

METHODS FOR ANCHORING

The invention relates to a method for anchoring, to arrive at a situation in which the anchor cable is taut and in a substantially vertical orientation. Such a method is herein
5 known as vertical anchoring.

According to the present invention there is provided a method for anchoring an object in a body of water having a ground-like bottom, in which an anchor, comprising a fluke means with upper
10 surfaces having a centre of area and a shank means, which obliquely extends upwards and forwards from the fluke means and is connected by a first end to the fluke means and can be attached by a second end to a penetration or pulling line, is pulled into the bottom ground by means of the pulling line, and
15 wherein the anchor, after the fluke means has penetrated the bottom ground to a sufficient extent, is attached by means of an anchor line to the object, the point of engagement of the anchor line being essentially located above the centre of area of the upper surfaces of the fluke means and the pulling force
20 exerted thereon via the anchor line being essentially directed vertically.

The invention will now be further described on the basis of a number of embodiments, given merely as examples, which are
25 shown in the drawing, in which:

Figure 1 is a schematic side view of a first embodiment of the anchor for use in the method of the invention:

30 Figure 2 represents the anchor of Figure 1, in penetrated condition and whilst being weighed from the drilling platform, the fluke being disconnected from the shank at the rear;

Figure 3 is a schematic representation of the embodiment of the
35 anchor after maximum penetration, which is ready for the transition to a position for a vertical-anchoring method according to the invention;

5

figure 4 represents the anchor of figure 3 in a situation following the situation of figure 3, in which the anchor is incorporated in the vertical-anchoring system;

10

figure 5 shows a schematic side view of a vertical-anchoring system according to the invention for a semi-submersible;

figure 6 is a schematic top view of a vertical-anchoring system for a semi-submersible;

15

figures 7A, 7B, 8A, 8B, 9A, 9B show various possible embodiments of a disconnectable connection between fluke and shank; and

20

figures 10 and 11 show a third embodiment of the anchor according to the invention, being particularly suited for a vertical-anchoring system.

25

figure 12 is a vertical section along XII-XII in figure 13 of a preferred embodiment of the anchor;

figure 13 is a top view on the anchor of figure 12;

figures 14-16 represent the anchor of figures 12 and 13 during its placement for anchoring purposes; and

30

figures 17 and 18 represent the anchor of figures 12 and 13 during the first stage of weighing the anchor;

figure 19 shows another anchor according to the invention, viewed in centre longitudinal section;

figure 20 shows the anchor of figure 19 in top view;

figures 21A-B show a schematic representation of the mechanism for disconnecting the shank from the anchor of figures 19 and 20;

5

figure 22 shows a further detail of the mechanism for disconnecting the shank from the anchor of figures 19 and 20;

10

figures 23A-23D show the anchor of figures 19 and 20 during its penetration into the soil and the release of the shank;

figures 24A-B show the fashion in which the anchor can be weighed from the position as represented in figure 23D; and

15

figures 25A-B show a schematic representation in top view and in section of the weighing mechanism as shown in figures 24A-B.

20

The anchor 1 represented in figure 1 comprises a shank 2 and a fluke 3, which is reinforced with girders 13. The surface centre of gravity of the fluke is indicated by M. At the first end there is a shackle 5 mounted on the shank 2 by means of a pin 6, to which shackle the anchor line 14 is attached. The shank 2 furthermore comprises upper flukes 4, which provide extra holding power. The shank 2 is of the type described earlier, i.e. having two forwardly (to the right in the drawing) and upwardly converging shank legs. It is remarked that the anchor according to the invention may also comprise a non-convergent, parallel and/or curved shank. In the drawing one should thus imagine a second shank leg to be present, disposed behind the drawn shank leg. Stiffeners 7 extend between the two shank legs. The fluke 3 has a sharp penetration or front end and a rear end 29, and is also provided with stabilizers 10 on either end at the rear end. The shank 2, or rather each shank leg 2, is connected to the fluke 3 at its girders 13 by means of hinged joint 8. At the rear edge of each shank leg 2 a rack plate 11 is connected by means of a hinged connection 12, said plate comprising a rack 18 extending circularly about the

25

30

axis of rotation of hinged joint 8. The rack: plate 11 is disconnectably connected to the fluke 3 at 9, and such by means of a (not represented) pawl lever, which is attached to a fluke and which can be moved into and out of blocking engagement with the rack 18.

In figure 2 on the left the anchor 1 of figure 1 is shown as having penetrated the anchoring soil 15. The anchor line 14 is connected to an object disposed at a considerable distance, e.g. a drilling platform. Reference numeral 16 indicates the soil segment that is able to supply the counterforce required to keep the anchor in its anchoring position. If one wishes to weigh the anchor 1, firstly the (not shown) operating means are activated, so that the pawl is brought out of engagement with the rack 18, thus releasing the connection 9. If the anchor line 14 is then pulled in direction A, the fact that the resultant of the soil pressure on the fluke is located behind the hinged joint 8 ensures that the fluke 3 tilts backwards about hinged joint 8. Upon hauling in the anchor line 14 further, the fluke 3 will be able to turn freely about hinged joint 8 and assume the position of the least resistance. In this way the anchor in question will be easily weighed from the anchored object.

Figure 3 shows an anchor 1', being essentially identical to the anchor 1 represented in figures 1 and 2, except for i.a. the disconnectable connection 9'. Here it comprises an arched plate 11', comprising three holes which are spaced at equal distances with respect to the axis of hinged joint 8. The connection 9' furthermore comprises a set of pins movable in and out of engagement with the holes 19 and disposed under the fluke. A number of possible ways in which the pins can be moved back and forth are discussed on the basis of figures 7, 8 and 9. After the anchor 1' is pulled to the position in which maximum penetration is attained, as shown in figure 3, and in which the soil segment 17 presses against the fluke 3, the operating means is activated and the pins (not shown) are retracted from the holes 19 in question, so that the discon-

nectable connection 9' is released. Subsequently the anchor line 14 is transferred to an essentially vertical position above the fluke 3, and as a result of the disconnected connection 9' the shank 2 can turn along about the hinged joint 8, and in this case
5 suitably formed passages in the fluke 3 allow the plate 11 to turn also. Thus the position of the anchor 1' as represented in figure 4 is attained, the anchor being tensioned in direction B and pressing against the soil segment 20 with the fluke 3 and the auxiliary fluke 51. Here the fluke angle between fluke 3 and shank
10 2 is preferably fixed again by re-establishing the disconnectable connection 9', the pin again engaging a hole 19 located at a suitable spot in plate 11.

In figure 5 a vertical-anchoring system
15 is shown, in which anchors 1', brought to a position as represented in figure 4, are connected with anchor lines 14 to a semi-submersible 23, floating on the body of water 21. Figure 6 shows what kind of anchor assembly can be used for the anchoring system of figure 5. The anchors 1' are first pulled into the ground with
20 the aid of a Stevtensioner, i.a. described in European patent 81258. In this embodiment oppositely paid-out anchors 1' are ingeniously pulled towards one another by pulling anchor line 27', which is passed through a tensioner 26 comprising a one-way blocking means and being disposed near the bottom of the sea, to near
25 to the water level, thus shortening the portion of the anchor line 27' extending between the anchor in question and the tensioner 26, consequently reducing the distance between the two anchors. After the anchors have thus penetrated the soil sufficiently deep and the flukes in the latter direction of pulling exert forces on soil
30 segments having the shape of soil segment 17 in figure 3, the disconnectable connections of the anchors are disconnected and the anchor lines 14 are turned around to a vertical direction until the situation represented in figure 4 is obtained, having soil segments 20 which are trapezoidal in section and which act on the
35 flukes.

Figures 7A and 7B show first embodiments of an operating means and a disconnectable connection

5 A hydraulic piston secured to the underside of fluke 3 which can e.g. be operated acoustically, comprises a piston rod 38, at its end 31 being hinged on two arms 30a and 30b extending on either side, the said arms in their turn being hinged on pins 33a and 33b at their other ends at the location of hinges 32a and 32. These pins are supported by and guided into eye plates 34a, 34b also secured on the fluke, in such a fashion that the pins only move in their longitudinal direction. The pins 33a and 33b protrude through plates 35a and 35b, also secured to the fluke and comprising a pin passage, which plates may also be part of the reinforcements 13 of the fluke 3. Also represented are the plates 36a and 36b, comprising holes destined for pins 33a and 33b, which plates are integrally formed with the shank means of the anchor in question. When the hydraulic piston 37 is activated in any way whatsoever from a place located at a distance from the anchor, the piston rod 38 can be pushed outwards, thus displacing hinge 31, and as a result of the pins 33a and 33b being guided through the plates 34a, 34b, 35a and 35b secured to the fluke, the hinges 32a and 32b can move towards one another while retracting the pins 33a and 33b from the plates 36a, 36b. Then the disconnectable connection between shank and fluke has been released.

25 Figures 8A and 8B show a second embodiment of the operating means, having a disconnectable connection which can even be compared to the one represented in figures 7A and 7B, therefore comprising reciprocally disposed pins 43a and 43b, which are guided into plates 44a, 45a, 44b, 45b secured to the fluke, and protrude into plates 46b in the coupled state. A hydraulic piston 41 is now disposed transversely but is also transversely movable. The piston rod 42 is guided through a plate 40 secured to the fluke. The piston 43 connected to the piston rod divides the cylinder into right chamber 47 and left chamber 48. 30 The piston rod 42 is connected to the pin 43b via the arm 49. When fluid is now supplied to the chamber 48 by activation of the oper-

ating means, on account of the displacement of the hydraulic cylinder and the piston 43 the chamber will be enlarged until the disconnected state as shown in figure 8B has been attained.

5 Figures 9A and 9B show another possible embodiment of the operating means of the anchor. Represented is
a hydraulically operable pin 53b, being movable into and out of a
hole 58b of a plate 57b connected to a shank leg. The plate 57b is
slidably disposed between the plates 59b and 60b secured to the
10 fluke, said plates also comprising holes for receiving the pin 53.
The pin 53b is connected to a piston 51b, which can be forced to
the right (at the left as seen in the drawing) by fluid supplied
through a conduit 55b to chamber 54b and on the other side is
forced to the left by a spring 52b, bearing on the end wall of
15 cylinder 50b. When the operating means is activated, pressurized
fluid is supplied from a reservoir, not shown, to the chamber 54b,
causing the piston 51b to move to the right until it abuts against
a stop surface 56b in cylinder 50b, in which position of the piston
the pin 53b has been retracted from the hole 58b, so that the
20 plate 57b is able to move with respect to the plates 60b and 59b
connected to the fluke. When subsequently the fluke angle is
altered through manipulation of the anchor line, the pressurizing
of chamber 54b by means of fluid can be ceased, so that the spring
52b will force the pin to the left. This is advantageous when the
25 aim is to re-establish the disconnectable connection by having the
pin protrude into a possibly present next hole in the plate 57b
connected to the shank. In this way the connection is automatically
established and maintained. The movement of the pin into and
out of the hole 58b can furthermore be facilitated when at least
30 in the vicinity of the hole the pin has a shape that tapers in a
direction extending from the piston.

Figures 10 and 11 show an anchor which is also suited to be used in vertical-anchoring
35 systems. The anchor 101 comprises a shank 102, a fluke 103 and an upper fluke 104,
located on top of the shank, said two flukes at their rear

ends each being provided with auxiliary flukes 115, 116, respectively, which extend obliquely downwards and rearwards with respect to the flukes 103 and 104. The auxiliary flukes 115 and 116 are hinged on the flukes 103 and 104 and restricted in their possible extent of inflection by abutments (not shown) on the underside of the flukes 103 and 104. The anchor 101 furthermore comprises at its rear side 129 stabilizers 110 and at its front side 128 a penetration end. At 108 the shank 102 is hinged on the fluke 103, and at 109, connected to the fluke in a disconnectable fashion, e.g. through a pin/hole connection discussed in the foregoing, also established with the aid of a hole plate 111 integrally formed with the shank 102.

A special feature is that the anchor line 114 about halfway down the shank 102 at 113 is rotatably connected to the shank 102, but is connected to the upper end 105 of the shank is connected with the aid of a break connection or break line 112. When a pulling force is exerted in the direction C, it will be just as if the anchor 101 is pulled in the normal, usual manner for pulling anchors into the ground. When the anchor has penetrated the soil sufficiently deeply, one merely has to swing out the anchor line 114 to a vertical orientation in order to use the anchor 101 in a vertical-anchoring system, upon which the break line 112 will break and the anchor line 114 is only connected to the anchor at the location of reference numeral 113. In this way the fluke angle can remain unaltered and an anchor for a vertical-anchoring system has been placed in a simple manner. Alternatively, two lines can be used, the one anchor line being then connected to the upper end 105 of the anchor 101 and being used during penetration of the anchor, whereas another anchor is connected to the shank 102 at 113, and is merely used when a pulling force in direction D has to be exerted in the vertical-anchoring system.

It is remarked that although the above description refers to a semi-submersible when dealing with figures 5 and 6, the invention is equally applicable to tension-leg platforms.

The anchor 201 represented in figures 12 and 13 comprises a fluke 202, with a longitudinal plane of symmetry I-I, which fluke is essentially composed of a conical upper plate 203 and an also conical lower plate 204, being attached to the upper plate 203 along its edge. The space between the upper plate 203 and the lower plate 204 is essentially hollow. The fluke 202 is furthermore reinforced by two longitudinal girders 205 and 206 and a cross bracing 228, 229. At the front end or penetration end the longitudinal girders 205 and 206 merge into penetration tips 207 and 208, which have been flanged just a little bit more with respect to the plane of the upper plate 203 of the fluke 202. This feature advances the initial stage of penetration into the anchoring soil. At its rear end the fluke 202 comprises an auxiliary fluke 209, attached by means of hinges 210 and 211 onto the fluke. At its top and centre of gravity T, the double-conical fluke 203 is connected via a releasable coupling, operable by means of remote control, to the lower end of a chain F. The coupling may be operated acoustically, vide e.g. Dutch patent application 86 00126, but also mechanically, hydraulically or pneumatically, through a conduit 226 suited for that purpose, as the chain F offers the option to exclude the necessity of an extra, loose line by guiding it along the chain F.

At the top of the fluke 203 at the rear of the centre of gravity T, furthermore two attachment means 216 and 217 are provided, by which cables 212 and 213, respectively, are connected to the fluke 202. At 224 the other end of these cables 212 and 213 is connected to coupling plate 220, to which at 221 a penetration anchor line E is connected. The coupling plate 220 is also provided with an attachment means 225 for cables 214 and 215, which are attached at the location of attachment means 218 and 219, respectively, at the front of the fluke 202. Thus a construction built of tension cables 212-215 is obtained, comparable to a shank but much lighter than the usual shanks built of plates and transverse reinforcements. The coupling plate 220 is so formed as to be disposed in two possible positions between the cables 212-215 and the anchor

line E. The first position, represented by the uninterrupted lines in figure 12, is desirable when the anchor of figure 12 is to be used in muddy soil. In that case the angle between the fluke, in this case the frontmost part of the upper surface 203 of the fluke 202, and the direction of pulling in the anchor line E should be approx. 48°. In sandy soils, this angle amounts to approx. 30°, for which purpose the coupling plate 220 can be mounted reversedly up to the position represented by 220' in interrupted lines in figure 12. In this embodiment, the cables 212, then 212', are connected to attachment means 225' and the cables 214, then 214', are connected to attachment means 224'.

Apart from that an extra cable G can be seen in figures 12 and 13, extending between a connection 222, where this cable G is connected to the lower end of chain F, and an attachment eye 231 on the coupling plate 220. The function of this cable G will be further elucidated hereinafter.

When the anchor 201 of figures 12 and 13 has to be cast, one should take care that the anchor ends up on the anchoring soil 230 in the position shown in figure 14. The chain F will then have some surplus length, making it slack. If, e.g. aboard an auxiliary vessel, the chain E is pulled (vide the arrow), then the fluke 202 with its tips 207 and 208 will engage the soil and embed itself deeper and deeper. During penetration only portion F' of the upper surface 203 as hatched in figure 13 will meet resistance from the soil in the bottom 230. The portion G' disposed behind that (vide figure 13) will not or hardly meet any resistance. Here the chain F follows the downwards movement of the anchor 201. Figure 15 represents the anchor during penetration. When the anchor has penetrated sufficiently deep, the position of figure 16 has been obtained. The anchor line E is then paid out and connected to a buoy that is set out so as to be able to easily pick up the anchor line later on. Alternatively, the anchor line E may be connected to the anchor through a breaking wire adjusted to the desired holding power. Then the moment has come to connect the cable or

- 11 -

chain F to the object to be anchored, this being e.g. a semi-submersible or TLP. Aboard this object tensioning means are provided for pulling the chain F taut. The point of engagement of chain F is disposed in or near the centre of gravity of the fluke and also at the top of the double-conical fluke. When exerting the vertical pulling force on the fluke the portion G' (figure 13) will also be active in offering resistance against displacement of the fluke. Additional resistance is provided by the auxiliary fluke 209, which was initially pulled freely along into the soil but is now twisted by soil pressure until it is stopped by the stop surfaces suited therefor on the fluke 202. This restricts the rearward motion of the fluke 202. Therefore the anchor according to the invention is an anchor quite capable of penetrating mud or sand and extremely suited for vertical-anchoring systems.

Drilling platforms and TLPs are more and more displaced to a next location during their lives. It may be advantageous if parts of the anchoring system can be used again. The manner in which such can be done according to the invention is represented in figures 17 and 18. From the TLP or the drilling platform a conduit 226 extends along the chain F, which conduit can be used to operate the coupling 223 between the lower end of the chain F and the fluke 202, so as to release it. The conduit 226 may be a simple pulling cable, by means of which the connection 223 can be pulled apart into part 223" on the fluke 2 and part 223' at the lower end of the chain F. The connection between the lower end of the chain F and cable G will remain unchanged. When subsequently the chain F is pulled, this pulling force will be transferred via cable G to the coupling plate 220 and thus to the cables 212-215 and finally to the fluke 202. Then the situation of figure 18 is attained, in which the anchor 201 is pulled from the bottom and weighed onto the TLP or onto the drilling platform itself. In this respect it is particularly advantageous that with simple means the anchor can be weighed from the anchored object itself. It goes without saying that cable G can also replace the two cables 212 and 213 (figure 13) during the penetration situation and be

arranged at the correct length for the desired angle of penetration.

5 The anchor 300 as represented in figures 19 and 20 comprises a
fluke 301 and a shank 302, 303. The fluke 301 comprises a front-
most fluke part 307 and a rearmost fluke part 308, being hinged on
one another at 309 about an axis and perpendicularly to the plane
of drawing. The upper surface 311 of the fluke is curved. In the
10 surface centre of gravity Z of the upper surface 311 the fluke 301
comprises an attachment plate 305, to which the vertical-anchoring
chain 306 is attached by means of a closing link 310. The shank
comprises two rearmost wires 302 (disposed on either side of the
plane of symmetry) and two frontmost wires 303 (disposed on either
15 side of the plane of symmetry), being joined at the top end and
comprising an attachment eye 304 for connection to a penetration
anchor line. At their other end the shank wires 302 and 303 are
passed through slits 318 and 319 (vide figure 20) towards the
underside of the fluke, where they are attached to the attachment
20 member 312 protruding downward from the underside of the fluke.
For this purpose the shank wires 302 and 303 are fitted at their
outer ends with cable eyes 315 and 316, through which a pin 314
protrudes which is to be further discussed hereinafter, which pin
cooperates with the attachment member 312 to keep the cable eyes
315 and 316 in their proper positions with respect to the fluke.
25 Another pin 313 can be seen at the front of the means 312.

In figure 20 the fluke 301 is shown in top view, but some parts
which are disposed at the underside of the fluke have also been
shown for illustrative reasons. Furthermore some height lines of
30 the upper surface 311 of the fluke are shown so as to underline
the curved nature of the fluke 301. Apart from that the plane of
symmetry S-S is shown, extending perpendicularly to the plane of
the drawing. At the underside of the upper surface 311 girders 317
are mounted on either side of the plane of symmetry. With their
35 undersides these girders 317 constitute a reversed U-shaped gutter
for laterally enclosing and for guiding the portions of the shank

wires 302 and 303 which extend underneath the fluke 301. At the position where the upper plate 355 (vide figure 21A) of this guiding ends, there is the passage slit 318 at the front and the passage slit 319 at the rear. These are suited to allow the cable eyes 315 and 316 to pass. The rear edge of the slits 319 is defined by a front edge of the hingeable rear part 308 of the fluke 301.

It is remarked that, as can be seen in figure 20, there are two pins 313, 314 on each side of the fluke, one disposed behind the other. Now it is possible to secure the cable eyes 315, 316 with the aid of the pin 314, in which case the shank will assume the position as represented in figure 19 by means of wires 302' and 303'. The fluke angle amounts to approx. 32° in this case. Alternatively, it is possible to attach the cable eyes 315, 316 to the fluke with the aid of the pin 313. Then the position of the shank with respect to the fluke as represented by the wires 302, 303 in figure 19 is attained, the fluke angle being approx. 50° . As a further alternative the cable eye 315 can be attached to the fluke by means of pin 314 and the cable eye 316 can also be attached to the fluke by means of pin 313. The fluke angle will then have an intermediate value, in this case 41° .

Figure 20 furthermore schematically shows some parts of the disconnecting mechanism for the shank wires 302 and 303. These parts are disposed on the other side of the upper surface 311. The pins 313 and 314 can be seen, which are connected to ends of the operating rods 321, 320, respectively, which are attached in a fashion to be discussed hereinafter to a further operating rod 339, respectively, the latter rod being furthermore connected through a further operating part 326 to an operating line 337, which is attached to the vertical-anchoring line 306.

The disconnecting mechanism is furthermore elucidated on the basis of figures 21A, 21B and 22. In figures 21A and 21B the disconnecting mechanism and the way it is operated are represented in a sec-

tion perpendicular to the plane of symmetry S. One can see the upper surface 311 of the fluke, conical in section, as well as the undersurface of the fluke 328, at least partly similar in section.

5 The attachment plate 305 for the vertical-anchoring line extends through the fluke. The closing link 310 of the vertical-anchoring line is attached to the plate 305. On either side of the plane of symmetry S the same type of disconnecting mechanism is provided. On should bear in mind that on either side of the plane of sym-
10 metry S there are shank wires 302, 303. In the downwardly protruding part 312 of the longitudinal girders 317, in their side plates 329, 330 to be precise, holes 332, 331, respectively, are provided, into which the pin 314 can be slid. In its coupling position, depicted in figure 21A, the pin 314 protrudes through the
15 hole 332, through the cable eye 315, through the cable eye 316 as well as through the hole 331. In this fashion the shank wires 302, 303 are securely attached to the underside of the fluke. The pin 314 is firmly secured to the end of an angular rod 333, which can also be slid back and forth in a direction perpendicular to the
20 plane of symmetry S, during which it is guided by suitable guiding means 334. At its other end the arm 333 is hinged at 327 on a lever member 336, being firmly secured at its other end to a rod 339 extending perpendicularly to the plane in the drawing. This rod (vide also figures 20 and 22) is pivotably borne on the fluke
25 at 341 and 342. Bearing 341 is positioned in the transverse beam 323. As can be deduced from figures 20 and 22, the rod 339 comprises at its rear end a further, fixed lever member 326, at whose radial outer end 338 the connecting wire 337 is connected at 238. At its other end, the connecting wire 337 is connected to the ver-
30 tical-anchoring line 306.

In figure 22 it can be observed that the two pins 313 and 314 are both connected to the rod 339 in a similar fashion. Now if by exerting a pulling force on the vertical-anchoring line 306 so as to
35 pull it more tautly a pulling force is also exerted on the connecting line 337, the levers 326 will be twisted upwards (vide

figures 21A-B), as a result of which the rods 339 will also be twisted in the directions Q_1 and Q_2 . This will cause the lever members 336 to be twisted downwards and inwards, so that the arms 333 are guidingly shifted inwards. Then the situation of figure 21B is finally achieved, in which the pins 314 have been moved out of the cable eyes 315 and 316.

Figures 23A-D schematically show the fashion in which the anchor of figures 19 and 20 can be installed. In figure 23A, by means of a penetration anchor line (not shown) which is attached to the outer end 304 of the shank 302, 303, the fluke 301 is pulled in the direction of arrow J. The vertical-anchoring line 306, being attached to the fluke by means of plate 305, is dragged along through the soil. At the underside of the fluke the end blocks of the shank wires 302 and 303 can be seen, which comprise cable eyes 315, 316 in which the pin 314 engages. In figure 23B it has been established, on the basis of the tension measured in the penetration anchor line, that the anchor, or to be more precise the fluke, has penetrated sufficiently and appears to be able to supply the desired (vertical) holding power. Then the vertical anchor line 306, which was initially slack, is pulled taut with the aid of a winch aboard a vessel (not shown) in the vertical direction K. By pulling this line taut, the disconnecting mechanism at the underside of the fluke is activated, causing the pin 314 to slide out of the cable eyes so that the eyes 315 and 316 of the shank wires 302 and 303 are detached from the fluke. Then the penetration anchor line is pulled in direction L (vide figure 23C) and the ends 315, 316 will first move away from one another in the guidings along the underside of the fluke, subsequently to move through the slits 318, 319 towards the other side of the fluke, after which the shank has been completely released from the fluke and the penetration anchor line 306 and the shank can be weighed completely. Subsequently the vertical-anchoring line is tensioned in direction K, resulting in an upward force being exerted on the fluke in its centre of gravity Z. The fluke 301 will then move slightly upwards and due to the pressure exerted by the superposed

soil onto the fluke the rear part 308, which has a smaller surface than the remaining part of the fluke, will twist in the direction O untill it is stopped by abutment 358 (figure 19).

5 Figures 24A, 24B and figures show in what special manner the fluke 301, after having been operative in the position shown in figure 23D, can be removed from the soil. For this purpose the rear end of the rear part 308 of the fluke is connected by means of one or more wires 347 to a ring 346, slidable along the vertical-anchoring line 306 and initially kept in its position by means of breaking line 358, attached to one of the chain links. For clarity's sake the ring 346 is represented at a distance above the fluke. The line 306 comprises in its lower portion a chain, merging into a cable at its upper end 343, which in its turn is attached with its upper end to an auxiliary vessel 344. From the auxiliary vessel or platform 344 a line 357 is paid out, to the other end of which a catcher (ring) 345 is attached. This catcher 345 moves down the line 306 in direction M, until it arrives at the ring 346. As can be seen in figures 25A and 25B, the ring 345 not only comprises attachment plates 353 for the line 357, but also an annular protrusion 352 (vide the vertical section of figure 25B). The ring 346 connected through line 347 to the rear fluke 308, shown in upper view in figure 25A, comprises at its upper end some attachment plates 348, onto which by means of pins 349 levers 350 are hinged. The levers 350 comprise hooks 351 at their top end. When the ring 345 has moved downwards sufficiently, the annular teeth 352 will engage the hooks 351 and an upwards force, exerted on the line 357, will cause the breaking line 358 to break and the ring 346 to be tagged along upwards and thus the line 347 will be pulled taut, so that the hingeable rear part 308 of the fluke will be pulled upwards.

Various aspect of the anchor and fluke of the present application are described and claimed in our co-pending Applications GB-A-2273690 ~~and~~ GB-A-2286168, GB 9525680.6, GB9525681.4 and GB 9525682.2.

CLAIMS

1. A method for anchoring an object in a body of water having a ground-like bottom, in which an anchor, comprising a
5 fluke means with upper surfaces having a centre of area and a shank means, which obliquely extends upwards and forwards from the fluke means and is connected by a first end to the fluke means and can be attached by a second end to a penetration or
10 pulling line, is pulled into the bottom ground by means of the pulling line, and wherein the anchor, after the fluke means has penetrated the bottom ground to a sufficient extent, is attached by means of an anchor line to the object, the point of engagement of the anchor line being essentially located above the centre of area of the upper surfaces of the fluke means and
15 the pulling force exerted thereon via the anchor line being essentially directed vertically.

2. Method according to claim 1, wherein the fluke means of the anchor used has a front end or penetration end and
20 a rear end, and the shank means of the anchor used is provided at a second end with first means for attachment to an anchor line or pulling line, said shank means being attached by means of at least one hinged joint to the fluke means at a location at a distance from the centre of area, and being attached by
25 means of a disconnectable connection to the fluke means on the other side of the centre of area with respect to the hinged joint, operating means being present for effecting the disconnection of the disconnectable connection by remote control, said disconnectable connection being designed to
30 enable the shank means to assume a plurality of adjustable positions with respect to the fluke means; wherein, after the fluke means has been induced to penetrate sufficiently, the operating means are operated for releasing the disconnectable connection; wherein the pulling line is pulled substantially in
35 a vertical direction, causing the shank means to be rotated with respect to the fluke means until the pulling line substantially extends vertically above the fluke means and, either automatically or with the aid of operating means, the disconnectable connection is established in order to fix the
40 thus attained position of the shank with respect to the fluke means.



3. Method according to claim 2, using an anchor in which the disconnectable connection is located at the first end of the shank means.

5

4. Method according to claim 2 or 3, wherein the disconnectable connection is again established when the angle between the fluke means and shank means has become 90°.

10

5. Method according to claim 1, wherein the fluke means of the anchor used has a front or penetration end and a rear end, and the shank means of the anchor used is provided at a second end with first means for attachment to an anchor line or pulling line, said shank means being attached by means of at least one hinged joint to the fluke means at a location at a distance from the centre of area, and being attached by means of a disconnectable connection to the fluke means in a location on the other side of the centre of area with respect to the hinged joint, operating means being present for effecting the disconnection of the disconnectable connection by remote control, said disconnectable connection being designed to enable the shank means to assume a plurality of adjustable positions with respect to the fluke means, in which the shank means between the first and the second end comprises second means for attachment to an anchor line; wherein the pulling line is connected to the second attachment means located between the first and the second end of the shank means and, by means of a breaking connection, is connected to the first end of the shank means; and wherein, after the fluke means has been induced to penetrate sufficiently deeply, the pulling line is pulled in a substantially vertical direction so that the breaking connection of the pulling line with the first end of the shank means breaks and the pulling line is brought to a position extending substantially vertically above the fluke means and is fixed to the object to act as an anchor line.

6. Method according to claim 1, wherein the fluke means of the anchor used has a front or penetration end and a rear end, and the shank means of the anchor used is provided at a second end with first means for attachment to a penetration

40



* C L M S *

or pulling line, said shank means being attached by means of at least one hinged joint to the fluke means at a location at a distance from the centre of area, and being attached by means of a disconnectable connection to the fluke means in a location on the other side of the centre of area with respect to the hinged joint, operating means being present for effecting the disconnection of the disconnectable connection by remote control, said disconnectable connection being designed to enable the shank means to assume a plurality of adjustable positions with respect to the fluke means, in which the shank means between the first and the second end comprises second means for attachment to an anchor line; wherein the pulling line is connected to the first attachment means and the anchor line is connected to the second attachment means located between the first and the second end of the shank means; and wherein the anchor is penetrated into the bottom ground by pulling on the pulling line; and wherein, after the anchor has been penetrated to a sufficient extent, the anchor line, after having been attached to the object which is to be anchored, is used in order to provide for substantially vertical pulling forces on the anchor.

7. Method according to claim 5 or 6, using an anchor in which the second means for attachment of an anchor line are located at least substantially directly above the surface centre of area of the fluke means.

8. Method according to any one of claims 5 to 7, using an anchor of which the fluke means at its rear end merges into an auxiliary fluke means, which is arranged to extend obliquely downwards and rearwards from the fluke means.

9. Method according to claim 8, using an anchor of which the auxiliary fluke means is freely hinged on the fluke means and comprises a stop means for limiting the amount of downward travel of the auxiliary fluke means.

10. Method according to claim 1, wherein the fluke means of the anchor used comprises a fluke, which is so formed



as to have a penetration or front side and a rear side, as well as a longitudinal plane of symmetry intersecting these sides, said fluke comprising means for attachment of an anchor line
5 for a vertical anchoring system and means for attachment of the shank means, said shank means comprising at least two connecting means spaced in the longitudinal plane of symmetry, said shank means connecting the fluke to a pulling or penetration line, the fluke being so formed that at least its upper
10 surface has a shape convexly curved or buckled in cross-section along the plane of symmetry, the attachment means for the anchor line being located near the centre of area of the upper surfaces of the fluke means.

15 11. Method according to claim 10, using an anchor fluke in which the lower surface of the fluke is substantially equal in shape to the upper surface of the fluke.

20 12. Method according to claim 10, using an anchor fluke in which the top surface and possibly the lower surface of the fluke also has a correspondingly curved or buckled appearance in a cross-section in a plane comprising the centre of area and is perpendicular to the said plane of symmetry of the fluke.

25 13. Method according to claim 12, using an anchor fluke in which the upper surface and possibly the lower surface are substantially conical.

30 14. Method according to any one of claims 10 to 13, using an anchor fluke comprising connecting means between the fluke and the penetration line, which are formed as cable-shaped or chain-shaped connecting lines.

35 15. Method according to claim 10, using an anchor fluke of which a part, bordering on the rear and being disposed to the rear of the centre of area, is hinged on the remaining part of the fluke, the hinge axis being perpendicular to the plane of symmetry, in such a fashion that the upper surface of the hingeable rear part is able to assume an angle of over 180°
40 with respect to the upper surface of the adjoining remaining



part of the fluke.

16. Method according to claim 15, using an anchor fluke
5 in which the fluke comprises means to limit the extent of travel of the rear end of the fluke with respect to the remaining part of the fluke.

17. Method according to claim 1, wherein the fluke
10 means and the shank means of the anchor used comprise a fluke and a shank, respectively, the fluke having a front or penetration side and a rear side, as well as a longitudinal plane of symmetry intersecting those sides, the anchor
15 furthermore comprising first attachment means for attaching the fluke to an anchor line of a vertical anchoring system, wherein the shank can be attached with the aid of second attachment means to a penetration line and is mounted on the fluke at its
20 other end through third attachment means, the shank comprising at least two cable-shaped or chain-shaped wires, at least two of which extend, when viewed in a projection of the plane of symmetry, divergingly towards the fluke, the anchor furthermore
25 comprising operating means for operating the third attachment means by remote control so as to release the wires, and as a result, the shank from the fluke, after which the anchor line of the vertical anchoring system is used for transfer of substantially vertical forces between the object to be anchored and the fluke.

18. Method according to claim 17, using an anchor in
30 which a part of the fluke bordering on the rear and being disposed to the rear of the centre of area, is hinged on the remaining part of the fluke, the hinge axis being perpendicular to the plane of symmetry, in such a fashion that the upper surface of the hingeable rear part is able to assume an angle
35 of over 180° with respect to the upper surface of the abutting remaining part of the fluke.

19. Method according to claim 1, wherein the fluke
means of the anchor used has a front or penetration end and a
40 rear end, and the shank means of the anchor used is provided at



a second end with first means for attachment to an anchor line or pulling line, in which the shank means between the first and the second end comprises second means for attachment to an anchor line; wherein the pulling line is connected to the second attachment means located between the first and the second end of the shank means and, by means of a breaking connection, is connected to the first end of the shank means; and wherein, after the fluke means has been induced to penetrate sufficiently deeply the pulling line is pulled in a substantially vertical direction so that the breaking connection of the pulling line with the first end of the shank means breaks and the pulling line is brought to a position extending substantially vertically above the fluke means and is fixed to the object to act as anchor line.

20. Method according to claim 1, wherein the fluke means of the anchor used has a front or penetration end and a rear end, and the shank means of the anchor used is provided at a second end with first means for attachment to a penetration or pulling line, in which the shank means between the first and the second end comprises second means for attachment to an anchor line; wherein the pulling line is connected to the first attachment means and the anchor line is connected to the second attachment means located between the first and the second end of the shank means; and wherein the anchor is penetrated into the bottom ground by pulling on the pulling line; and wherein, after the anchor has been penetrated to a sufficient extent, the anchor line, after having been attached to the object which is to be anchored, is used in order to provide for substantially vertical pulling forces on the anchor.

21. An anchoring method substantially as hereinbefore described with reference to the accompanying drawings.

