

**DIVERSION OF SAILING VESSEL BY TETHERING METHOD
AND APPARATUS THEREFOR WITH HARPOON MEANS**

5 TECHNICAL FIELD

 This invention relates to a method for diverting a sailing vessel by tethering means, such as a cable, particularly an errant vessel. The method may be applied by a watercraft installed with an apparatus for securing the
10 cable to the errant vessel.

BACKGROUND ART

15 In the aftermath of the 9/11 attacks, counter-terror doctrines meant to deal with, for example, "one minute one execution" hostage situations becomes grossly inadequate to deal with zealous and suicidal subversives determined to cause the widest possible destruction of property and lives with virtually no chance for negotiations nor care to make demands.

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 Apart from airspace security, there have been heightened fears of maritime threats be it man-made or terrorist acts. For example, large vessels, ships or oil tankers may be hijacked and cruised at top speed towards targets such as harbours, seafront or offshore installations such as petrochemical

facilities, or another cruise liner full of passengers. Due to the massive size and hence the momentum of the errant ship in full steam ahead, it may not be possible to stop it in time or, even sufficiently destructive force may sink it, creates a sunken wreckage disruptive to shipping lanes.

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An option must thus be found to alter the direction of sail of the errant vessel to a safer location at sea for further appropriate action so that damage may be contained and coastal environmental damage minimised.

10 Whilst we have not found any relevant prior art, our own co-pending patent applications No. SG-200403108-4, SG-200508616-0, SG-200600202-6 and SG-200407511-5 have disclosed various methods of diverting a sailing vessel by external means but none is relevant to the present tethering method which we disclose hereinafter.

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SUMMARY OF DISCLOSURE

The general embodiment of our method comprises a method for
20 diverting a sailing vessel by tethering means comprising the steps of:

- bringing into range a harpoon means capable of piercing the hull of said vessel wherein the harpoon means comprising
 - a head having extraction-preventing means; and
 - a tail attached to a tethering element of sufficient length;

- piercing said hull with the harpoon means with the extraction-preventing means deployed, thereby preventing extraction thereof;
- tugging onto said tethering element to achieve a desired diversion.

5 In one preferred embodiment, the harpoon means may be mounted onto a watercraft to bring the harpoon means into range by approaching said vessel from an aft position. Preferably, the harpoon means head's extraction-preventing means comprises a plurality of radially unfoldable spokes that are foldable backwardly to be flush with or less than the harpoon head's diameter
10 and capable of radially unfolding to a limited degree. Upon piercing the hull of the vessel, the spokes preferably unfold and latch the head against the hull's inner surface.

 In a second preferred embodiment, the tethering element attached to
15 the harpoon means may be a cable of sufficient tensile strength. The cable may unwind to a length of up to 40 metres between the watercraft and vessel. The watercraft may then tug onto the cable to tether the vessel to a desired direction.

20 In a second aspect of our invention, a watercraft is designed for use in a method for diverting a sailing vessel by tethering means wherein at least one harpoon means is hard-mounted on at at least one of the bow, portside, starboard and stern. The harpoon means may preferably be mounted to strike in a multiple angles, in a variable angle or strike, and/or in an array.

In preferred embodiments of the watercraft, high-traction low-speed propulsion such as Voith-Schneider Propulsion means, and low-traction high-speed propulsion means such as hydrodynamic lifting elements, comprising
5 front and back hydrofoils, including propeller-mounted front hydrofoils may be installed below the hull.

In a third aspect of our invention, a harpoon capable of piercing the hull of a vessel is provided comprising a head having an extraction-preventing
10 means at a first end and attached to one end of a tethering element of sufficient length which other end is secured to a watercraft.

Preferably, the extraction-preventing means comprises a plurality of foldable spokes which are radially foldable backwards to be flush with said
15 harpoon head's diameter and capable of radially unfolding to a limited degree. Upon piercing the hull of the vessel, the harpoon means head's foldable spokes unfold and latch against the hull's inner surface.

LIST OF ACCOMPANYING DRAWINGS

The present invention will be described in detail with reference to the accompanying drawings that follows, wherein specific embodiments are
5 described as non-limiting examples or illustrations of the workings of the invention, in which:

- FIGURE 1 shows a perspective view of a watercraft having a preferred embodiment of full capabilities envisaged in our present invention;
- 10 FIGURE 2 shows a side view of the watercraft of FIG. 1;
FIGURE 3 shows a top view of the watercraft of FIG. 1;
FIGURE 4 shows a front or bow view of the watercraft of FIG. 1;
FIGURE 5 shows in perspective view a watercraft approaching a vessel to be diverted from an aft position;
- 15 FIGURE 6 shows in side view the situation of FIG. 5;
FIGURE 7 shows in front or bow view the watercraft within harpoon range to the vessel to be diverted;
- FIGURE 8 shows in plan view the vessel being engaged by the watercraft according to the method of the present invention;
- 20 FIGURE 9 shows in perspective view the situation of FIG. 8; and
FIGURE 10 shows in side view the harpoon piercing the vessel's hull in sequence of FIG. 10(a), FIG. 10(b) and FIG. 10(c).

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

The watercraft proposed for implementing our method of diverting a sailing vessel may be schematically shown in various views in FIGURES 1 to 4 which are being referred to collectively. The apparatus of our proposed watercraft (10) which is key to executing our method is the harpoon means (12a, 12b, 12c) which may be provided as a single harpoon with multiple angles of launch. Alternatively, it may be provided with variable angle of strike or as multiple units of harpoons arranged in multiple directions or angles of launch or in an array.

Each of the harpoons may preferably be hard-mounted on the watercraft (10). One or more of the harpoons (12a, 12b, 12c) may be provided on the bow, portside, starboard and/or stern. A key feature of the harpoon is that the tail end of the harpoon is attached to a tethering means which may be a rope or cable of sufficient tensile strength and length. The cable may be coiled in a reel (14) or bobbin for fast unwinding upon the launch or firing of the harpoon.

To assist the tugging, winding and unwinding of the cable, a towing cable reel installation, such as that disclosed in US Patent No. 6,698,374, having a 360° turning to steer and guide the cable attached to a large shipping vessel would be useful.

The propulsion of the watercraft is preferably provided in two forms, that is - a high-traction low-speed propulsion and a low-traction high-speed propulsion. For the high-traction low-speed propulsion a preferred propulsion technology is the Voith-Schneider Propulsion (VSP) available from VOITH Turbo Marine, Heidenheim, Germany. VSP propellers (16) are preferably installed in a central position at the bottom of the watercraft's hull, i.e. in between front and back hydrodynamic lifting elements such as hydrofoils (18a, 18b) installed below the hull. For low-traction high-speed propulsion, the front hydrofoils (18a) may be mounted with propellers (20). As shown in the drawings, a pair of propellers may be provided. With this propulsion, as the watercraft picks up speed, the hydrofoils would lift the hull above the water to achieve a low traction but high speed cruise. Speed of above 30 knots should be easily attainable with such lifting foils attached to the hull.

The key apparatus to engaging the errant vessel for tugging is a specially-designed harpoon (12) which is capable of piercing the hull (30) as illustrated in FIGURE 10. The harpoon is preferably launched by explosives or gun or small cannon so as to be effective within a relatively longer range to pierce the hull plate.

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An alternative method of lodging the harpoon with the errant vessel would be bringing the watercraft with the harpoon to approach the errant vessel, ramming and directly puncturing the errant vessel's hull without launching the harpoon. Once the harpoon is in the errant vessel's hull, the

attachment mechanism will open up and the watercraft will move away with the errant vessel in tow.

The harpoon head comprises a head (32) having an extraction-
5 preventing means at a first end and attached to one end of a tethering element, such as a cable, of sufficient length which other end is secured to a watercraft. The head is made of an especially hard material that is capable of puncturing a typical hull of a large ship such as an oil tanker, which typical thickness is about 18 – 20 mm.

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As shown in FIG. 10(a), the extraction-preventing means comprises a plurality of foldable elements (34) which may preferably be radially unfolding spokes that are foldable backwards with the harpoon stem as the axle or hub. The spokes are foldable to be flush with the harpoon head's diameter and
15 capable of radially unfolding to a limited degree.

Upon piercing the hull of the vessel, the harpoon means head's foldable elements (34) may unfold and latch against the hull's inner surface (36) so as to prevent the harpoon head (32) from being extracted out of the
20 hole of the punctured hull. The foldable spokes (34) may be shaped as fins for aerodynamic purposes as well as for structural strength in resisting further unfolding upon reaching the limit of unfolding and thus latching the harpoon head against the inside surface of the hull plate (30) when pull backwards as shown in FIGURE 10(c).

Preferably, the harpoons are detachable and positioned at the stern of the watercraft as shown in FIGURES 5 – 9 which illustrates an example of the method for diverting a sailing vessel (40) by tethering means. Broadly, our
5 method comprises the steps of, firstly, bringing into range a harpoon means capable of piercing the hull of the errant vessel (40). The harpoon's preferred configuration is as described above, i.e. its head provided with extraction-preventing means and a tethering element such as a cable attached to the tail of the harpoon.

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The next step comprises launching the harpoon so as to strike the hull of the vessel (40) with such force so as to pierce the hull plate (30). Once the hull plate (30) is punctured and the head (32) lodged into the inner side of the hull, the extraction-preventing means may be deployed to prevent extraction
15 of the harpoon head. Finally, the watercraft from which the harpoon is fired may tug onto the errant vessel, via the cable attached to the tail of the harpoon, so as to achieve a desired diversion.

As shown in FIGURE 5 (with FIGURE 6 showing a side view thereof), a
20 preferred approach to the errant vessel is to pursue it and bring the harpoon into firing range from an aft position of the errant vessel. In this example, the harpoon means is mounted onto the stern of the watercraft. FIGURE 7 shows the pursuing watercraft (10) in a range close enough to fire the harpoon to pierce the hull. Upon reaching within firing range, the watercraft (10)

preferably slows down to allow the harpoon to be aimed at the appropriate spot on the vessel's hull. Once the harpoon head pierces the hull of the vessel (40), the spokes unfold and latch against the hull's inner surfaces (36) to prevent the head's withdrawal.

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FIGURE 8 shows the watercraft with a tethering element, such as a cable (42) of sufficient tensile strength, tugging in a stern-to-stern manner the errant vessel in an aft position. Preferably, the cable (42) is allowed to unwind from a reel or bobbin mounted on the watercraft until a length of up to 40
10 metres between the watercraft and the vessel.

When the watercraft (10) pulls away with the cable (42) to the vessel's starboard (rightward), the effect thus diverts the vessel (40) to turn port side (leftward). Conversely, if the watercraft (10) pulls away with the cable (42) to
15 the vessel's port side (leftward), the effect would cause the vessel (40) to be diverted to the starboard (rightward). With such tethering manoeuvring, the errant vessel (40) may thus be guided to the desired direction.

The watercraft may preferably uses high-traction propulsion means,
20 such as operating the VSP propellers, when engaging and tugging the vessel. While an optimal distance of about 40 metres is prescribed for maintaining the tugging distance between the vessel and watercraft, the cable may have a total length of about 80 – 120 metres for slack and takeup length in the tethering operation.

While the above illustration of the method is shown for an errant vessel, it will be obvious to a skilled person that it can also be used to guide precisely a totally cooperative large ship, or an incapacitated, damaged, 5 leaking or malfunctioning ship, in navigating through a crowded harbour or through a narrow passageway. It will also be obvious that our present method and embodiments may be used in combination with our other methods and embodiments previously disclosed in our co-pending applications mentioned hereinbefore. Such combination and other embodiments not specifically 10 described herein are to be construed as falling within the scope and letter of the following claims.

CLAIMS

1. A method for diverting a sailing vessel by tethering means comprising the steps of:
 - 5 - bringing into range a harpoon means capable of piercing the hull of said vessel wherein said harpoon means comprising
 - a head having extraction-preventing means; and
 - a tail attached to a tethering element of sufficient length;
 - piercing said hull with said harpoon means with said extraction-
 10 preventing means deployed, thereby preventing extraction thereof;
 - tugging onto said tethering element to achieve a desired diversion.
2. A method according to Claim 1 wherein the harpoon means is brought into range from an aft position of the errant vessel.
- 15 3. A method according to Claim 2 wherein the harpoon means is mounted onto a watercraft bringing said harpoon means into range by approaching said vessel from an aft position.
- 20 4. A method according to Claim 1 wherein said harpoon means head's extraction-preventing means comprises a plurality of radially unfoldable spokes.

5. A method according to Claim 4 wherein the spokes are foldable backwardly to be flush with or less than the harpoon head's diameter and capable of radially unfolding to a limited degree.
- 5 6. A method according to any one of Claims 4 and 5 wherein, upon piercing the hull of the vessel, the spokes unfold and latch the head against the hull's inner surface.
7. A method according to Claim 1 wherein the tethering element attached
10 to the harpoon means is a cable of sufficient tensile strength.
8. A method according to any one of Claims 1 and 7 wherein the cable is unwind to a length of up to 40 metres between the watercraft and vessel.
- 15 9. A method according to any one of Claims 1, 7 and 8 wherein the watercraft tugs onto the cable to tether the vessel to a desired direction.
10. A watercraft for use in a method for diverting a sailing vessel by tethering means wherein at least one harpoon means is hard-mounted on at
20 at least one of bow, portside, starboard and stern.
11. A watercraft according to Claim 10 wherein the harpoon means is mounted to strike in a multiple angles.

12. A watercraft according to any one of Claims 10 – 11 wherein a plurality or harpoon means is mounted on board in a variable angle or strike, and/or in an array.

5 13. A watercraft according to Claim 10 comprising at least one of

- high-traction low-speed propulsion and
- low-traction high-speed propulsion.

14. A watercraft according to Claim 13 wherein the high-traction low-speed
10 propulsion includes Voith-Schneider Propulsion means.

15. A watercraft according to Claim 13 wherein the low-traction high-speed propulsion includes hydrodynamic lifting elements installed below the hull.

15 16. A watercraft according to Claim 15 wherein the hydrodynamic lifting bodies are front and back hydrofoils, including propeller-mounted front hydrofoils.

17. A watercraft according to any one of Claims 13 – 16 comprising Voith-
20 Scheider propellers installed in between front and back hydrofoils at the bottom of the hull.

18. A watercraft according to any one of Claims 10 - 17 for use in a method for diverting a sailing vessel by tethering means according to any one of Claims 1 – 8.
- 5 19. A harpoon capable of piercing the hull of a vessel comprising a head having an extraction-preventing means at a first end and attached to one end of a tethering element of sufficient length which other end is secured to a watercraft.
- 10 20. A harpoon according to Claim 19 wherein the extraction-preventing means comprises a plurality of foldable spokes which are radially foldable backwards to be flush with said harpoon head's diameter and capable of radially unfolding to a limited degree.
- 15 21. A harpoon according to Claim 19 wherein, upon piercing the hull of the vessel, the harpoon means head's foldable spokes unfold and latch against the hull's inner surface.
22. A harpoon according to any one of Claims 19 – 21 for use in a method
20 according to any one of Claims 1 – 9.