrating bodies (51, 52, 53, 54) per pressure element lies between 2 and 10, and more preferably between 3 and 5.
6. Drag head as claimed in any of the foregoing claims, **characterized in that** the number of pressure elements (21, 22, 23, 24) lies between 2 and 8, and more preferably between 3 and 5.

7. Drag head as claimed in any of the foregoing claims, **characterized in that** the pressure elements (21, 22, 23, 24) are provided with a series of teeth (61, 62, 63, 64) extending substantially transversely of the dragging direction and engaging on the bottom (50) upstream of the disc-shaped penetrating bodies (51, 52, 53, 54) during use.

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8. Drag head as claimed in any of the foregoing claims, **characterized in that** the pressure elements (21, 22, 23, 24) are provided with support means (71, 72, 73, 74) which during use engage on the bottom (50) upstream of the disc-shaped penetrating bodies (51, 52, 53, 54), and optionally of the teeth (61, 62, 63, 64).

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9. Drag head as claimed in claim 8, **characterized in that** the support means (71, 72, 73, 74) comprise slide blocks.

10. Drag head as claimed in any of the claims 7-9, **characterized in that** the disc-shaped penetrating elements (51, 52, 53, 54) have a penetration depth, and that the teeth (61, 62, 63, 64) engage on the bottom higher than the disc-shaped penetrating bodies.

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11. Drag head as claimed in any of the claims 8-10, **characterized in that** the teeth (61, 62, 63, 64) have a penetration depth, and that the support means (71, 72, 73, 74) engage on the bottom (50) higher than the teeth.

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12. Drag head as claimed in any of the foregoing claims, **characterized in that** the drag head (1) is provided with closing means (81, 82) which substantially close the opening between the visor (2) and the bottom (50).

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13. Drag head as claimed in any of the foregoing claims, **characterized in that** the drag head comprises at least one series of jet pipes for injecting water under high pressure.

14. Method for dredging an at least partially hard bottom under water with a trailing suction hopper dredger, equipped with a drag head as claimed in any of the claims 1-13, wherein the drag head is lowered onto the bottom and dragged thereover, wherein a suction force is exerted through the suction pipe on the space at least partially closed off via closing means and enclosed by the visor and the bottom, so that the disc-shaped

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penetrating bodies penetrate via their peripheral edge into the bottom and cause cracks therein under the influence of the weight of the pressure elements and the underpressure, and wherein the broken-off soil chips are suctioned up through the suction pipe.

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15. Method as claimed in claim 14, **characterized in that** during the dredging the pressure elements translate independently of each other in a direction substantially perpendicularly of the bottom.

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16. Method as claimed in claim 14 or 15, **characterized in that** the support means of a pressure element engage first on the bottom, wherein the pressure element is forced to follow the contour of the bottom, wherein the teeth then engage on the bottom so that the bottom is at least partially levelled, after which the penetrating bodies engage on the bottom.