

UNDERWATER PLOUGH AND METHOD OF OPERATING AN UNDERWATER PLOUGH

The present invention relates to an underwater plough and a method of operating an underwater plough. In particular, the present invention relates to an underwater plough for providing an elongated element into a submerged surface and a method of providing an elongated element into a submerged surface.

Underwater ploughs are commonly used for ploughing or cutting a trench into a submerged surface, for example a seabed or other submerged water-soil interface, and simultaneously laying an elongated element, for example cables such as power transmission cables, telecommunications cables or the like, into the resulting trench. A known underwater plough 100 is illustrated in Figure 1.

The underwater plough 100 includes a body portion 102 for receiving and guiding an elongated element 101 therethrough. The body portion 102 typically includes a bell mouth 104 at its front end, the bell mouth 104 being an entry point for upstream portions of the elongated element 101 into the body portion 102 during operation. A plough share 106 extends from an underside of the body portion 102. The plough share 106 includes a cutting edge 108 for cutting a bottom of a trench as the underwater plough 100 is towed. The plough share 106 further includes a heel portion 110 extending rearwardly from the cutting edge 108.

In use, the underwater plough 100 is drawn over the submerged surface via a tow line connected to the drawbar 112 (shown in a non-towing, launch and recovery position in Figure 1) by a towing vessel, which is typically at water surface level. As the plough 100 is drawn over the surface a trench is formed by the cutting edge 108 and the elongated element 101 is guided into the trench rearwardly of the plough share 106 by a depressor 114, cooperating with a rear surface of the plough share 106.

Underwater ploughs, such as that shown in Figure 1, generally operate on the 'long beam' principle in that the cutting depth of the plough share 106 is controlled by the height of skids 116 positioned forwardly of the plough share 106. In doing so, the underwater plough 100 naturally tends towards an orientation in which the underwater plough 100 is partially supported by the heel portion 110. That is, the heel portion 110 is subject to a vertical reaction force from the ground, resulting from the weight of the underwater plough 100.

During operation underwater ploughs must be stable – particular during the initial stage of lowering the cutting edge to the required depth. For example, pivoting of the underwater plough around the forward skids should be avoided as this may leverage the plough share 106 from the trench disrupting operation. Generally stability is achieved by lowering the relative tow point as much as possible to reduce the moment about the skids 116.

Known systems lower the relative tow point by articulating components of the underwater plough – for example the bell mouth and drawbar may be rotatable relative to the remainder

of the body portion or the plough share may be rotatable relative to body portion (otherwise termed the plough beam). However, the additional functionality provided by such solutions increase the cost, weight and complexity of the plough. Furthermore, the additional complexity may introduce potential failure points within the underwater plough.

- 5 Despite the additional complexity, an articulating bell mouth is beneficial in a number of ways. For example the product cable can be followed, for example by lowering the bell mouth, to reduce the chance of loop formation under the underwater plough in operation. In addition, the bell mouth can be raised during deployment and recovery to ensure the cable wrap angle through the plough is minimised to avoid difficulties with slack and residual cable tension in
10 the ground and increased product contact loading.

It is an aim of the present invention to provide an improved underwater plough that addresses the above problems without foregoing the advantages provided by known systems.

Summary of the invention

- According to a first aspect of the present invention there is provided an underwater plough for
15 providing an elongated element into a submerged surface, the underwater plough comprising:
a body portion for receiving and guiding an elongated element therethrough, the body portion having:
a first end positioned at or towards the front of the underwater plough;
a second end positioned at or towards the rear of the underwater plough; and
20 a longitudinal axis along which the first end and second end are spaced;
a plough share extending from an underside of the body portion, the plough share comprising a cutting edge for cutting a bottom of a trench in which the elongated element is to be deposited;
support means for supporting the underwater plough with respect to a submerged
25 surface, the support means comprising:
a first set of at least one support member extending from an underside of the body portion, the at least one support member of the first set having a contact portion for contacting the submerged surface; and
a second set of at least one support member extending from an underside of
30 the body portion, the at least one support member of the second set having a contact portion for contacting the submerged surface, wherein the contact portion of the at least one support member of the first set and the contact portion of the at least one support member of the second set define a contact plane;
35 wherein the at least one support member of the first set is rotatable with respect to the body portion and the at least one support member of the second set is rotatable with respect to the body portion,

actuating means configured to rotate the at least one support member of the first set with respect to the body portion and/or to rotate the at least one support member of the second set with respect to the body portion.

wherein the underwater plough has an operational configuration for a ploughing operation in

5 which:

the at least one support member of the first set extends from the body portion in a first direction;

the at least one support member of the second set extends from the body portion in a second direction, at an angle to the first direction;

10 the longitudinal axis of the body portion is angled with respect to the contact plane, with the longitudinal axis being closer to the contact plane at the first end of the underwater plough than at the second end of the underwater plough; and

the cutting edge is positioned so as to contact with the submerged surface or the bottom of the trench during the ploughing operation;

15 wherein the underwater plough is configured such that actuation of the actuating means within the operational configuration varies the first direction and the second direction changing the orientation of the longitudinal axis of the body portion with respect to the contact plane and/or the distance between the body portion and the contact plane while the underwater plough is supported by the support means.

20 That is, during use the weight of the underwater plough and any soil surcharge load can be supported by the support member(s) of the first set - i.e. the skids - and the support member(s) of the second set – i.e. the stabilisers. This allows the underwater plough to be operated in a stable pitched forward orientation. This stable orientation is achieved without complex articulating components. For example, there is no necessity for an articulated bell mouth or
25 an articulated plough share.

In certain embodiments the underwater plough is configured such that, in the operational configuration, the at least one support member of the first set and the at least one support member of the second set contact the submerged surface such that the weight of the underwater plough on the submerged surface is supported by the at least one support member
30 of the first set and the at least one support member of the second set so that the plough orientation and the depth of the resultant trench can be controlled by varying the first direction and second direction.

In certain embodiments the plough share comprises a heel portion extending rearwardly from the cutting edge, wherein in the operational configuration the heel portion is angled with
35 respect to the contact plane so that the heel portion can remain elevated from the submerged surface or a bottom of the trench during the ploughing operation. In this manner the

underwater plough is not reliant on a heel reaction when changing the plough orientation and depth of the resultant trench.

In certain embodiments the first direction is such that the at least one support member of the first set extends towards, or past, the front of the underwater plough.

- 5 In certain embodiments the second direction is such that the least one support member of the second set extends towards, or past, the plough share at the rear of the underwater plough. The at least one support member of the second set are rearwardly extending stabilisers.

- 10 In certain embodiments in the operational configuration the angle between the first direction and the second direction is from about 80 degrees to about 180 degrees. In this manner, the range of the first and second directions allows the cutting edge to be lowered from the submerged surface to the required trench depth, while the weight of the underwater plough is supported by the skids and stabilisers.

In certain embodiments:

- 15 a connection point between the at least one support member of the first set and the body portion is located towards, or proximal to, the first end of the body portion; and a connection point between the at least one support member of the second set and the body portion is located towards, or proximal to, the first end of the body portion.

- 20 By connecting both sets of support members towards the front of the underwater plough, the centre of mass of the plough is shifted forwardly in comparison to known systems. This helps balance the underwater plough during deployment. In addition this helps moves the connection points further from the soil rupture surface.

In certain embodiments a connection point between the plough share and the body portion is located towards, or proximal to, the second end of the body portion.

- 25 In certain embodiments the at least one support member of the second set is sized so as to be able to extend from the connection point between the at least one support member of the second set and the body portion to the cutting edge of the plough share. That is, the rearwardly extending support members are able to extend from the forwardly positioned connection point to the rear of the plough. As such, the rearwardly extending support members can support the rear of the underwater plough.

- 30 In certain embodiments in the operational configuration the at least one support member of the second set extends from the connection point between the at least one support member of the second set and the body portion up to, or past, the cutting edge of the plough share.

In certain embodiments the actuating means comprises:

- 35 first actuating means coupled to the body portion and the at least one support member of the first set, the first actuating means being configured to rotate the at least one support member of the first set with respect to the body portion; and

second actuating means coupled to the body portion and the at least one support member of the second set, the second actuating means configured to rotate the at least one support member of the second set with respect to the body portion.

In certain embodiments in the operational configuration, the orientation of the plough share with respect to the body portion is fixed. With the present invention it is not required that the plough share articulates with respect to the body portion. As such, the underwater plough is less complex but can still achieve a stable pitched forward configuration.

In certain embodiments the plough share includes:

- a main body from which the cutting edge extends; and
- a rear surface along which, in use, the elongated element traverses as it passes from the body portion into the trench cut by the cutting edge.

In certain embodiments the underwater plough further comprises a depressor extending from the second end of the body portion, the depressor being configured to guide the elongated element into the trench cut by the cutting edge.

In certain embodiments a lower portion of the rear surface is convex. In this manner the elongated element follows a curved path as it traverses the rear surface of the plough share and is deployed. This helps maintain the curvature of the elongated element above the MBR as it is deployed from the underwater plough with the plough pitched forward during deployment

In certain embodiments the underwater plough includes a drawbar coupled to the body portion, the drawbar being for connection to a towing line.

In certain embodiments the drawbar is rotatable between a towing position and a deployment position.

According to a second aspect of the present invention there is provided an assembly for providing an elongated element into a submerged surface, comprising:

- an underwater plough according to the first aspect of the invention;
- a vessel comprising a towing line, wherein said towing line is connected to the drawbar of said underwater plough.

According to a third aspect of the present invention there is provided a method of operating an underwater plough for providing an elongated element into a submerged surface, the method comprising:

providing a underwater plough comprising:

- a body portion for receiving and guiding an elongated element therethrough, the body portion having:
 - a first end positioned at or towards the front of the underwater plough;
 - a second end positioned at or towards the rear of the underwater plough; and
 - a longitudinal axis along which the first end and second end are spaced;

a plough share extending from an underside of the body portion, the plough share comprising a cutting edge for cutting a bottom of a trench in which the elongated element is to be deposited;

support means for supporting the underwater plough with respect to a submerged surface, the support means comprising:

a first set of at least one support member extending from an underside of the body portion, the at least one support member of the first set having a contact portion for contacting the submerged surface; and

a second set of at least one support member extending from an underside of the body portion, the at least one support member of the second set having a contact portion for contacting the submerged surface;

wherein the at least one support member of the first set is rotatable with respect to the body portion and the at least one support member of the second set is rotatable with respect to the body portion,

actuating means configured to rotate the at least one support member of the first set with respect to the body portion and/or to rotate the at least one support member of the second set with respect to the body portion,

positioning the underwater plough on the submerged surface in an operational configuration in which:

the at least one support member of the first set extends from the body portion in a first direction, the first direction being angled away from the longitudinal axis of the body portion;

the at least one support member of the second set extends from the body portion in a second direction, at an angle to the first direction, the second direction being angled away from the longitudinal axis of the body portion;

the contact portion of the at least one support member of the first set and the contact portion of the at least one support member of the second set are in contact with the submerged surface;

the longitudinal axis of the body portion is angled with respect to the submerged surface, with the longitudinal axis being closer to the submerged surface at the first end of the underwater plough than at the second end of the underwater plough; and

the cutting edge is in contact with the submerged surface or the bottom of the trench;

performing a ploughing operation with the underwater plough; and

actuating the actuating means with underwater plough in the operational configuration such that the first direction and the second direction are varied to change the orientation of the longitudinal axis of the body portion with respect to the submerged surface and/or the distance

between the body portion and the submerged surface while the underwater plough is supported by the support means.

In certain embodiments the underwater plough of the third aspect of the invention is that of the first aspect of the invention.

- 5 In certain embodiments in the operational configuration, the at least one support member of the first set and the at least one support member of the second set contact the submerged surface such that the weight of the underwater plough on the submerged surface is supported by the at least one support member of the first set and the at least one support member of the second set so that the plough orientation and the depth of the resultant trench can be
10 controlled by varying the first direction and second direction.

In certain embodiments the first direction is such that the at least one support member of the first set extends towards, or past, the front of the underwater plough.

In certain embodiments the second direction is such that the least one support member of the second set extends towards, or past, the plough share at the rear of the underwater plough.

- 15 In certain embodiments in the operational configuration the angle between the first direction and the second direction is from about 80 degrees to about 180 degrees.

In certain embodiments:

- a connection point between the at least one support member of the first set and the body portion is located towards, or proximal to, the first end of the body portion; and
20 a connection point between the at least one support member of the second set and the body portion is located towards, or proximal to, the first end of the body portion.

In certain embodiments a connection point between the plough share and the body portion is located towards, or proximal to, the second end of the body portion.

- In certain embodiments the at least one support member of the second set is sized so as to
25 be able to extend from the connection point between the at least one support member of the second set and the body portion to the cutting edge of the plough share.

In certain embodiments in the operational configuration the at least one support member of the second set extends from the connection point between the at least one support member of the second set and the body portion up to, or past, the cutting edge of the plough share.

- 30 According to a fourth aspect of the present invention there is provided a method of deploying an underwater plough for providing an elongated element into a submerged surface, the method comprising:

providing a underwater plough comprising:

- a body portion for receiving and guiding an elongated element therethrough, the body
35 portion having:
a first end positioned at or towards the front of the underwater plough;
a second end positioned at or towards the rear of the underwater plough; and

- a longitudinal axis along which the first end and second end are spaced;
a plough share extending from an underside of the body portion, the plough share comprising a cutting edge for cutting a bottom of a trench in which the elongated element is to be deposited;
- 5 support means for supporting the underwater plough with respect to a submerged surface, the support means comprising:
- a first set of at least one support member extending from an underside of the body portion, the at least one support member of the first set having a contact portion for contacting the submerged surface; and
- 10 a second set of at least one support member extending from an underside of the body portion, the at least one support member of the second set having a contact portion for contacting the submerged surface; and
- a drawbar coupled to the body portion, the drawbar being for connection to a towing line;
- 15 positioning the underwater plough on a surface of a deployment vessel in a deployment configuration in which:
- the at least one support member of the first set extends from the body portion in a first direction;
- the at least one support member of the second set extends from the body portion in a second direction, at an angle to the first direction;
- 20 the contact portion of the at least one support member of the first set and the contact portion of the at least one support member of the second set are in contact with the surface of the deployment vessel;
- the longitudinal axis of the body portion is angled with respect to the surface of the deployment vessel, with the longitudinal axis being closer to the surface of the deployment vessel at the first end of the underwater plough than at the second end of the underwater plough;
- 25 the drawbar is in a deployment position wherein the drawbar is angled with respect to the longitudinal axis of the body portion so as to extend substantially vertically from the body portion; and
- 30 the cutting edge is in contact with or adjacent to the surface of the deployment vessel;
- loading an elongated cable onto the underwater plough; and
- suspending the underwater plough from a towing line connected to the drawbar and deploying the underwater plough from the deployment vessel to a submerged surface in a body of water.
- 35 The deployment configuration allows for a kinder path as the elongated element passes through the underwater plough on the deployment vessel. That is, with the underwater plough

pitched forward the elongated element is subject to less severe bending as it passes through the underwater plough.

In certain embodiments the underwater plough of the fourth aspect of the invention is that of the first aspect of the invention.

- 5 In certain embodiments the step of deploying the underwater plough from the deployment vessel to a submerged surface in a body of water comprises:

over-boarding the underwater plough from the deployment vessel with the underwater plough in the deployment configuration.

- 10 In certain embodiments the step of deploying the underwater plough from the deployment vessel to a submerged surface in a body of water further comprises:

touching the underwater plough is down to the submerged surface with the underwater plough in the deployment configuration.

- 15 The deployment configuration reduces the risk of damage to the elongated element as the underwater plough reaches the submerged surface. That is, the deployment configuration allows the plough share to be angled in such a way that the elongated element cannot be trapped underneath the plough share as the underwater plough touches down on the submerged surface.

In certain embodiments the step of deploying the underwater plough from the deployment vessel to a submerged surface in a body of water further comprises:

- 20 configuring the underwater plough in a second deployment configuration by:
reducing the angle between the first direction and the second direction; and
rotating the drawbar forwardly to a second deployment position; and
lowering the underwater plough through the body of water in the second deployment configuration.

- 25 In the second deployment configuration the weight of the underwater plough is shifted. This helps ensure the underwater plough can be deployed through the body of water in an orientation that allows for the elongated element to pass through the underwater plough with a low wrap angle.

- 30 According to a fifth aspect of the present invention there is provided a method of deploying and operating an undersea plough combining the third and fourth aspects of the present invention.

According to a sixth aspect of the present invention there is provided an underwater plough for providing an elongated element into a submerged surface, the underwater plough comprising:

- 35 a body portion for receiving and guiding an elongated element therethrough, the body portion having:
a first end positioned at or towards the front of the underwater plough;

a second end positioned at or towards the rear of the underwater plough; and
a longitudinal axis along which the first end and second end are spaced;
a plough share extending from an underside of the body portion, the plough share comprising a cutting edge for cutting a bottom of a trench in which the elongated
5 element is to be deposited;
support means for supporting the underwater plough with respect to a submerged surface, the support means comprising:
a first set of at least one support member extending from an underside of the body portion, the at least one support member of the first set having a contact
10 portion for contacting the submerged surface; and
a second set of at least one support member extending from an underside of the body portion, the at least one support member of the second set having a contact portion for contacting the submerged surface, wherein the contact portion of the at least one support member of the first set and the contact
15 portion of the at least one support member of the second set define a contact plane;
a drawbar coupled to the body portion, the drawbar being for connection to a towing line;
wherein the underwater plough has a deployment configuration for deployment to a
20 submerged surface in which:
the at least one support member of the first set extends from the body portion in a first direction;
the at least one support member of the second set extends from the body portion in a second direction, at an angle to the first direction;
25 the longitudinal axis of the body portion is angled with respect to the contact plane, with the longitudinal axis being closer to the contact plane at the first end of the underwater plough than at the second end of the underwater plough;
the drawbar is in a deployment position wherein the drawbar is angled with respect to the longitudinal axis of the body portion so as to extend substantially vertically from the
30 body portion;
the cutting edge is positioned so as to contact with, or be adjacent to, the surface of the vessel prior to deployment and/or contact with, or be adjacent to, the submerged surface following deployment; and
the plough share is orientated such that portions of the plough share that extend
35 rearwardly from the cutting edge are elevated from the surface of the vessel prior to deployment and/or are elevated from the submerged surface following deployment.

In certain embodiments the underwater plough has a second deployment configuration in which:

the angle between the first direction and the second direction is reduced in comparison to the first deployment configuration; and

- 5 the drawbar is in a second deployment position, in which the drawbar is rotated forwardly in comparison to the first deployment position.

In certain embodiments the underwater plough of the sixth aspect of the invention includes all the features of the underwater plough of the first aspect of the invention.

- As used herein, it would be understood that 'providing an elongated element into a submerged surface' in the present disclosure may be otherwise termed 'providing an elongated element
10 in a seabed', 'guiding an elongated element onto a submerged surface or seabed' or 'guiding an elongated element into a trench formed in a submerged surface or sea bed'.

As used herein, it would be understood that the terms 'front' and 'back', with regards to an underwater plough are defined relative to the direction of plough movement during operation.

- 15 Similarly it would be understood that the terms 'upstream' or 'downstream', with regards to an underwater plough are defined relative to the direction of elongated element deployment rather than the direction of plough movement.

- As used herein, unless otherwise specified the features "at an angle" or "angled" (for example 'the second direction being at an angle to the first direction') refer to an angle when considering
20 the side views of the underwater plough illustrated in the Figures – that is, angled within a substantially vertical plane through the underwater plough.

As used herein, it would be understood that the term 'underside' refers to the side of the underwater plough, or the body portion thereof, that faces downwardly towards the underlying submerged surface in use.

- 25 As used herein, it would be understood that 'an operational configuration for a ploughing operation' is a configuration, or particular arrangement of the features of the underwater plough, that allows it to perform a ploughing operation, i.e. to plough or cut a trench in a particular surface. This phrase may otherwise be termed 'wherein in operation the underwater plough is movable or configured in such a way that'. Similarly, a 'deployment configuration' is
30 a configuration, or particular arrangement of the features of the underwater plough, that allows it to be deployed from a vessel.

Brief Description of the Drawings

Embodiments will now be described by way of example only with reference to the accompanying drawings in which:

- 35 Figure 1 illustrates a side view of a known underwater plough;
Figure 2 illustrates a side view of an underwater plough in a stowage configuration;
Figures 3 and 4 illustrate the underwater plough of Figure 2 in an operational configuration;

Figure 5 illustrates the underwater plough of Figure 2 at a lowermost cutting position; and Figures 6 to 9 illustrate the underwater plough of Figure 2 during deployment to a submerged surface.

In the drawings like reference numerals refer to like parts.

5 Detailed Description of the Invention

Figure 2 illustrates an underwater plough 200 for providing an elongated element into a submerged surface. As an example the underwater plough 200 may be used for trenching (burying) cable, such as a power transmission cable, telecoms cable or the like, into a submerged surface, such as a seabed or riverbed.

- 10 The underwater plough 200 includes a body portion (otherwise termed a plough beam) 202 for receiving and guiding an elongated element therethrough. The body portion 202 includes a first end 202₁ positioned at or towards the front of the underwater plough 200 and a second end 202₂ positioned at or towards the rear of the underwater plough 200. The underwater plough 200 has a longitudinal axis, represented by dashed line 203, along which the first end
15 202₁ and second end 202₂ are spaced. As shown in Figure 2, in the stowage configuration the longitudinal axis 203 of the underwater plough 200 is generally aligned with the forward, trenching, direction of the plough 200.

- In this example the body portion 202 includes a bell mouth 204 located at the first end 202₁ of the body portion 202, the bell mouth 204 being configured to receive an elongated element
20 therethrough. In use an elongated element is received at the bell mouth 204 before passing through the body portion 202 from the first end 202₁ to the second end 202₂.

- The underwater plough 200 further includes a plough share 206 extending from an underside of the body portion 202. In this example the plough share 206 is connected to the body portion 202 at a connection point or region, the connection point or region being located towards, or
25 proximal to, the second end 202₂ of the body portion 202. That is, the plough share 206 is located towards, or at, the rear of the underwater plough 200.

- The plough share 206 includes a cutting edge 208 for cutting a bottom of the trench in which the elongated element is to be deposited. In this example the cutting edge 208 extends forwardly from a main body of the plough share 206. In this example the plough share 206
30 includes a heel portion 224 extending rearwardly from the cutting edge 208. In this example, the heel portion 224 constitutes the base of the plough share 206.

- The underwater plough 200 further includes a depressor 214 extending from the second end 202₂ of the body portion 202, the depressor 214 being configured to guide the elongated element into the trench cut by the cutting edge 208. The depressor 214 is aligned with a rear
35 surface of the plough share 206 such that as the elongated element passes from the body portion 202 to the trench, the elongated element is guided into the trench by the rear surface of the plough share 206 and the depressor 214.

The underwater plough 200 further includes support means for supporting the underwater plough 200 with respect to a submerged surface.

The support means includes a first set of at least one support member 216 extending from an underside of the body portion 202. In this example, the support members 216 of the first set
5 are skids. In this example the first set includes two skids 216, separated across the width of the body portion 202. However it would be understood that the first set may include any number of skids 216.

In this example, each skid 216 is connected to the body portion 202 at a respective connection point 230. In this example, the connection point 230 between each skid 216 and the body
10 portion 202 is located towards, or proximal to, the first end 202₁ of the body portion 202. That is, the skids 216 extend from a position at, or towards, the front of the underwater plough 200. Each skid 216 includes a contact portion 217 for contacting the submerged surface. In this example the contact portion 217 is a pivotable foot positioned at an end of an elongated leg portion, the elongated leg portion being connected to the body portion 202.

15 The support means further includes a second set of at least one support member 218 extending from an underside of the body portion 202. In this example, the support members 218 of the second set are stabilisers. In this example the second set includes two stabilisers 218, separated across the width of the body portion 202. However it would be understood that the second set may include any number of stabilisers 218.

20 In this example, each stabiliser 218 is connected to the body portion 202 at a respective connection point 232. The connection point 232 between each stabiliser 218 and the body portion 202 is located towards, or proximal to, the first end 202₁ of the body portion 202. That is, the stabilisers 218 extend from a portion at, or towards, the front of the underwater plough 200. In this manner the connection point 232 is spaced from the soil rupture surface.

25 In this example the connection points between the stabilisers 218 and the body portion 202 are positioned behind the connection points between the skids 216 and the body portion 202. That is, the skids 216 are closer to the first end 202₁ of the body portion 202 than the stabilisers 218.

Although the connection points 230, 232 are spaced along the longitudinal axis of the
30 underwater plough 200, both are positioned towards the front of the underwater plough 200 and the spacing is relatively small in comparison to the length of the underwater plough 200. For example, the connection points 230, 232 may be spaced by from about 10cm to about 100cm. This positioning and spacing helps the underwater plough 200 more easily achieve a pitched forward configuration while still supported by the skids 216 and the stabilisers 218.

35 That is, with a close spacing between the connection points 230 the pitch of the underwater plough 200 is more sensitive to changes in the directions of the skids 216 and the stabilisers 218.

Each stabiliser 218 includes a contact portion 219 for contacting the submerged surface. In this example the contact portion 219 is a curved end at an end of an elongated leg portion, the elongated leg portion being connected to the body portion 202.

In this example, the stabilisers 218 are sized so as to be able to extend from the body portion 202 to, or past, the cutting edge 208 of the plough share 206. That is, in a configuration where the stabilisers 218 are oriented towards the cutting edge 208, the contact portion 219 of the stabilisers 218 will extend up to, or past, the cutting edge 208. In other words, the distance from the connection point 232 to the contact portion 219 of the respective stabiliser 218 is greater than or substantially equal to the distance from the connection point 232 to the cutting edge 208. In this manner the stabilisers 218 are sized so as to be able to support the plough share 206 and the rear of the underwater plough 200.

The contact portions of the skids 216 and the stabilisers 218 define a contact plane. That is, the plane that includes the contact portions of the skids 216 the contact portions of the stabilisers 218 is defined as a contact plane. For example, when the underwater plough 200 is located on a horizontal seafloor, the contact plane would be coplanar with the seafloor.

The skids 216 and the stabilisers 218 are rotatable with respect to the body portion 202. In this example, each skid 216 is rotatable about the connection point 230 between the respective skid 216 and the body portion 202. Specifically, each skid 216 is rotatable about a rotational axis extending from the connection point 230 in a direction that is normal to the longitudinal axis 203 of the body portion 202.

For example for an underwater plough 200 located on a horizontal seafloor, the rotational axis would be horizontal and normal to the longitudinal axis 203 of the body portion 202 (i.e. into the page when considering the side view of Figure 2). In the same manner, each stabiliser 218 is rotatable about the connection point 232 between the respective stabiliser 218 and the body portion 202 and is rotatable about a rotational axis extending from the connection point 230 in a direction that is normal to the longitudinal axis 203.

The underwater plough 200 includes actuating means configured to rotate the skids 216 and/or to rotate the stabilisers 218 with respect to the body portion 202. In this example the actuating means comprises separate actuating means for the skids 216 and the stabilisers 218. That is, the actuating means includes first actuating means 220 coupled to the body portion 202 and the skids 216, the first actuating means 220 being configured to rotate the skids 216 with respect to the body portion 202. Further the actuating means includes second actuating means 222 coupled to the body portion 202 and the stabilisers 218, the second actuating means 222 being configured to rotate the stabilisers 218 with respect to the body portion 202.

In this example each of the first actuating means 220 and the second actuating means 222 include at least one hydraulic actuator, electrical actuator, pneumatic actuator or the like.

'Actuation' of these actuators relates to extension or retraction of the actuator. In this example the first actuating means 220 includes a separate hydraulic cylinder for each of the skids 216. Similarly the second actuating means 220 includes a separate hydraulic cylinder for each of the stabilisers 218. However in other examples each of the first actuating means 220 and the second actuating means may include a single actuator, or actuator system, configured to actuate more than one skid 216 or stabiliser 218, respectively.

As illustrated in the Figures, the actuators of both the first actuating means 220 and the second actuating means 222, are connected to the body portion 202 at positions spaced from the connection points 230, 232 of the skids 216 and the stabilisers 218, respectively. As such, actuation of the actuating means causes the skids 216 / stabilisers 218 to rotate about their respective connection points 230, 232.

In this example the underwater plough 200 includes a drawbar 212 coupled to the body portion 202. The drawbar 212 is best shown in Figures 6 to 9. The drawbar 212 is for connection to a towing line. It would be understood that the underwater plough 200 may include two separate drawbars – for example at port and starboard – which may both operate in the manner described herein.

In Figures 2 and 3 the drawbar 212 is in a towing position, in which the plough 300 is towable along the submerged surface via a towing line. That is, the drawbar 212 is orientated so as to be substantially parallel with the longitudinal axis 203 of the body portion 202. As a result the connection point with the towing line is towards, or at, the front of the underwater plough 200. In the stowage configuration shown in Figure 2 the underwater plough 200 is configured to as to be stowed on the deck of a vessel prior to deployment into the body of water. In the stowage configuration the contact plane is substantially coplanar with the heel portion 224 of the plough share 224. As such, when located on the deck of the vessel, the skids 216, stabilisers 218 and plough share 206, including the heel portion 224, are all in contact with the deck of the vessel. Figure 3 illustrates the underwater plough 200 in an operational configuration for a ploughing operation.

In the operational configuration the skids 216 extend from the body portion 202 in a first direction. The stabilisers 218 extend from the body portion 202 in a second direction, at an angle to the first direction. In this example, both the first direction and the second direction are angled away from the longitudinal axis of the body portion.

In this example the first direction is such that the skids 216 extend towards, or past, the front of the underwater plough 200. As such, the skids 216 provide support to the front of the underwater plough 200.

In this example the second direction is such that the stabilisers 218 extend towards, or past, the plough share 206 at the rear of the underwater plough 200. In particular the second direction is such that stabilisers 218 extend to, or past, the cutting edge 208 of the plough

share 206. As such, the stabilisers 218 provide support to the plough share 206 and the rear of the underwater plough 200.

In this manner the skids 216 and stabilisers 218 are arranged so as to contact the submerged surface at positions that allow them to support the weight of the underwater plough 200 and any resulting soil surcharge loads. That is, the first and second directions are such that the skids 216 and stabilisers 218 extend away from each other. This ensures the skids 216 and stabilisers 218 contact the ground at positions that provide a wide and stable base while allowing the underwater plough 200 to be pitched forward by the skids 216 and stabilisers 218 (as described below).

In the operational configuration the longitudinal axis 203 of the body portion 202 is angled with respect to the contact plane, with the longitudinal axis 203 being closer to the contact plane at the first end 202₁ of the underwater plough 200 than at the second end 202₂ of the underwater plough 200. That is, the underwater plough 200 is pitched forward, with the bell mouth 204 angled, or pointed, towards the submerged surface, in use.

In this example the orientation between the body portion 202 and the plough share 206 is fixed, at least in the operational configuration. Therefore, as the longitudinal axis 203 of the body portion 202 is angled towards the submerged surface, the plough share 206 is also pitched forward, relative to the stowage configuration.

In the operational configuration the cutting edge 208 is positioned so as to contact with the submerged surface or the bottom of the trench during the ploughing operation. As the plough share 206 is pitched forward, portions of the plough share 206 extending rearwardly from the cutting edge 208 remain elevated from the submerged surface or a bottom of the trench during the ploughing operation. Put another way, away from the cutting edge 208 the base of the plough share 206 remains elevated from the submerged surface. In this example, the heel portion 224 extends rearwardly from the cutting edge 208 and is therefore angled with respect to the contact plane in the operational configuration. In this manner the heel portion 224 can remain elevated from the submerged surface or a bottom of the trench during the ploughing operation.

With the plough share 206 pitched forward the cutting edge 208 essentially provides a single contact point between the plough share 206 and the submerged surface or the bottom of the trench during the ploughing operation. That is, the cutting edge 208 points downwardly towards the submerged surface. It would be understood that in arrangements where the plough share 206 includes multiple laterally spaced cutting edges, for cutting a wide trench for example, the cutting edges may each provide a contact point between the plough share 206 and the submerged surface or the bottom of the trench during the ploughing operation.

In use, the underwater plough 200, loaded with an elongated element or cable, is positioned on the submerged surface in the operational configuration. The underwater plough 200 is then

towed so as to perform a ploughing operation. That is, the underwater plough 200 is towed so as to traverse the submerged surface. As it does so, the underwater plough 200 moves relative to the cable, and the upstream section of the cable passes through the underwater plough 200 and is deposited into the trench formed by the cutting edge 208, downstream of the underwater plough 200.

The underwater plough 200 is configured such that actuation of the actuating means within the operational configuration varies the first direction and the second direction (through rotation of the respective skid 216 or stabiliser 218) changing the orientation of the longitudinal axis 203 of the body portion 202 with respect to the contact plane and/or changing the distance between the body portion 202 and the contact plane. That is, when the underwater plough 200 is in use and positioned on a submerged surface, the actuating means are actuated such that, within the operational configuration, the first direction and the second direction are varied. That is, the angle between the skids 216 and the stabilisers 218 is varied. In doing so this changes the orientation of the longitudinal axis 203 of the body portion 202 with respect to the submerged surface and/or changes the distance between the body portion 202 and the submerged surface. During this, or these, changes the underwater plough 200 is supported by the support means.

Figures 4 and 5 illustrate the underwater plough 200, in use, at different stages of actuation of the actuating means. Specifically, the sequence illustrated by Figures 3 to 5 show the skids 216 and the stabilisers 218 rotating away from each other such that the body portion 202 is lowered towards the submerged surface and the longitudinal axis 203 is brought to a substantially horizontal position. Rotation of the skids 216 and stabilisers 218 away from each other is achieved by retraction of one or both of the first and second actuating means 220 and 222.

As an example, the operational configuration of the underwater plough 200 may encompass an angle between the first direction and the second direction from about 80 degrees to about 180 degrees. For example in Figure 3, the angle between the skids 216 and the stabilisers 218 is approximately 90 degrees. In Figure 4, the angle between the skids 216 and the stabilisers 218 is approximately 120 degrees.

In this example, the ploughing operation carried out by the underwater plough 200 in the operational configuration is that of progressively cutting a trench to a required depth. That is, with the underwater plough 200 in the configuration shown in Figure 3, as the underwater plough 200 is towed the cutting edge 208 begins to cut a trench in the submerged surface. As the actuating means are actuated the body portion 202, and as a result also the plough share 206, are lowered so that the depth of the cut trench is increased – as shown in Figure 4 for example. The orientation of the longitudinal axis 203 of the body portion 202 changes, with

the longitudinal axis 203 rotating towards a more horizontal position (for a horizontal submerged surface). This changes the cutting angle of the cutting edge 208.

In the configuration shown in Figure 5, the body portion 202 is at its lowermost position adjacent to the submerged surface so that the trench depth is at its maximum. However it
5 would be understood that the desired trench depth may be reached prior to this lowermost position.

During actuation of the actuating means (and the resulting change in the first and second directions), the underwater plough 200 is supported by the support means. That is, the underwater plough 200 is configured such that, in the operational configuration, the skids 216
10 and the stabilisers 218 can support the weight of the underwater plough 200 and any additional soil surcharge loads in its entirety on the submerged surface. In this manner, the plough orientation and the depth of the resultant trench can be controlled with the support means alone – i.e. by varying the first and second directions. This removes reliance on a reaction
15 force in the plough share 206 – for example in the heel portion 224. Instead, as shown in Figure 4, the heel portion 224 can remain elevated from the submerged surface or bottom of the trench until the trench is cut to a required depth by the cutting edge 208. As such, the cutting edge 208 may remain as the only contact point between the plough share 206 and the submerged surface or the bottom of the trench during the ploughing operation.

Supporting the underwater plough 200 primarily with the supporting means rather than relying
20 on the heel portion of the plough share allows the underwater plough 200 to be operated pitched forward without the need for additional functionality in the plough – for example an articulating bell mouth or articulating plough share. In this manner the underwater plough 200 can be provided with a fixed orientation between the body portion 202 and the bell mouth 204, at least in the operational configuration. Similarly the underwater plough 200 can be provided
25 with a fixed orientation between the body portion 202 and the plough share 206, at least in the operational configuration.

As such, the tow point for the underwater plough 200 is sufficiently low so as to ensure a stable arrangement. However, the reduction in functionality increases the reliability of the subsea
30 plough 200. With the bell mouth 204 orientated downwardly the risk of a cable loop forming under the underwater plough 200 is also reduced.

In addition, by reducing the heel friction the stability of the underwater plough 200 is actually increased. In particular, with the arrangement of the present disclosure the supporting reaction force is at seabed level throughout the ploughing operation, rather than at the base of the trench. This reduces the moment arm of the supporting reaction force about the contact portion
35 217 of the skids 216 and reduces the risk of the underwater plough 200 rolling over forward or tipping sideways in the event of offset tow load.

It is noted that in known systems rear stabilisers are used simply to limit uncontrolled sinkage in very soft conditions and also to give some stability when landing the plough on the submerged surface. They provide little or no support to the weight of the underwater plough and instead are normally in-float when the heel portion is subject to a reaction force from the ground due to the weight of the underwater plough.

Although Figures 3 to 5 illustrate the skids 216 and stabilisers 218 lowering the cutting edge 208 of the underwater plough 200, the same processes may occur in reverse to raise the cutting edge 208 from a cut trench. Specifically, while the weight of the underwater plough 200 is supported by the skids 216 and stabilisers the actuating means may actuate to change the orientation of the longitudinal axis 203 of the body portion 202 with respect to the submerged surface and/or to change the distance between the body portion 202 and the submerged surface. In doing so the plough share 206 is lifted from the cut trench. In general, the relative actuation of the first actuating means 220 and the second actuating means 222 will dictate if, or by how much, the orientation of the longitudinal axis 203 of the body portion 202 with respect to the submerged surface will change. Similarly the relative actuation of the first actuating means 220 and the second actuating means 222 will dictate if, or by how much, the distance between the body portion 202 and the submerged surface will change.

The underwater plough 200 may include, or be coupled to, a control system configured to control actuation of the actuating means based on a determination of one or more of the trench depth, the relative position of the bell mouth 204, skids 216 and stabilisers 218, or the inclination of the body portion 202. Such determinations may be based on signals from sensors within the underwater plough 200 or signals from external sensors, such as sonars providing ground level feedback. The control means may include predetermined relationships between the actuation of the actuating means (i.e. either or both of the skids 216 and stabilisers 218) and the change in the depth of the trench.

It would be understood that details relating to the specific features of the plough would vary depending on the required plough specification. For example, the geometry of the skids 216, the geometry of the stabilisers 218, the materials used for the skids 216 and stabilisers 218, the load capacity of actuators used would all be specific depending on the size of the plough, the range of tow loads, the soil type etc. Of course, it would be understood that the additional support functionality required of the stabilisers 218 would impact the choice of stabiliser length, cross-section and material and also the load capacity of the actuators used to actuate the stabilisers 218. For example, stronger materials and actuators with a higher load capacity may be selected to ensure the stabilisers can contribute substantially to supporting the weight of the plough.

Figures 6 to 9 illustrate the process of deployment for the underwater plough 200. Figure 6 illustrates the underwater plough 200 positioned on the deck of a vessel, which is typically

also the towing vessel. The cable 201 to be layed in the cut trench is loaded on to the plough 200. Once loaded, the cable 201 extends from upstream components, such as a Linear Cable Engine (LCE) 250, through the bell mouth 204, through the body portion 202 and between the rear surface of the plough share 206 and the depressor 214, to downstream components, such as the stern roller 252.

In Figure 6 the underwater plough 200 is shown in a first deployment configuration, which is similar to the above described operational configuration. The first deployment configuration only differs from the operational configuration in that the drawbar 212 is in a deployment position (otherwise termed a launch and recovery position). In the deployment position the drawbar 212 is angled away from the longitudinal axis 203 of the body portion 202. In this example the drawbar 212 may be angled with respect to the longitudinal axis 203 of the body portion 202 so as to extend substantially vertically from the body portion 202 when the underwater plough 200 is positioned on the surface of the deployment vessel.

As shown in Figure 6, the first deployment configuration of the underwater plough provides a kinder cable path between LCE 250 and the stern roller 252. That is, with the underwater plough 200 pitched forward the cable 201 is subject to less severe bending as it passes through the underwater plough 200.

As shown in Figure 7, the towing line 254 is used to lift the underwater plough 200, overboard the underwater plough 200 over the stern roller 252 and then lower the underwater plough 200 to the submerged surface. When the underwater plough 200 is suspended in the first deployment configuration, the centre of gravity of the underwater plough 200 is substantially below the drawbar 212. As such, rotational moments around the connection point between the drawbar 212 and the body portion 202 are minimal. Therefore the underwater plough 200 can remain in the desired orientation with the drawbar 212 substantially vertical as the underwater plough 200 is over-boarded.

In this example a lower portion of the rear surface of the plough share 206 is curved. Put another way, the lower portion of the rear surface of the plough share 206 is convex. In contrast the remainder of the rear surface may be substantially flat. As an example, the convex lower portion of the rear surface of the plough share 206 may have a radius of from about 1m to about 7m. In this manner, the effective radius of the cable 201 as it passes over the rear surface of the plough share 206 is reduced so that excessive bending of the cable 201 below the minimum bend radius (MBR) is avoided. As an example the MBR for telecommunications cables can be about 1.5m and the MBR for large power cables can be about 5m. This eases the passage of the cable 201 through the underwater plough 200 without the need for a large or pivoting bell mouth. This is particularly advantageous during the over-boarding process shown in Figure 7.

Figure 8 illustrates the underwater plough 200 as it is lowered to the submerged surface. In this example, the underwater plough 200 has been shifted to a second deployment configuration. In the second deployment configuration the angle between the first direction and the second direction (i.e. the angle between the skids 216 and the stabilisers 218) has been reduced from the first deployment configuration. In this example the second deployment configuration of the underwater plough 200 corresponds largely to the stowage configuration shown in Figure 2.

In addition, the drawbar 212 has been rotated forwardly from the first deployment position illustrated in Figures 6 and 7 to a second deployment position. In the second deployment position the drawbar 212 is still angled away from the longitudinal axis 203 of the body portion 202 but the angle is less. That is, the drawbar 212 is closer to the towing position. For example in the second deployment position the drawbar 212 may be at an angle from about 30 degrees to about 70 degrees relative to the longitudinal axis 203 of the body portion, aptly from about 40 to about 60 degrees.

The reduction in angle between the skids 216 and the stabilisers 218 ensures that the centre of gravity of the underwater plough 200 remains generally below the drawbar 212 while the underwater plough 200 is suspended with the drawbar 212 in the second deployment position. When suspended in the second deployment configuration, the bell mouth 204 points generally upwardly towards the surface of the water body. This ensures a kinder cable path through the underwater plough 200, with a low cable wrap angle. This reduces the tension build-up in the cable due to wrap friction build up. This effect is particularly important nearer the vessel where the cable tension is greatest due to self-weight of the cable in the water.

Positioning the connection points 230, 232 towards the front of the body portion 202 is beneficial in balancing the weight of the underwater plough 200 in such a way that the cable path illustrated in Figure 8 can be easily achieved. That is, positioning the stabilisers 218 towards the rear of the underwater plough 200 would make it difficult to arrange the centre of gravity underneath the drawbar 212 when in the configuration shown in Figure 8.

Prior to touch-down the drawbar 212 is rotated from the second deployment position back to the first deployment position. This allows the underwater plough 200 to touch down with the contact plane on the submerged surface. This is done just before touch down when the cable 201 is at its lowest tension.

Figure 9 illustrates the underwater plough 200 touching down on the submerged surface with the underwater plough 200 in the deployment/operational configuration. As described above, the underwater plough 200 is supported by the supporting means with the heel portion 224 elevated from the submerged surface. Landing the underwater plough 200 on the submerged surface with the plough share 206 at a positive pitch angle reduces the risk of damage to the cable product upon landing since it leaves the underwater plough 200 above the submerged

surface. That is, there is less chance of the cable 201 being trapped between the plough share 206 and the submerged surface as it lands.

It will be clear to a person skilled in the art that features described in relation to any of the embodiments described above can be applicable interchangeably between the different
5 embodiments. The embodiments described above are examples to illustrate various features of the invention.

Throughout the description and claims of this specification, the words “comprise” and “contain” and variations of them mean “including but not limited to”, and they are not intended to (and do not) exclude other moieties, additives, components, integers or steps. Throughout the
10 description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

A normal reference frame relating to (components of) the plough may be used when assessing
15 the orientation thereof. Accordingly, when the plough is positioned on a flat ground surface, “horizontal” is parallel to said flat ground surface, and “vertical” is perpendicular to said flat ground surface (i.e. upwards from said flat ground surface), even when said flat ground surface is inclined.

Features, integers, characteristics, compounds, chemical moieties or groups described in
20 conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some
25 of such features and/or steps are mutually exclusive. The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. An underwater plough for providing an elongated element into a submerged surface, the underwater plough comprising:
- 5 a body portion for receiving and guiding an elongated element therethrough, the body portion having:
- a first end positioned at or towards the front of the underwater plough;
 - a second end positioned at or towards the rear of the underwater plough; and
 - a longitudinal axis along which the first end and second end are spaced;
- 10 a plough share extending from an underside of the body portion, the plough share comprising a cutting edge for cutting a bottom of a trench in which the elongated element is to be deposited;
- support means for supporting the underwater plough with respect to a submerged surface, the support means comprising:
- 15 a first set of at least one support member extending from an underside of the body portion, the at least one support member of the first set having a contact portion for contacting the submerged surface; and
- a second set of at least one support member extending from an underside of the body portion, the at least one support member of the second set having a
- 20 contact portion for contacting the submerged surface, wherein the contact portion of the at least one support member of the first set and the contact portion of the at least one support member of the second set define a contact plane;
- wherein the at least one support member of the first set is rotatable with respect
- 25 to the body portion and the at least one support member of the second set is rotatable with respect to the body portion,
- actuating means configured to rotate the at least one support member of the first set with respect to the body portion and/or to rotate the at least one support member of the second set with respect to the body portion,
- 30 wherein the underwater plough has an operational configuration for a ploughing operation in which:
- the at least one support member of the first set extends from the body portion in a first direction;
 - the at least one support member of the second set extends from the body portion in a
- 35 second direction, at an angle to the first direction;

the longitudinal axis of the body portion is angled with respect to the contact plane, with the longitudinal axis being closer to the contact plane at the first end of the underwater plough than at the second end of the underwater plough; and the cutting edge is positioned so as to contact with the submerged surface or the bottom of the trench during the ploughing operation;

wherein the underwater plough is configured such that actuation of the actuating means within the operational configuration varies the first direction and the second direction changing the orientation of the longitudinal axis of the body portion with respect to the contact plane and/or the distance between the body portion and the contact plane while the underwater plough is supported by the support means.

2. The underwater plough of claim 1, wherein the underwater plough is configured such that, in the operational configuration, the at least one support member of the first set and the at least one support member of the second set contact the submerged surface such that the weight of the underwater plough on the submerged surface is supported by the at least one support member of the first set and the at least one support member of the second set so that the plough orientation and the depth of the resultant trench can be controlled by varying the first direction and second direction.

3. The underwater plough of any preceding claim, wherein the plough share comprises a heel portion extending rearwardly from the cutting edge, wherein in the operational configuration the heel portion is angled with respect to the contact plane so that the heel portion can remain elevated from the submerged surface or a bottom of the trench during the ploughing operation.

4. The underwater plough of any preceding claim, wherein the first direction is such that the at least one support member of the first set extends towards, or past, the front of the underwater plough.

5. The underwater plough of any preceding claim, wherein the second direction is such that the least one support member of the second set extends towards, or past, the plough share at the rear of the underwater plough.

6. The underwater plough of any preceding claim, wherein in the operational configuration the angle between the first direction and the second direction is from about 80 degrees to about 180 degrees.

7. The underwater plough of any preceding claim,
wherein a connection point between the at least one support member of the first set
and the body portion is located towards, or proximal to, the first end of the body portion;
and
- 5 wherein a connection point between the at least one support member of the second
set and the body portion is located towards, or proximal to, the first end of the body
portion.
8. The underwater plough of any preceding claim, wherein a connection point between
10 the plough share and the body portion is located towards, or proximal to, the second end of
the body portion.
9. The underwater plough of claim 7, wherein the at least one support member of the
second set is sized so as to be able to extend from the connection point between the at least
15 one support member of the second set and the body portion to the cutting edge of the plough
share.
10. The underwater plough of claim 9, wherein in the operational configuration the at least
one support member of the second set extends from the connection point between the at least
20 one support member of the second set and the body portion up to, or past, the cutting edge
of the plough share.
11. The underwater plough of any preceding claim, wherein the actuating means
comprises:
- 25 first actuating means coupled to the body portion and the at least one support member
of the first set, the first actuating means being configured to rotate the at least one
support member of the first set with respect to the body portion; and
second actuating means coupled to the body portion and the at least one support
member of the second set, the second actuating means configured to rotate the at
30 least one support member of the second set with respect to the body portion.
12. The underwater plough of any preceding claim, wherein in the operational
configuration, the orientation of the plough share with respect to the body portion is fixed.
- 35 13. The underwater plough of any preceding claim, wherein the plough share includes:
a main body from which the cutting edge extends; and

a rear surface along which, in use, the elongated element traverses as it passes from the body portion into the trench cut by the cutting edge.

14. The underwater plough of claim 13, wherein the underwater plough further comprises
5 a depressor extending from the second end of the body portion, the depressor being configured to guide the elongated element into the trench cut by the cutting edge.

15. The underwater plough of claim 13 or claim 14, wherein a lower portion of the rear
10 surface is convex.

16. The underwater plough of any preceding claim, wherein the underwater plough
includes a drawbar coupled to the body portion, the drawbar being for connection to a towing
line.

17. The underwater plough of claim 16, wherein the drawbar is rotatable between a towing
15 position and a deployment position.

18. An assembly for providing an elongated element into a submerged surface,
comprising:
20 a) an underwater plough according to claim 16 or 17;
b) a vessel comprising a towing line, wherein said towing line is connected to the drawbar
of said underwater plough.

19. A method of operating an underwater plough for providing an elongated element into
25 a submerged surface, the method comprising:
providing a underwater plough comprising:

a) a body portion for receiving and guiding an elongated element therethrough, the body
portion having:
30 i) a first end positioned at or towards the front of the underwater plough;
ii) a second end positioned at or towards the rear of the underwater plough; and
iii) a longitudinal axis along which the first end and second end are spaced;
b) a plough share extending from an underside of the body portion, the plough share
comprising a cutting edge for cutting a bottom of a trench in which the elongated
element is to be deposited;
35 c) support means for supporting the underwater plough with respect to a submerged
surface, the support means comprising:

- a first set of at least one support member extending from an underside of the body portion, the at least one support member of the first set having a contact portion for contacting the submerged surface; and
- a second set of at least one support member extending from an underside of the body portion, the at least one support member of the second set having a contact portion for contacting the submerged surface;
- wherein the at least one support member of the first set is rotatable with respect to the body portion and the at least one support member of the second set is rotatable with respect to the body portion,
- actuating means configured to rotate the at least one support member of the first set with respect to the body portion and/or to rotate the at least one support member of the second set with respect to the body portion,
- positioning the underwater plough on the submerged surface in an operational configuration in which:
- the at least one support member of the first set extends from the body portion in a first direction, the first direction being angled away from the longitudinal axis of the body portion;
- the at least one support member of the second set extends from the body portion in a second direction, at an angle to the first direction, the second direction being angled away from the longitudinal axis of the body portion;
- the contact portion of the at least one support member of the first set and the contact portion of the at least one support member of the second set are in contact with the submerged surface;
- the longitudinal axis of the body portion is angled with respect to the submerged surface, with the longitudinal axis being closer to the submerged surface at the first end of the underwater plough than at the second end of the underwater plough; and
- the cutting edge is in contact with the submerged surface or the bottom of the trench;
- performing a ploughing operation with the underwater plough; and
- actuating the actuating means with underwater plough in the operational configuration such that the first direction and the second direction are varied to change the orientation of the longitudinal axis of the body portion with respect to the submerged surface and/or the distance between the body portion and the submerged surface while the underwater plough is supported by the support means.
20. The method of claim 19, wherein in the operational configuration, the at least one support member of the first set and the at least one support member of the second set contact the submerged surface such that the weight of the underwater plough on the submerged

surface is supported by the at least one support member of the first set and the at least one support member of the second set so that the plough orientation and the depth of the resultant trench can be controlled by varying the first direction and second direction.

5 21. The method of claim 19 or 20, wherein the first direction is such that the at least one support member of the first set extends towards, or past, the front of the underwater plough.

22. The method of any of claims 19 to 21, wherein the second direction is such that the least one support member of the second set extends towards, or past, the plough share at the
10 rear of the underwater plough.

23. The method of any of claims 19 to 22, wherein in the operational configuration the angle between the first direction and the second direction is from about 80 degrees to about 180 degrees.

15 24. The method of any of claims 19 to 23,
wherein a connection point between the at least one support member of the first set and the body portion is located towards, or proximal to, the first end of the body portion;
and
20 wherein a connection point between the at least one support member of the second set and the body portion is located towards, or proximal to, the first end of the body portion.

25. The method of any of claims 19 to 24, wherein a connection point between the plough
25 share and the body portion is located towards, or proximal to, the second end of the body portion.

26. The method of any of claims 19 to 25, wherein the at least one support member of the second set is sized so as to be able to extend from the connection point between the at least
30 one support member of the second set and the body portion to the cutting edge of the plough share.

27. The method of any of claims 19 to 26, wherein in the operational configuration the at least one support member of the second set extends from the connection point between the
35 at least one support member of the second set and the body portion up to, or past, the cutting edge of the plough share.

28. A method of deploying an underwater plough for providing an elongated element into a submerged surface, the method comprising:

providing a underwater plough comprising:

5 a body portion for receiving and guiding an elongated element therethrough, the body portion having:

a first end positioned at or towards the front of the underwater plough;

a second end positioned at or towards the rear of the underwater plough; and

a longitudinal axis along which the first end and second end are spaced;

10 a plough share extending from an underside of the body portion, the plough share comprising a cutting edge for cutting a bottom of a trench in which the elongated element is to be deposited;

support means for supporting the underwater plough with respect to a submerged surface, the support means comprising:

15 a first set of at least one support member extending from an underside of the body portion, the at least one support member of the first set having a contact portion for contacting the submerged surface; and

a second set of at least one support member extending from an underside of the body portion, the at least one support member of the second set having a contact portion for contacting the submerged surface; and

20 a drawbar coupled to the body portion, the drawbar being for connection to a towing line;

positioning the underwater plough on a surface of a deployment vessel in a deployment configuration in which:

25 the at least one support member of the first set extends from the body portion in a first direction;

the at least one support member of the second set extends from the body portion in a second direction, at an angle to the first direction;

30 the contact portion of the at least one support member of the first set and the contact portion of the at least one support member of the second set are in contact with the surface of the deployment vessel;

the longitudinal axis of the body portion is angled with respect to the surface of the deployment vessel, with the longitudinal axis being closer to the surface of the deployment vessel at the first end of the underwater plough than at the second end of the underwater plough;

35 the drawbar is in a deployment position wherein the drawbar is angled with respect to the longitudinal axis of the body portion so as to extend substantially vertically from the body portion; and

the cutting edge is in contact with or adjacent to the surface of the deployment vessel;
loading an elongated cable onto the underwater plough; and
suspending the underwater plough from a towing line connected to the drawbar and deploying
the underwater plough from the deployment vessel to a submerged surface in a body of water.

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29. The method of claim 28, wherein the step of deploying the underwater plough from the
deployment vessel to a submerged surface in a body of water comprises:

over-boarding the underwater plough from the deployment vessel with the underwater
plough in the deployment configuration.

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30. The method of claim 29, wherein the step of deploying the underwater plough from the
deployment vessel to a submerged surface in a body of water further comprises:

touching the underwater plough is down to the submerged surface with the underwater
plough in the deployment configuration.

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31. The method of claim 29 or 30, wherein the step of deploying the underwater plough
from the deployment vessel to a submerged surface in a body of water further comprises:

configuring the underwater plough in a second deployment configuration by:

reducing the angle between the first direction and the second direction; and

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rotating the drawbar forwardly to a second deployment position; and

lowering the underwater plough through the body of water in the second deployment
configuration.