

COUPLER

TECHNICAL FIELD

- 5 **[0001]** The present invention relates to a coupler for coupling a marine vessel line and a tugboat line, a line handling system for a tugboat, and a tugboat.

BACKGROUND

- 10 **[0002]** A tugboat helps to manoeuvre another vessel by pushing or towing the other vessel. For example, the other vessel may not be permitted to move under its own propulsion, such as a container ship in a crowded harbour or a narrow canal, or may be unable to move under its own propulsion, such as a disabled ship.
- 15 **[0003]** In order for a tugboat to be able to tow another vessel (such as a container ship), a tow line must extend between, and be secured to, the tugboat and the other vessel. One way of providing this tow line involves the successive exchange of lines of increasing strength (and, usually, diameter) between the vessels. For example, the end of a heaving line is thrown to a position on a foredeck of the tugboat from the other vessel, such as from the fore of the aft of the
- 20 other vessel. The heaving line is then tied to a messenger line that is stored on the tugboat. The messenger line is attached to a tow line that is also stored on, and attached to, the tugboat. The heaving line, and thereafter the messenger line and then the tow line, is then pulled up to the other vessel, for example using a capstan of the other vessel. The tow line is then attached to the other vessel, such as by being placed over a bollard on the other vessel. The tugboat is then
- 25 able to manoeuvre the other vessel using the tow line extending between them. However, it may be difficult for the heaving line to be accurately thrown to the required position on the foredeck. There may also be a risk of a crew member on the foredeck being hit and potentially injured when the heaving line is thrown to the tugboat. Therefore, an improved system may be needed to address these problems.

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SUMMARY

- [0004]** According to a first aspect of the present invention, there is provided a coupler for coupling a marine vessel line and a tugboat line, the coupler comprises: a coupling zone for receiving the
- 35 marine vessel line and the tugboat line; a guide configured to receive a connector and guide the

connector around the coupling zone to wrap the connector around the lines; and a securing member configured to secure the connector to the lines such that the lines are coupled, wherein the securing member is upstream of the guide and is configured to bend the connector prior to the connector being received by the guide.

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[0005] By bending the connector prior to the connector being received by the guide, the connector may be pre-bent before it is wrapped around the lines. This may help to reduce the likelihood of the connector becoming stuck in the guide. Moreover, the pre-bending of the connector may help to guide the connector around the lines in the coupling zone. The coupler may also be able to
10 withstand and operate in harsh/hostile conditions (for example, in adverse weather conditions), where it may be hazardous for a crew member to be present.

[0006] Optionally, the guide comprises a channel to guide the connector around the coupling zone, and a roller arranged along the channel to direct the connector along the channel. The
15 roller may help to urge the connector along the channel, which may help to reduce the likelihood of the connector becoming stuck in the channel.

[0007] Optionally, the coupler is configured to wrap the connector around the lines a plurality of times. This may help to ensure that the connector is sufficiently secured to the lines. Optionally,
20 the number of times which the connector is wrapped around the lines is determined based in the thickness of the lines. This may allow the amount of connector used to be tailored to the specific lines being coupled, which may help to reduce excess or too little connector being used.

[0008] Optionally, the coupler comprises a feed mechanism configured to feed the connector
25 from a supply toward the securing member, and the securing member comprises a cutting element configured to cut the connector from the supply. In this way, the securing member may act to both couple the lines together and cut the connector from the supply. This may help to increase the simplicity of the system as fewer components may be utilised. Moreover, as there may be fewer components present, this may reduce the likelihood of a failure occurring in the
30 system.

[0009] Optionally, the cutting element comprises a lip that extends around the periphery of the securing member. Optionally, the lip is integrally formed with the cutting element. Optionally, the securing member comprises a hardened material. This may help to cut the connector from the

supply. Moreover, this may help to reduce the likelihood of the securing member being damaged while cutting the connector from the supply.

5 [0010] Optionally, the coupler comprises the supply of the connector. Optionally, the supply comprises a spindle onto which the connector is wound. Optionally, the supply and/or the spindle may be removeable from the coupler. This may allow the supply and/or spindle to be replaced and/or replenished to ensure that the coupler does not run out of connector.

10 [0011] Optionally, the feed mechanism is configured to feed the connector toward the securing member at a first rate and the roller is configured to rotate at a second rate, the second rate greater than the first rate. In this way, the roller rotates at a rate faster than the connector is passing through the coupler. This may help the roller to urge the connector through the channel to help to reduce the likelihood of the connector becoming stuck in the channel.

15 [0012] Optionally, the connector comprises a length of wire. Optionally, the wire has a diameter between 0.5 and 3 millimetres. Optionally, the wire has a diameter between 0.5 and 2 millimetres. Optionally, the wire has a diameter between 0.7 and 0.9 millimetres. By providing a relatively thin wire, it may be easier to cut the wire from the supply. Optionally, the wire comprises stainless steel.

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[0013] Optionally, the securing member is actuatable to twist together free ends of the connector to secure the connector to the lines. In this way, no additional elements are needed to secure the connector to the lines which may help to reduce the complexity of the system.

25 [0014] Optionally, the securing member is actuatable to both twist together the free ends of the connector and cut the connector from the supply. Both the twisting and the cutting may occur at substantially the same time, which may increase the speed and/or efficiency of the system.

30 [0015] Optionally, the securing member is rotatable about a rotational axis to secure the connector to the lines and is translatable along the rotational axis to move the cutting element relative to the supply to cut the connector from the supply. By translating the securing member along the rotational axis, this may help to force the cutting member against the connector to cut the connector from the supply. Optionally, the securing member reciprocates along the rotational axis when the securing member is rotated about the rotational axis.

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[0016] Optionally, the securing member comprises a cylindrical cam which is engageable with a projection of the coupler to cause the securing member to translate along the rotational axis during rotation of the securing member about the rotational axis. This may cause the securing member to translate along the rotational axis at the same time as rotating about the rotational axis, which
5 may enable the connector to be cut from the supply and secured to the lines at substantially the same time.

[0017] Optionally, the securing member is configured to rotate a predetermined number of times to secure the connector to the lines. For example, the securing member may rotate between 5
10 to 15 times, between 7 to 13 times, between 9 to 11 times or 10 times. This may help to ensure that the connector is sufficiently secured to the lines and may also help to ensure that the connector is completely cut from the supply.

[0018] Optionally, the securing member comprises a bending surface and the securing member
15 is alignable with the feed mechanism such that the connector is directed toward the bending surface to bend the connector. The bending surface may act to passively bend the connector when the connector contacts the bending surface. In this way, the connector may be bent prior to the connector being received by the guide without the use of an additional component.

[0019] Optionally, the securing member comprises a pair of protrusions between which the
20 connector is configured to pass, wherein the pair of protrusions engage with the connector when the securing member is rotated such that the connector is twisted when the securing member is rotated. The protrusions may allow the securing member to engage with the connector without the need for an additional device to grip the connector, which may help to simplify the coupler.

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[0020] Optionally, the coupler comprises a motor configured to actuate the securing member. Optionally, the motor is an electric motor. Optionally, the motor comprises a position sensor configured to sense a position of a rotor of the motor. Optionally, the position of the rotor is used to determine a status of the coupler. For example, the position of the rotor may be used to
30 determine an amount of the connector used and therefore an amount of the connector remaining in the supply. Optionally, the position sensor comprises an encoder. The encoder may allow the position of a rotor of the motor to be known. This information may be used to determine how many rotations of the rotor have occurred.

[0021] Optionally, the coupling zone is defined by the housing and the channel of the guide is arranged in a surface of the housing. Optionally, the channel extends around greater than 50% of the circumference of the coupling zone. Optionally, the channel extends around greater than 75% of the circumference of the coupling zone. Optionally, the channel extends around substantially the entire circumference of the coupling zone. This may help to wrap the connector fully around the lines.

[0022] Optionally, the housing comprises a first section and a second section, wherein the first section is moveable relative to the second section. Optionally, the first section is hingedly attached to the second section. Optionally, the coupler comprises a further motor configured to move the first section relative to the second section. In this way, the first section can be moved relative to the second section to allow and/or restrict movement of the lines into and out of the coupling zone.

[0023] Optionally, the coupler is operable in a first configuration in which the housing restricts movement of the lines in a first axis and a second axis which are orthogonal to each other but not in a third axis orthogonal to both the first axis and the second axis, and in a second configuration in which the housing restricts movement of the lines in the first axis but not in the second axis and the third axis. This may help to hold the lines in the coupling zone in the first configuration while a connector is applied, while allowing the lines to freely enter and exit the coupling zone in the second configuration, e.g. after the connector is applied or before the connector is applied.

[0024] Optionally, a marine vessel comprises the coupler according to the first aspect of the present invention. Optionally, the marine vessel comprises a tugboat.

[0025] According to a second aspect of the present invention, there is provided a line handling system comprising a coupler for coupling a marine vessel line and a tugboat line, the coupler comprising: a coupling zone for receiving the marine vessel line and the tugboat line; a guide configured to receive a connector and guide the connector around the coupling zone to wrap the connector around the lines; and a securing member configured to secure the connector to the lines such that the lines are coupled, wherein the securing member is upstream of the guide and is configured to bend the connector prior to the connector being received by the guide.

[0026] According to a third aspect of the present invention, there is provided a tugboat comprising a coupler for coupling a marine vessel line and a tugboat line, the coupler comprising: a coupling

zone for receiving the marine vessel line and the tugboat line; a guide configured to receive a connector and guide the connector around the coupling zone to wrap the connector around the lines; and a securing member configured to secure the connector to the lines such that the lines are coupled, wherein the securing member is upstream of the guide and is configured to bend the connector prior to the connector being received by the guide.

[0027] According to a fourth aspect of the present invention, there is provided a tugboat comprising a line handling system comprising a coupler for coupling a marine vessel line and a tugboat line, the coupler comprising: a coupling zone for receiving the marine vessel line and the tugboat line; a guide configured to receive a connector and guide the connector around the coupling zone to wrap the connector around the lines; and a securing member configured to secure the connector to the lines such that the lines are coupled, wherein the securing member is upstream of the guide and is configured to bend the connector prior to the connector being received by the guide.

[0028] According to a fifth aspect of the present invention, there is provided a method of coupling a marine vessel line and a tugboat line, the method comprising: providing a connector; placing the marine vessel line and the tugboat line in a coupling zone of a coupler, the coupler comprising a guide configured to receive the connector and guide the connector around the coupling zone, and a securing member configured to secure the connector to the lines; bending the connector prior to the connector being received by the guide; guiding the connector around the coupling zone to wrap the connector around the lines; and securing the connector to the lines with the securing member such that the lines are coupled.

[0029] Optional features of aspects of the present invention may be equally applied to other aspects of the present invention, where appropriate.

BRIEF DESCRIPTION OF DRAWINGS

[0030] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

[0031] Figure 1 shows a partial schematic top view of an example of a tugboat according to an embodiment of the present invention, wherein a line guide mechanism of a line handling system of the tugboat is at a stowed position on or adjacent a deck of a hull of the tugboat;

[0032] Figure 2 shows a schematic front view of the tugboat of Figure 1, wherein the line guide mechanism has been moved to an operation position, at which the line guide mechanism is for guiding a portion of a line of the tugboat towards a predetermined region of a perimeter of the hull;

[0033] Figure 3 shows a schematic front view of the tugboat of Figure 2, wherein the line guide mechanism has been moved to a deployed position, at which the line guide mechanism protrudes away from the hull over the water in which the tugboat is sitting for guiding a line of a marine vessel towards the predetermined region of the perimeter of the hull;

[0034] Figure 4 shows a partial schematic top view of the tugboat of Figure 3, in which it can be seen that the line of the tugboat has been guided to the predetermined region of the perimeter of the hull by the line guide mechanism;

[0035] Figure 5 shows a partial schematic top view of the tugboat of Figures 3 and 4, wherein the tugboat is now adjacent a marine vessel to be assisted and a line of the marine vessel is draped over one of two guide arms of the line guide mechanism;

[0036] Figure 6 shows a partial schematic top view of the tugboat of Figure 5, wherein the guide arm over which the line of the marine vessel is draped has been rotated relative to the hull so that a distal end of the guide arm is closer to an axis that extends in a fore and aft direction of the tugboat;

[0037] Figure 7 shows a partial schematic top view of the tugboat of Figure 6, wherein secondary guides of the line guide mechanism have been rotated relative to the guide arm to drive the line of the marine vessel along the guide arm towards the predetermined region of the perimeter of the hull;

[0038] Figure 8 shows a partial schematic top view of the tugboat of Figure 7, wherein the secondary guides have been further rotated relative to the guide arm to lift the line of the marine vessel from the guide arm and carry the line further towards the predetermined region of the perimeter;

[0039] Figure 9 shows a schematic isometric view of a coupler in a first configuration;

[0040] Figure 10 shows a schematic isometric view of the coupler of Figure 9 in a second configuration;

5 [0041] Figure 11 shows a schematic cross-sectional view of the coupler of Figure 9;

[0042] Figure 12 shows a schematic isometric view of a coupling member of the coupler of Figure 9;

10 [0043] Figure 13 shows a schematic side view of the coupling member of Figure 12;

[0044] Figure 14 shows a schematic top view of the coupling member of Figure 12;

15 [0045] Figure 15 shows partial schematic side view of the lines as coupled using a connector by the coupler of Figure 9;

[0046] Figure 16 shows a partial schematic isometric cross-sectional view of the coupler of Figure 9;

20 [0047] Figures 17 and 18 show schematic isometric and front views respectively of a roller of the coupler;

[0048] Figure 19 shows a partial schematic top view of the tugboat in which the lines are connected by the connector and have been removed from the coupling zone of the coupler; and
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[0049] Figure 20 shows a flow diagram of a method of coupling a marine vessel line a tugboat line.

DETAILED DESCRIPTION

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[0050] Figure 1 shows a partial schematic top view of an example of a tugboat 1 according to an embodiment of the present invention. The tugboat 1 is for assisting a marine vessel, such as a container ship, to manoeuvre. The tugboat 1 comprises a hull 11 that has a perimeter P which is defined by a fender of the tugboat 1. In some examples, the fender is omitted. The tugboat 1
35 comprises a deck 12 within the perimeter P and a wheelhouse 18 on the deck 12. The tugboat 1

further comprises a pair of line stores 16 for storing lines 15, wherein each of the line stores 16 is in the form of a winch. The lines 15 stored by the line stores 16 are tow lines 15 (also known in the art as towing lines).

5 [0051] The tugboat 1 also carries a messenger line 13 for use in the process of hauling a tow line 15 from the tugboat 1 to a marine vessel that is to be assisted by the tugboat 1. When out of use, the messenger line 13 is stored on the deck 12 itself. In Figure 1, the messenger line 13 is shown as having a first end coupled to the free end of one of the tow lines 15. For example, when the free end of the tow line 15 has an eye, the first end of the messenger line 13 may be attached to
10 the eye. The opposite, second end of the messenger line 13 is shown in Figure 1 as hanging or draping over the perimeter P of the hull 11. In this example, the messenger line 13 is provided at the bow end of the tugboat 1. However, due to movement of the tugboat 1 relative to the water in which the tugboat 1 sits, the messenger line 13 has been drawn by the water from the centre of the bow along the starboard side of the tugboat 1 towards the stern.

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[0052] The second end of the messenger line 13 comprises a buoyant element to aid floating of the second end of the messenger line 13 and a portion of the messenger line 13 is coloured so as to be highly visible. This portion of the messenger line 13 extends for a certain distance (e.g. approximately one metre) from the second end of the messenger line 13. This highly visible
20 portion of the messenger line 13 may help a member of the crew of the tugboat 1 to identify the position of the messenger line 13, and particularly whether the messenger line 13 is correctly stowed when out of use. In some examples, the buoyant element and/or the highly visible portion of the messenger line 13 may be omitted.

25 [0053] In Figure 1, an intermediate portion of the messenger line 13 is shown to be extending through a bitt or other guide 14 on the deck 12. The bitt or guide 14 helps to guide the messenger line 13, and the tow lines 15 from the line stores 16, in use, and may further be used for attaching one or both of the tow lines 15 securely to the tugboat 1.

30 [0054] The tugboat 1 also has a line handling system 10. The line handling system 10 comprises a line guide mechanism 100 that is movable relative to the hull 11 to an operation position, as shown in Figure 2. At the operation position, the line guide mechanism 100 is for guiding movement of a portion of a line of the tugboat 1 towards a predetermined region R of the perimeter P of the hull 11. In this example, the line of the tugboat 1 to be guided by the line guide mechanism
35 100 is the messenger line 13, but in other examples a line of the tugboat 1 other than the

messenger line 13 may be guided by the line guide mechanism 100. Positioning the line of the tugboat 1 in or near the predetermined region R of the perimeter P in this way may aid subsequent coupling of the line of the tugboat 1 to a line of a marine vessel to be assisted by the tugboat 1, as will be described below in more detail.

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[0055] The predetermined region R of the perimeter P is at the bow end of the hull 11 on a central axis A-A that extends in a fore and aft direction of the tugboat 11. In some examples, the predetermined region R of the perimeter P is, for example, at the stern of the tugboat 1 or on the port or starboard side of the tugboat 1. In some examples, the line handling system 10 is movable, such as rotatable e.g. about an axis that passes through the hull 11, relative to the hull 11 so as to vary the predetermined region R of the perimeter P towards which the line guide mechanism 100 is able to guide the line of the tugboat 1. Such an axis may pass through the deck 12. The axis may be substantially parallel to a yaw axis of the tugboat 1. The line handling system 100 may be moveable in this way while the tugboat 1 moves relative to the marine vessel to be assisted by the tugboat 1. This movability of the line handling system may be useful for enabling the line handling system 10 to guide the line of the tugboat 1 towards a particular part of the perimeter P that will facilitate subsequent coupling of the line of the tugboat 1 to the line of the marine vessel. The part of the perimeter P may, for example, be the part of the perimeter P that is closest to the marine vessel.

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[0056] In Figure 1, the line guide mechanism 100 is shown at a stowed position. At the stowed position, the line guide mechanism 100 is located within the perimeter P of the hull 11. More specifically, at the stowed position, the line guide mechanism 100 is located on or adjacent the deck 12 and below a working surface of the edge of the hull 11. The line guide mechanism 100 is substantially parallel to the deck 12 when at the stowed position. Accordingly, the line guide mechanism 100 is less likely to get in the way of crew members and operation of equipment on the tugboat 1. Moreover, the line guide mechanism 100 is unlikely to interrupt the movement of lines, such as the tow lines 15, along the working surface. In other examples, at the stowed position, the line guide mechanism 100 may be located elsewhere, such as on or above an upper edge of the hull 11, or outside of the perimeter P of the hull 11.

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[0057] The line guide mechanism 100 comprises first and second guide devices 110, 120 and an intermediate portion 130 between the first and second guide devices 110, 120. The first guide device 110 is located on the port side and the second guide device 120 is located on the starboard side. In some examples, the first and second guide devices 110, 120 are arranged otherwise,

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such as both on the port or starboard side. In some examples, one or other of the first and second guide devices 110, 120 may be omitted, so that the line guide mechanism 100 comprises only one guide device 110, 120.

5 [0058] The first guide device 110 comprises a first guide arm 111, and the second guide device 120 comprises a second guide arm 121. Each of the first and second guide arms 111, 121 has a distal end 111d, 121d that is distal from the intermediate portion 130, an opposite proximate end that is adjacent the intermediate portion 130, and each of the first and second guide arms 111, 121 is curved so as to bow outwards away from the other of the first and second guide arms 111, 121 between the proximate and distal ends.

[0059] The line guide mechanism 100 is movable relative to the hull 11 between the stowed position of Figure 1 and the operation position of Figure 2. More specifically, the line guide mechanism 100 is rotatable between the stowed and operation positions about an axis B-B that is substantially parallel to the deck 12. The axis B-B about which the line guide mechanism 100 is rotatable between the stowed and operation positions is substantially parallel to a width of the tugboat 1. The line guide mechanism 100 comprises an electric motor 140 for driving movement of the line guide mechanism 100 to and from the operation position relative to the hull 11, and a user operable controller 19 for controlling the driver 140.

20 [0060] The user operable controller 19 is in the wheelhouse 18 of the tugboat 1. The user operable controller 19 comprises an input device for a user to input commands to the controller 19, such as button(s), dial(s), joystick(s) or a touchscreen. In some examples, the line guide mechanism 100 is manually moveable to and from the operation position, such as between the stowed and operation positions. Although the user operable controller 19 is in the wheelhouse 18 in Figure 1, in some examples the user operable controller 19 is provided elsewhere, such as on the deck 12.

30 [0061] When the line guide mechanism 100 is at the operation position of Figure 2, the first and second guide arms 111, 121 protrude upwards away from the hull and are configured so that, in use, a part of a line of the tugboat 1 overlying either one of the guide arms 111, 121 is encouraged to move along the guide arm 111, 121 that the line overlies and away from the distal end 111d, 121d of the guide arm 111, 121 towards the predetermined region R of the perimeter P. This encouragement of movement may be due to the action of a gravitational force on the line and/or

due to a portion of the line lying in the water in which the tugboat 1 sits and being pulled by the water so as to create a force that draws the line downward.

[0062] The configuration of the first and second guide arms 111, 121 that encourages this movement comprises the geometry and surface properties of the first and second guide arms 111, 121, and the positioning of the first and second guide arms 111, 121 relative to the hull 11. More specifically, the first and second guide arms 111, 121 are shaped so as to avoid or reduce hinderance to movement of lines along them. Moreover, each of the first and second guide arms 111, 121 is smooth, to facilitate sliding, rolling or other movement of lines along them. Indeed, all surfaces along which the lines may move are smoothly curved and free from sharp or pointed features, so as to avoid the lines catching. Furthermore, the first and second guide arms 111, 121 are aligned relative to the hull 11 so that movement of a part of a line along either of the first and second guide arms 111, 121 is movement towards the predetermined region R of the perimeter P. In other embodiments, the first and second guide arms 111, 121 may have any or all of these characteristics, and/or may have other characteristics that help to encourage this line movement towards the predetermined region R of the perimeter P.

[0063] As mentioned above, the second end of the messenger line 13 is shown in Figure 1 as hanging or draping over the perimeter P of the hull 11. The alignment of the messenger line 13 is such that part of the messenger line 13 overlies the second guide arm 121 when the line guide mechanism 100 is at the stowed position. Accordingly, as the line guide mechanism 100 moves relative to the hull 11 between the stowed position of Figure 1 and the operation position of Figure 2, the part of the messenger line 13 overlying the second guide arm 121 is lifted away from the hull 11. As the second guide arm 121 becomes increasingly normal or perpendicular to the deck as the operation position is approached, the part of the messenger line 13 experiences an increasing force in the direction generally towards the hull 11 and the water in which the tugboat 1 sits. When the line guide mechanism 100 reaches the operation position of Figure 2, the part of the messenger line 13 slides, rolls or otherwise moves along the second guide arm 121 towards the predetermined region R of the perimeter P, if it has not already done so during the movement of the line guide mechanism 100, as indicated by the arrow in Figure 2. The messenger line 13 thus falls or otherwise moves into the predetermined region R of the perimeter P.

[0064] It will be noted that respective secondary guides 112, 122 of the first and second guide devices 110, 120, which will be described in more detail below, overlay the first and second guide arms 111, 121 when the line guide mechanism 100 is at the stowed position. This may help to

make the line guide mechanism 100 relatively compact when in the stowed position, and to avoid the secondary guides 112, 122 otherwise contacting or interfering with the rim of the hull 11 during movement of the line guide mechanism 100 between the stowed and operation positions. The secondary guides 112, 122 are moved relative to the first and second guide arms 111, 121 of the
5 respective guide devices 110, 120 before or after the line guide mechanism 100 has reached the operation position, so as to reduce the chance of movement of the line (in this embodiment, the messenger line 13) along one or other of the first and second guide arms 111, 121 being blocked by the secondary guides 112, 122.

10 **[0065]** Each of the first and second guide arms 111, 121 are rotatable relative to the hull 11 about a respective pivot point 111p, 121p. Such rotation moves the respective distal ends 111d, 121d of the guide arms 111, 121 distal to the pivot points 111p, 121p towards and away from the central axis A-A that extends in a fore and aft direction of the tugboat 1.

15 **[0066]** The first and second guide arms 111, 121 are movable towards and away from each other. More specifically, the first and second guide arms 111, 121 are rotatable relative to the hull 11 about the respective pivot points 111p, 121p, so as to move the distal ends 111d, 121d of the guide arms 111, 121 towards and away from each other. The ability of the first and second guide
20 arms 111, 121 to move in this way may provide several benefits, such as helping to make the line guide mechanism 100 relatively compact when in the stowed position, permitting the angle of inclination of the guide arms 111, 121 to be adjusted to control the rate at which the line of the tugboat 1 moves along one or other of the guide arms 111, 121 when the line guide mechanism 100 is at the operation position, and aiding the capture of a line of the marine vessel to be assisted when the line guide mechanism 100 is at a deployed position, as will be discussed below.

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[0067] When the line guide mechanism 100 is at the operation position, the first and second guide arms 111, 121 and the intermediate portion 130 of the line guide mechanism 100 together substantially define a U-shape. The line guide mechanism 100 is movable relative to the hull 11 between the operation position and a deployed position. Figures 3 and 4 respectively show a
30 schematic front view and a partial schematic top view of the tugboat 1 of Figures 1 and 2, but when the line guide mechanism 100 is at the deployed position. When the line guide mechanism 100 is at the deployed position, the line guide mechanism 100 protrudes away from the hull 11 for guiding a line of a marine vessel towards the predetermined region R of the perimeter P of the hull 11. The marine vessel could be a vessel the tugboat 1 is to assist to manoeuvre. More
35 specifically, when the line guide mechanism 100 is at the deployed position, the line guide

mechanism 100 protrudes away from the perimeter P of the hull 11 and over the water in which the tugboat 1 sits. Positioning the line of the marine vessel in or near the predetermined region R of the perimeter P in this way may aid subsequent coupling of the line of the tugboat 1 to the line of the marine vessel, as will be described below in more detail.

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[0068] Since the line guide mechanism 100 is for guiding the line of the marine vessel towards the predetermined region R of the perimeter P, it is possible for the line (such as a heaving line) of the marine vessel to be thrown towards the line guide mechanism 100, rather than towards the deck 12 of the tugboat 1 or a crew member standing on the deck 12. Accordingly, crew members
10 on the tugboat 1 may be less likely to be injured, and the tugboat 1 itself may be less likely to be damaged, by lines thrown from the marine vessel. Moreover, as the line guide mechanism 100 spans a relatively large distance, this may provide an easier “target” for the line of the marine vessel to hit when thrown from the marine vessel.

[0069] The line handling system 10 is rotatable, e.g. about an axis that passes through the hull 11, relative to the hull 11 so as to vary the predetermined region R of the perimeter P towards which the line guide mechanism 100 is able to guide the line of the marine vessel. Such an axis may pass through the deck 12 and may be substantially parallel to a yaw axis of the tugboat 1. This movability of the line handling system 10 may facilitate successful throwing of the line of the
20 marine vessel to the tugboat 1, since the visible “target” defined by the line guide mechanism 100, and more specifically by the guide arms 111, 121, may be positioned to face the marine vessel. The line handling system 100 may be moveable in this way while the tugboat 1 and the marine vessel move relative to each other, so that the “target” remains the same from the perspective of the marine vessel irrespective of the position of the tugboat 1 relative to the marine vessel.

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[0070] The line guide mechanism 100 is movable relative to the hull 11 between the deployed and stowed positions shown in Figures 4 and 1, respectively. The line guide mechanism 100 does not protrude away from the hull 11 when at the stowed position in this embodiment, as described above. However, in other examples, the line guide mechanism 100 may protrude away
30 from the hull 11 when at the stowed position, but optionally to a lesser extent than when the line guide mechanism 100 is at the deployed position.

[0071] As discussed above, the line guide mechanism 100 comprises first and second guide devices 110, 120, each of which comprises a respective one of the guide arms 111, 121. The
35 guide arms 111, 121 protrude away from the hull 11 when the line guide mechanism 100 is at the

deployed position. Furthermore, as also discussed above, each of the first and second guide arms 111, 121 are rotatable relative to the hull 11 about the respective pivot points 111p, 121p, so as to move the respective distal ends 111d, 121d of the guide arms 111, 121 towards and away from each other. When the line guide mechanism 100 is at the deployed position, the pivot points 111p, 121p are located inwardly of the perimeter P of the hull 11. In some examples, the pivot points 111p, 121p may be located on or outwardly of the perimeter P of the hull 11. The line (such as a heaving line) of the marine vessel is intended to be received between the first and second guide arms 111, 121. Moving the distal ends 111d, 121d away from each other increases the width of an area the guide arms 111, 121 are able to sweep during movement of the tugboat 1. In turn, this increases the area into which the line of the marine vessel may be thrown, while still subsequently being guidable by the line guide mechanism 100 towards the predetermined region R of the perimeter P of the hull 11.

[0072] The first and second guide arms 111, 121 are movable independently of each other relative to the hull 11. However, in some examples, the first and second guide arms 111, 121 are movable dependently on each other relative to the hull 11. As indicated in Figure 1, the line guide mechanism 100 comprises a drive mechanism 142 for driving movement of the first and second guide arms 111, 121 relative to the hull 11, and a user operable controller for controlling the drive mechanism 142. The drive mechanism 142 comprises an electric motor, but in some examples may take any suitable form, such as one or more electric or other motors, optionally with a drivetrain or gearbox between the motor(s) and the first and second guide arms 111, 121.

[0073] In Figures 3 and 4, and as compared to the arrangement shown in Figure 2, it can be seen that the first and second guide arms 111, 121 have been moved relative to the hull 11 so that the distal ends 111d, 121d of the guide arms 111, 121 are splayed further apart. Indeed, the distal ends 111d, 121d are spaced apart by a distance greater than the beam (i.e. the maximum width) of the tugboat 1.

[0074] In Figure 5, the tugboat 1 of Figures 3 and 4 is now adjacent a marine vessel 2 to be manoeuvred by the tugboat 1. The marine vessel may, for example, be a container ship. Moreover, a portion of a line 20 of the marine vessel 2 (e.g. a heaving line 20), has been thrown from a position on the marine vessel 2 astern of the first guide arm 111 of the line guide mechanism 100, and is draped over the first guide arm 111 of the line guide mechanism 100. The heaving line 20 may, for example, have a diameter of 12 millimetres. Once the heaving line 20 of the marine vessel 2 is draped over the first guide arm 111 of the line guide mechanism 100

in this way, the heaving line 20 is thereafter able to be guided towards the predetermined region R of the perimeter P of the hull 11 by the line guide mechanism 100.

[0075] More specifically, and with reference to Figure 6, the first guide arm 111 over which the heaving line 20 of the marine vessel 2 is draped has been rotated relative to the hull 11, so that the distal end 111d of the first guide arm 111 moves closer to the central axis A-A that extends in the fore and aft direction of the tugboat 1. This has the effect of drawing the heaving line 20 closer to the predetermined region R of the perimeter P of the hull 11.

[0076] The heaving line 20 is then guided still closer to the predetermined region R of the perimeter P of the hull 11 by the secondary guides 112, 122 of the line guide mechanism 100, which were briefly discussed above. Each of the guide devices 110, 120 of the line guide mechanism 100 comprises a respective one of the secondary guides 112, 122. The first secondary guide 112 is movable relative to the first guide arm 111 for driving a line along the first guide arm 111 towards the predetermined region R of the perimeter P. Similarly, the second secondary guide 122 is movable relative to the second guide arm 121 for driving a line along the second guide arm 121 towards the predetermined region R of the perimeter P. Still further, the movement of the secondary guides 112, 122 of the first and second guide devices 110, 120 relative to the hull 11 comprises movement of the secondary guides 112, 122 towards each other.

[0077] The secondary guides 112, 122 are rotatable relative to the guide arms 111, 121, but in other embodiments the movement of the secondary guides 112, 122 relative to the guide arms 111, 121 may be other than rotations, such as translations or a combination of rotations and translations. The rotations of the secondary guides 112, 122 are about the same respective axes as the rotations of the guide arms 111, 121 relative to the hull 11. That is, the secondary guides 112, 122 are rotatable about the same pivot points 111p, 121p as the first and second guide arms 111, 121.

[0078] The first and second secondary guides 112, 122 are movable independently of each other relative to the hull 11 and the respective guide arms 111, 121. As indicated in Figure 1, the line guide mechanism 100 comprises a drive device 144 for driving movement of the first and second secondary guides 112, 122 relative to the hull 11 and the respective guide arms 111, 121, and a user operable controller for controlling the drive device 144. The drive device 144 comprises an electric motor, but in some examples may take any suitable form, such as one or more electric or

other motors, optionally with a drivetrain or gearbox between the motor(s) and the first and second secondary guides 112, 122.

5 [0079] The first guide arm 111 comprises an indicator or marker M that is located part way along the first guide arm 111. The indicator or marker M indicates a position or region on the first guide arm 111. More specifically, the indicator or marker M indicates a position or region on the first guide arm 111 at which the line 20 of the marine vessel 2 should be located before the first secondary guide 112 is moved to drive the line 20 along the first guide arm 111 towards the predetermined region R of the perimeter P. The region may be that between the indicator or marker M and the pivot point 111p of the first guide arm 111. A crew member is able to visually monitor the position or progress of the line 20 relative to the indicator or marker M. When they note that the line 20 is at the position or region on the first guide arm 111 indicated by the indicator or marker M, they cause movement of the first secondary guide 112 to drive the line 20 along the first guide arm 111 towards the predetermined region R of the perimeter P. This causation may be due to the crew member's operation of the user operable controller for controlling the drive device 144, or due to the crew member's manual movement of the first secondary guide 112. Accordingly, the indicator or marker M helps to ensure that the line 20 is correctly positioned on the first guide arm 111 for successful subsequent driving of the line 20 along the first guide arm 111 by the first secondary guide 112. The second guide arm 121 also comprises such an indicator or marker M that is located part way along the second guide arm 121 for indicating a position or region of the second guide arm 121 at which a line of a marine vessel should be located before the second secondary guide 122 is moved to drive the line along the second guide arm 121 towards the predetermined region R of the perimeter P.

25 [0080] With reference to Figure 7, both of the secondary guides 112, 122 have been rotated relative to the hull 11 and the first guide arm 111, as compared to the situation shown in Figure 6. This has the effect of bringing the first secondary guide 112 into contact with the heaving line 20 of the marine vessel 2, and then driving the heaving line 20 along the first guide arm 111 and closer towards the predetermined region R of the perimeter P of the hull 11.

30 [0081] With reference to Figure 8, both of the secondary guides 112, 122 have been further rotated relative to the hull 11 and the first guide arm 111, as compared to the situation shown in Figure 7. This has the effect of lifting the heaving line 20 of the marine vessel 2 from the first guide arm 111 and carrying the heaving line 20 further towards the predetermined region R of the perimeter P of the hull 11.

[0082] It will be noted from Figures 7 and 8 that, during movement of the respective secondary guides 112, 122 relative to the hull 11, the secondary guides 112, 122 cross over each other at a cross over point C that moves along both of the secondary guides 112, 122. This crossing over means that the secondary guides 112, 122 and the hull 11 together surround the space within which the heaving line 20 and the messenger line 13 are located. This helps to retain the heaving line 20 and the messenger line 13 relative to the line guide mechanism 100. Furthermore, each of the secondary guides 112, 122 has a parabolic shape. This may help to avoid the cross over point C forming a sharp angle and reduces the risk of the secondary guides 112, 122 trapping or pinching the heaving line 20 at the cross over point C.

[0083] As shown in Figure 8, both the messenger line 13 of the tugboat 1 and the heaving line 20 of the marine vessel 2 are located in the predetermined region R of the perimeter P of the hull 11. Furthermore, the two lines 13, 20 are in the space surrounded by the secondary guides 112, 122 and the hull 11. The two lines 13, 20 are now to be coupled by the coupler 200 of the line handling system 10.

[0084] Figure 9 shows a schematic isometric view of the coupler 200 for coupling the heaving line 20 (i.e. the marine vessel line) and the messenger line 13 (i.e. the tugboat line). The coupler 200 is actuatable to couple together the lines 13, 20 by applying a connector 210 to the lines 13, 20. The coupler 200 is selectively actuatable by a user, such as from the user operable controller 19, to apply the connector 210 to the lines 13, 20 to couple together the lines 13, 20. In some examples, the coupler 200 is actuatable only following receipt of a confirmation signal from another device. The coupler 200 may only be actuatable after information indicative of the secondary guides 112, 122 being in the position shown in Figure 8 (where the secondary guides 112, 122 are fully crossed over each other) is received. This may help to ensure that the lines 13, 20 are in the correct position before the actuator 200 is actuated. In some examples, the coupler 200 comprises a sensor (e.g. a proximity sensor) to detect the presence of the lines 13, 20.

[0085] The coupler 200 comprises a coupling zone 201 for receiving the lines 13, 20 (not shown in Figure 9) and a guide 202 configured to receive the connector and guide the connector around the coupling zone 201 to wrap the connector around the lines 13, 20. The connector 210 is a length of wire (shown in Figure 14), although other forms of connector are envisaged, such as a clip or a strap. The coupler 200 comprises a supply 203 of wire and is configured to cut the connector 210 from the supply 203. The supply 203 comprises a spindle 213 on which the wire

is wound. The wire has a diameter of between 0.5 and 3 millimetres. The wire typically has a diameter of between 0.5 and 2 millimetres, e.g. 0.8 millimetres. The supply 203 holds 100 metres of wire from which successive connectors 210 can be cut. In some examples, the supply 203 comprises 1 metre, 5 metres, 10 metres, 25 metres or 50 metres of wire from which successive
5 connectors 210 can be cut. The spindle 213 is removeable from the coupler 200 to allow for the supply 203 to be replenished. For example, a new length of wire may be wrapped around the spindle 203 or the spindle 203 may be replaced with a new spindle 203 which is pre-wrapped with wire.

10 **[0086]** The coupler 200 comprises three electric motors 220, 221, 222 to drive the coupler 200. A first motor 220 drives a feed mechanism 208 (not visible in Figures 9 and 10) which feeds the connector 210 toward the guide 202. A second motor 221 drives a securing member 209 which is configured to secure the connector 210 to the lines 13, 20. A third motor 222 drives the first portion 205 of the housing 204 to cause the first portion 205 to move relative to the second portion
15 206. Although three motors 220, 221, 222 are shown in Figures 9 and 10, a greater or lesser number of motors 220, 221, 222 may be used. Moreover, although the first, second and third motors 220, 221, 222 are electric motors in Figures 9 and 10, the motors 220, 221, 222 may comprise other types of motor. For example, the motors may be hydraulic or pneumatic motors or a mixture of electric, hydraulic or pneumatic motors.

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[0087] The coupler 200 comprises a housing 204 comprising a first section 205 and a second section 206. The coupling zone 201 is defined between the first section 205 and the second section 206 which has a substantially circular cross-sectional shape. The diameter of the coupling zone 201 is at least equal to the combined diameters of the lines 13, 20 to enable the lines to be
25 fully received in the coupling zone 201. The diameter of the coupling zone 201 is around 100 millimetres. In some examples, the coupling zone 201 may comprise a different cross-sectional shape, e.g. an elongate oval. The first portion 205 of the housing 204 is hingedly attached to the second portion 206 of the housing at a pivot point 231. This allows the first portion 205 to rotate relative to the second portion 206 about the pivot point 231 between a first configuration and a
30 second configuration. In the first configuration (as shown in Figure 9) the housing 204 restricts movement of the lines 13, 20 in a first axis (indicated by arrow Y) and a second axis (indicated by arrow Z) which are orthogonal to each other, but not in a third axis (indicated by arrow X) which is orthogonal to both the first axis Y and the second axis Z. In the first configuration, movement of the lines 13, 20 into and/or out of the coupling zone 201 is restricted in the first axis Y and the
35 second axis Z. For example, if the lines 13, 20 are in the coupling zone 201, when the coupler

200 is in the first configuration, the lines 13, 20 are prevented from being lifted out of the coupling zone 201 along the second axis Z. In the second configuration (as shown in Figure 10), the housing 204 restricts movement of the lines 13, 20 in the first axis Y but not in the second axis Z and the third axis X. Therefore, in the second configuration, the lines 13, 20 may be freely placed
5 in and/or removed from the coupling zone 201 along the second axis Z and/or the third axis X. In this way, when the coupler 200 is in the first configuration the lines 13, 20 may be held in place while the connector 210 is secured to the lines. Once the connector 210 has been secured to the lines 13, 20, the coupler 200 is placed in the second configuration to allow the coupled lines 13, 20 to be removed from the coupling zone 201 and allow additional lines to be received by the
10 coupling zone 201 to be subsequently coupled together.

[0088] Figure 11 shows a schematic cross-sectional view of the coupler 200 of Figures 9 and 10. The coupler 200 is switchable between the first configuration and the second configuration through the actuation of the third motor 222. The first portion 205 comprises a toothed section
15 232 which is fixed to the first portion 205 such that movement of the toothed section 232 causes the first portion 205 to rotate about the pivot point 231. The third motor 222 is connected to a worm gear 233 such that actuation of the third motor 222 causes rotation of the worm gear 233. The worm gear 233 engages with the toothed section 232 such that rotation of the worm gear 233 causes the toothed section, and therefore the first portion 205, to rotate about the pivot point 231.
20 To switch the coupler 200 from the first configuration to the second configuration, the third motor 222 is actuated to rotate the worm gear 233 in a first direction and cause the toothed section 232 and first portion 205 to rotate 90 degrees clockwise (from the view of Figure 11) around the pivot point 231. The third motor 222 comprises an encoder 234 which provides information indicative of a position of a rotor of the third motor 222. This information may then be used to determine
25 how far the first portion 205 has rotated about the pivot point 231. In some examples, the first portion may rotate by more or less than 90 degrees so long as the lines 13, 20 are able to be received and/or removed from the coupling zone 201. To switch the coupler 200 from the second configuration back to the first configuration, the third motor 222 is actuatable to rotate the worm gear in a second direction opposite to the first direction. This causes the toothed section 232 to rotate the first portion 90 degree anticlockwise so as to close the coupling zone 201 and arrive at
30 the first configuration.

[0089] The guide 202 comprises a channel 207 formed in the first and second portions 205, 206 of the housing 204. The channel 207 extends around the entire circumference of the coupling zone 201 and is configured to guide the connector 210 around the coupling zone 201 so as to
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entirely encircle the lines 13, 20 disposed in the coupling zone 201. The depth of the channel 207 is at least equal to the outer diameter of the connector 210. As such, the connector 210 may be fully encompassed by the channel 207 such that no part of the connector 210 extends into the coupling zone 201. This may help to prevent the connector from interfering with the lines 13, 20, and, for example, becoming stuck on the lines 13, 20. Although the channel 207 extends around the entire circumference of the coupling zone 201 in the present example, in some examples the channel 207 extends around a lesser proportion of the circumference, for example 75% of the circumference or 50% of the circumference. An inner surface of the channel 207 is configured to be substantially smooth and/or free of rough edges to help to facilitate movement of the connector through the channel 207. This may help to reduce the likelihood of the connector becoming stuck in the channel 207 as it passes through the channel 207.

[0090] The coupler 200 comprises the securing member 209 which is configured to secure the connector 210 to the lines 13, 20 such that the lines 13, 20 are coupled together. The securing member 209 is shown in more detail in Figures 12 to 14. The securing member 209 comprises a pair of protrusions 214, 215 with a valley 216 between the protrusions. The connector 210 is configured to pass between the protrusions 214, 215 and through the valley 216 as the connector 210 is fed around the coupling zone 201. Figure 14 shows a schematic top view of the securing member 209. The valley 216 is defined by a pair of non-parallel walls 238, 239 leading to a pair of parallel walls 240, 241. A width between the pair of protrusions 214, 216 is larger at a first side 242 of the securing member 209 than at a second side 243 of the securing member 209. As such, the valley 216 is wider on the first side 242 of the securing member 209 than on the second side 243 of the securing member 209. This may help to direct the connector 210 between the pair of protrusions 214, 215 and may help to account for the valley 216 and/or the securing member 209 not being exactly aligned with the feed mechanism 208 when a new connector 210 is provided.

[0091] The securing member 209 is configured to secure the connector 210 to the lines 13, 20 by twisting together free ends 211, 212 of the connector 210 after wrapping the connector 210 around the lines 13, 20. In use, the free ends 211, 212 of the connector 210 are positioned within the valley 216 between the protrusions 214, 215 of the securing member 209. To twist together the free ends 211, 212 of the connector 210, the second motor 221 is actuated to cause the securing member 209 to be rotated about a rotational axis D. The protrusions 214, 215 engage with the free ends 211, 212 of the connector 210 which causes the free ends 211, 212 to be

twisted together. The final arrangement of the connector 210 coupling the messenger line 13 and the heaving line 20 in accordance with this example is shown in Figure 15.

[0092] The coupler 200 is configured to wrap the connector 210 around the lines 13, 20 when the
5 coupler 200 is actuated. The wrapping of the connector 210 around the lines 13, 20 involves causing the connector 210 to encircle the bundle of the lines 13, 20 following the direction indicated by arrow H. The connector 210 is directed toward the securing member 209 by a feed mechanism 208, as shown in Figure 11. The feed mechanism 208 comprises a pair of rotatable wheels 217, 218 between which the connector 210 is fed. The wheels 217, 218 are driven by the
10 first motor 220 and engage with the connector 210 through friction to move the connector 210 toward the securing member 209. After the connector 210 passes between the wheels 217, 218, the connector 210 is fed through a tube 219 which may help to direct the connector 210 toward the securing member 209. The first motor 220 which drives the feed mechanism 208 comprises an encoder (not shown in Figures 9 or 10) which provides information indicative of a position of a
15 part of the first motor 220 (e.g. a rotor of the first motor 220) which can be used to determine the number of times the rotor (or other part of the first motor 220) has rotated. This information can then be used to determine the length of the wire supplied by the feed mechanism 208 which can also be used to determine how much wire remains on the supply 203. This information may be used to determine when the supply 203 need to be replaced and/or replenished which may help
20 to avoid the coupler 200 running out of wire for the connector 210.

[0093] The securing member 209 comprises a bending surface 223 which is configured to bend the connector 210 prior to the connector 210 being received by the guide 202. In use, the connector 210 is directed towards the bending surface 223 by the feed mechanism 208. The
25 bending surface 223 is located at an angle relative to the direction of travel of the connector 210 such that, when the connector 210 impacts the bending surface 223, the connector 210 is diverted in a direction obliquely angled relative to the initial direction of travel of the connector 210. The bending surface 223 has an angle of between 130° and 140°, e.g. 135°, relative to the direction of travel of the connector 210. After impacting the bending surface 223, the connector 210 passes
30 through the valley 216 between the protrusions 214, 215 of the securing member 209. As the securing member 209, and therefore the bending surface 223, is upstream of the guide 202, the connector 210 is bent prior to being received by the guide 202. The connector is bent into the form of an arc with a diameter greater than the combined diameter of the lines 13, 20 so as to help to cause the connector to wrap around the lines 13, 20. The diameter of the arc is directly
35 related to the angle of the bending surface 223. As such, depending on the thickness and/or type

of connector used, the angle of the bending surface 223 may be adjusted to provide the desired diameter of the arc.

[0094] As shown in Figures 12 and 13, the securing member 209 comprises a cylindrical cam 224. The cylindrical cam comprises a groove 235 in which a projection 225 of the coupler is received. As the cylindrical cam rotates, the projection 225 remains fixed relative to the housing such that the securing member translates relative to the projection 225 along a rotational axis D (as illustrated by arrow T) as the securing member 209 rotates (as illustrated by arrow S) about the rotational axis D. Due to the oscillating shape of groove 235 of the cylindrical cam 224, as the securing member 209 rotates about the rotational axis D, the cylindrical cam 224 causes the securing member 209 to reciprocate along the rotational axis D. The securing member 209 also comprises a cutting member in the form of a lip 226 around the periphery of the securing member 209. As the securing member 209 rotates about and translates/reciprocates along the rotational axis D, the lip 226 contacts the connector 210 and acts to cut the connector 210 from the supply 203. In this way, the securing member 209 may cut the connector 210 from the supply at the same time as twisting together the free ends 211, 212 of the connector 210 to secure the connector to the lines 13, 20. The lip 226 comprises a hardened material that is harder than the connector 210. This may help to reduce the likelihood of the lip 226 being damaged when cutting the connector 210 from the supply 203.

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[0095] Referring back to Figure 11, the securing member 209 is connected to the second motor 221 via a pair of gears 227, 228. A first gear 227 is connected to the second motor 221 and a second gear 228 is connected to the securing member 209. The first gear 227 meshes with the second gear 228 to transfer rotation from the second motor 221 to the securing member 209. A ratio between the sizes (e.g. the number of teeth) of the first and second gears 227, 228 is selected to step down the rate of rotation from the second motor 221 which is provided to the securing member 209. In Figure 11, the second gear 228 comprises twice the number of teeth as the first gear 227, such that there is a 1:2 ratio between the first gear 227 and the second gear 228. This means that for each rotation of a rotor of the second motor 221, the securing member will rotate 180 degrees (i.e. half a rotation). The second motor 221 further comprises an encoder 229 which is used to determine the number of times the rotor of the second motor 221 rotates. This may allow the number of times that the securing member 209 has rotated to be determined. This information may then be used to determine whether the free ends 211, 212 of the connector have been sufficiently twisted and/or whether the securing member 209 is in the correct position to receive a connector 210 from the feed mechanism 208. To secure the lines 13, 20 together, the

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securing member 209 is configured to rotate at least ten times. Therefore, when the encoder 229 detects that the rotor of the second motor 221 has rotated twenty times, this is indicative of the securing member 209 having rotating 10 times. The securing member 209 is then stopped from rotating further while the lines 13, 20 are still in the coupling zone 201. In some examples, the
5 securing member 209 may be configured to rotate greater or fewer than ten times to secure the lines 13, 20 together. For example, the securing member 209 may be configured to rotate at least two times, at least five times or at least 15 times to secure the lines 13, 20 together.

[0096] As indicated by arrow S in Figure 12, the securing member 209 is configured to rotate in
10 a first direction when twisting together the free ends 211, 212 of the connector 210 to secure the lines 13, 20 together. Once the lines 13, 20 have been secured by the connector 210, the lines 13, 20 are removed from the coupling zone 201 and the securing member 209 is rotated in a second direction opposite to the first direction. The securing member 209 is rotate in the second direction an equal number of times as the securing member 209 was rotates in the first direction.
15 This helps to ensure that the securing member 209 is reset and in the correct position to receive a connector when further lines are to be coupled together.

[0097] Figure 16 shows an isometric partial cross-sectional view of the coupler 200 of Figures 9 to 11. As shown in Figure 15 (as well as in Figure 11), the coupler 200 comprises a roller 230
20 which is arranged along the channel 207 of the guide 202. The roller 230 rotates in the same direction as the first wheel 217 (i.e. in the opposite direction to the second wheel 218) and is configured to direct the connector 210 along the channel. As the connector 210 passes along the channel 207, it engages with the roller 230 through friction. As the roller 230 rotates, the connector 210 engaged with the roller 230 is urge further along the channel by the roller 230. The
25 roller 230 extends into the channel 207 by an amount sufficient to ensure that the connector 210 engages with the roller 230, but not too large so as to block or inhibit movement of the connector 210 through the channel 207. Moreover, the diameter of the roller 230 is such that sudden changes of profile of the channel 207 are avoided, which may help to reduce the chance of the connector 210 becoming stuck at an interface between the roller 230 and the channel 207. In the
30 example shown in Figure 15, the roller 230 has a diameter of around 28 millimetres. In some examples, the roller 230 has a diameter larger or smaller than 28 millimetres.

[0098] The roller 230 is driven by the first motor 220 which also drives the feed mechanism 208. The roller 230 is connected to the first motor 220 by a series of gears which are arranged such
35 that the roller 230 rotates at a faster rate than the first and second wheels 217, 218 of the feed

mechanism 208. This may help to encourage the connector 210 along the channel 207 and help to prevent the connector 210 becoming stuck in the channel as it gets further from the supply 203.

[0099] Figures 17 and 18 show schematic isometric and front views of the roller 230 respectively.

5 The roller 230 comprises an outer surface 236 which comprises a slot 237 in which the connector 210 is configured to be received. The width of the slot 237 is substantially equal to the width of the channel 207. In some examples, the width of the slot 237 is larger or smaller than the width of the slot. In some examples, the width of the slot 237 is substantially equal to the diameter of the connector 210. The slot 237 of the roller 230 is shaped so as to encourage the connector
10 210 to move towards the centre of the slot 237 when the connector 210 is received by the slot 237. This may help to align the connector within the channel 207 and may also help to align the connector 210 with the valley 216 of the securing member 209. In the example shown in Figures 17 and 18, the slot 237 has a depth of around 4 millimetres. In some examples, the depth of the slot 237 is larger or smaller with 4 millimetres.

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[0100] In use, the coupler 200 is placed in the second configuration (as shown in Figure 10) and the lines 13, 20 are placed in the coupling zone 201. The coupler 200 is then placed in the first configuration (as shown in Figure 9) in preparation for the connector 210 to be secured to the lines 13, 20. The first motor 220 is activated to cause the pair of wheels 217, 218 to rotate and
20 feed the connector 210 from the supply 203 toward the bending surface 223 of the securing member 209. The connector 210 passes through the tube 219 towards the bending surface 223 which is angled with respect to the direction of travel of the connector 210 through the tube 219. As the connector 210 makes contact with the bending surface 223, it is diverted in a direction obliquely angled relative to the direction of travel of the connector 210 through the tube 219. This
25 causes the connector 210 to be bent into a shape that substantially follows the periphery of the coupling zone 201. After being bent by the bending surface 223, the connector 210 passes between the protrusions 214, 215 (i.e. through the valley 216) of the securing member 209 and through the channel 207 of the guide 202. The connector 210 continues to pass through the channel 207 so as to wrap around the lines 13, 20 until the connector 210 has been wrapped
30 around the lines 13, 20 a predefined number of times (e.g. three times). Each time the connector 210 wraps around the lines 13, 20, it passes between the protrusions 214, 215 of the securing member 209 such that the free ends 211, 212 of the connector 210 (once cut from the supply 203) are located between the protrusions 214, 215. Once the connector 210 has been wrapped around the lines 13, 20 the predefined number of times, the first motor 220 is deactivated to stop
35 the feed of the connector 210 from the supply 203. The second motor 221 is then activated to

actuate the securing member 209 and cause the securing member 209 to rotate about the rotational axis D while also translating along the rotational axis D. When the securing member 209 rotates, the free ends 211, 212 of the connector 210 located between the protrusions 214, 215 are twisted together to secure the connector 210 to the lines 13, 20. At the same time, as
5 the securing member 209 translates along the rotational axis D, the lip 226 of the securing member 209 cuts the connector 210 from the supply 203. Once the securing member 209 has been rotated a predefined number of times (e.g. ten times), the second motor 221 is deactivated and the coupler 200 is placed in the second configuration to allow the coupled lines 13, 20 to be removed from the coupling zone 201.

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[0101] As shown in Figure 19, when the lines 13, 20 have been coupled together, the secondary guides 112, 122 are moved apart from each other and the guide arms 111, 121 are moved apart from each other. This releases the heaving line 20 and coupled messenger line 13 from the space surrounded by the secondary guides 112, 122 and the hull 11, so that the messenger line 13 can
15 be pulled up to the marine vessel 2 using the heaving line 20. An end of at least one of the tow lines 15 may then be pulled up to the marine vessel 2 using the messenger line 13, and an opposite end of the at least one of the tow lines 15 may be attached to the bitt or guide 14 of the tugboat 1.

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[0102] When the line guide mechanism 100 is no longer required, the line guide mechanism 100 is returned from the deployed position to the stowed position. The coupler 200 can be moved from the position shown in Figure 8 onwards, at which the coupler 200 is actuatable to apply the connector 210 to the lines 13, 20 to couple together the lines 13, 20, to the position shown in Figure 1, at which the coupler 200 is stowed. The coupler 200 moves together with the line guide
25 mechanism 100 to a stowed position within the perimeter P of the hull 11 and adjacent the deck 12. In some examples, the coupler 200 remains in position, e.g. relative to the hull 11, between uses.

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[0103] While in the above described embodiments the line handling system 10 comprises a line guide mechanism 100, in examples the line guide mechanism 100 may be omitted so that the line handling system 10 is free from a line guide mechanism.

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[0104] While in the above described examples the line guide mechanism 100 is for protruding away from the hull 11 for guiding a line of the marine vessel towards a predetermined region R of the perimeter P, in some examples the line guide mechanism 100 is not for protruding away from

the hull 11 for guiding a line of the marine vessel towards a predetermined region R of the perimeter P. For example, the line guide mechanism 100 may be immovable from the operation position relative to the hull 11.

5 [0105] While in the above described examples the line guide mechanism 100 is movable relative to the hull 11 to an operation position at which the line guide mechanism 100 is for guiding movement of a portion of a line of the tugboat towards a predetermined region of the perimeter, in some examples the line guide mechanism 100 is not movable relative to the hull 11 to an operation position at which the line guide mechanism 100 is for guiding movement of a portion of
10 a line of the tugboat towards a predetermined region of the perimeter. For example, the line guide mechanism 100 may be immovable from the deployed position relative to the hull 11.

[0106] In some examples, two or more of the above described embodiments may be combined. In some examples, features of one embodiment may be combined with features of one or more
15 other embodiments.

[0107] Figure 20 shows a flow diagram of a method 300 of coupling a marine vessel line (e.g. the messenger line 13) and a tugboat line (e.g. the heaving line 20). The method 300 may be carried out using any coupler 200 as described herein. The method 300 comprises providing 301 the
20 connector 210 and placing 302 the lines 13, 20 in the coupling zone 201 of the coupler 200. The coupler 200 comprises the guide 202 configured to receive the connector 210 and guide the connector 210 around the coupling zone 210, and the securing member 209 configured to secure the connector 210 to the lines 13, 20. The method 300 further comprises bending 303 the
25 connector 210 prior to the connector 210 being received by the guide 202, guiding 304 the connector 210 around the coupling zone 201 to wrap the connector 210 around the lines 13, 20 and securing 305 the connector 210 to the lines 13, 20 with the securing member 209 such that the lines 13, 20 are coupled.

[0108] Examples of the present invention have been discussed, with particular reference to the
30 examples illustrated. However, it will be appreciated that variations and modifications may be made without departing from the scope of the invention as defined by the appended claims.

CLAIMS:

1. A coupler for coupling a marine vessel line and a tugboat line, the coupler comprising:
a coupling zone for receiving the marine vessel line and the tugboat line;
5 a guide configured to receive a connector and guide the connector around the coupling zone to wrap the connector around the lines; and
a securing member configured to secure the connector to the lines such that the lines are coupled, wherein the securing member is upstream of the guide and is configured to bend the connector prior to the connector being received by the guide.
- 10 2. The coupler according to claim 1, wherein the guide comprises a channel to guide the connector around the coupling zone, and a roller arranged along the channel to direct the connector along the channel.
- 15 3. The coupler according to claim 2, wherein the coupling zone is defined by a housing and the channel of the guide is arranged in a surface of the housing, the housing comprising a first section and a second section, wherein the first section is moveable relative to the second section.
- 20 4. The coupler according to claim 3, wherein the coupler is operable in a first configuration in which the housing restricts movement of the lines in a first axis and a second axis which are orthogonal to each other but not in a third axis orthogonal to both the first axis and the second axis, and in a second configuration in which the housing restricts movement of the lines in the first axis but not in the second axis and the third axis
- 25 5. The coupler according to any one of claims 1 to 4, wherein the coupler is configured to wrap the connector around the lines a plurality of times.
6. The coupler according to any one of claims 1 to 5, wherein the connector comprises a length of wire.
- 30 7. The coupler according to any one of claims 1 to 6, wherein the securing member is actuatable to twist together free ends of the connector to secure the connector to the lines.
8. The coupler according to any one of claims 1 to 7, wherein the coupler comprises a feed
35 mechanism configured to feed the connector from a supply toward the securing member, and

wherein the securing member comprises a cutting element configured to cut the connector from the supply.

9. The coupler according to claim 8, wherein the cutting element comprises a lip that extends
5 around a periphery of the securing member.

10. The coupler according to claim 8 or claim 9, wherein the feed mechanism is configured to feed the connector toward the securing member at a first rate and the roller is configured to rotate at a second rate, the second rate greater than the first rate.

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11. The coupler according to any one of claims 8 to 10, wherein the securing member is actuatable to both twist together free ends of the connector to secure the connector to the lines and cut the connector from the supply.

12. The coupler according to any one of claims 8 to 11, wherein the securing member is rotatable about a rotational axis to secure the connector to the lines and is translatable along the rotational axis to move the cutting element relative to the supply to cut the connector from the supply.

13. The coupler according to claim 12, wherein the securing member comprises a cylindrical cam which is engageable with a projection of the coupler to cause the securing member to translate along the rotational axis during rotation of the securing member about the rotational axis.

14. The coupler according to any one of claims 8 to 13, wherein the securing member
25 comprises a bending surface and the securing member is alignable with the feed mechanism such that the connector is directed toward the bending surface to bend the connector.

15. The coupler according to any one of claims 1 to 14, wherein the securing member comprises a pair of protrusions between which the connector is configured to pass, wherein the pair of protrusions engage with the connector when the securing member is rotated such that the
30 connector is twisted when the securing member is rotated.

16. A line handling system for a tugboat, the line handling system comprising the coupler according to any one of claims 1 to 15.

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17. A tugboat comprising the coupler according to any one of claims 1 to 15 or the line handling system according to claim 16.

18. A method of coupling a marine vessel line and a tugboat line, the method comprising:

5 providing a connector;

placing the marine vessel line and the tugboat line in a coupling zone of a coupler, the coupler comprising a guide configured to receive the connector and guide the connector around the coupling zone, and a securing member configured to secure the connector to the lines;

bending the connector prior to the connector being received by the guide;

10 guiding the connector around the coupling zone to wrap the connector around the lines;

and

securing the connector to the lines with the securing member such that the lines are coupled.

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