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METHODS AND ASSEMBLIES FOR TREATING BIO-FOULING ON WATER-BORNE VESSELS**FIELD OF THE INVENTION**

This invention is directed to methods and assemblies for treating bio-fouling on water-borne vessels.

BACKGROUND OF THE INVENTION

Fouling and other similar problems for water-borne vessels are known to the art. All vessels such as tankers, cargo and dry bulk carriers, barges and dredging plants, and other such water-borne objects have niches that are vulnerable to rapid fouling whatever anti-fouling coating is used. In addition, all such water-going craft, irrespective of any the type of anti-fouling coating or paint used, will eventually foul on their permanent underwater areas, and this will vary according to their working conditions. The initial stage of all fouling is micro fouling in nature and consists of slime forming on the underwater surfaces, and occurs within a few hours of cleaning the surface. Over time, the micro fouling facilitates the growth of macro fouling which includes barnacles, tubeworms, mussels, and other crustaceans.

The fouling will be greater in tropical/warmer waters than in cold or temperate waters within the same time period for the same vessel/vessel type. Fouling on the underwater portion of the hull will increase skin friction, and the increased friction will cause an increase in fuel consumption to maintain the same speed. An increase in fuel consumption also causes an increase in global greenhouse gas emissions. Fouling between the mandatory 5 yearly dry docking interval (or the 7.5 year extended dry-docking programme) for seagoing ships constructed of steel can be as high as an annual rate of 3%-5% increase in fuel consumption, giving rise to an increase in daily fuel consumption of 15%-25% at the end of 5 years, and 22.5%-37.5% at the end of 7.5 years.

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Fouling will also occur substantially more rapidly on any vessel with a 'biocide-free' underwater hull anti-fouling coating as compared to a biocide anti-fouling paint coating, and more so when the vessel is operating mainly in tropical zones. There is also greater wear and tear on machinery, and increased maintenance.

Furthermore, the International Maritime Organisation (IMO) may introduce a requirement to prevent the spread of 'non-indigenous invasive marine species'. Because of the niche areas (e.g. sea chests, bow thruster tunnels, hull appendages, rudder posts, anodic fittings and protrusions, for instance) present in all ships, it is typically impossible to carry out a reliably complete cleaning of all fouling using current cleaning methods. Even ships with a fresh anti-fouling coating coming out of dry-dock are not completely fouling-free. The problem of invasive species carried by ships has intensified due to expanded trade and traffic volume. The spread of invasive species is now recognized as one of the greatest threats to the ecological and the economic well-being of the planet.

One of the two main problems for a complete cleaning using current hull cleaning methods is the presence of macro fouling in inaccessible niche areas where it is not possible to clean because of the lack of access to do so. Previously considered methods and arrangements have attempted to address bio-fouling by providing heat treatment to vessels. These work on the principle that by heating the water in which the water-going craft floats to the required temperature and for the required duration, it will be possible for the 'hot water' to access the previously inaccessible and niche areas, irrespective of how small the opening may be, to 'kill' all the marine fouling. For example, these previously considered methods and arrangements have provided containers for vessels to dock within, and then heated the water inside the dock, either by introducing heated fluid, or by using heating coils on the floor of the dock. In one previously considered arrangement, water is pumped out of the top of such a dock, sent to a heater, and returned to the dock to increase the temperature of the water.

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These methods are typically expensive and impractical for most types of vessel, particularly large ships. Further, the amount of energy that will be required to heat all the water in a chamber surrounding a large hull may be prohibitive. Some such methods have used heaters on the vessel, which would usually be inadequate for larger vessels. In addition, these methods are highly inefficient due to the extremely long lengths of time taken to heat such large amounts of water for any reasonable sized vessel.

The other main problem that prohibits the hull from being cleaned is when the hull is heavily fouled with macro fouling, port authorities will usually not permit in-water cleaning within their ports and territorial waters. This is because of the risk of fouling the port and territorial areas with previously considered in-water cleaning operations, which usually discharge the water used for cleaning into the water surrounding the cleaning dock or bay, and because of the risk of invasive species being transferred to the local waters. The possibility of toxic anti-fouling paint being removed from the vessels' underwater hulls and polluting the water at the same time is also high. Putting the ship with macro fouling into dry dock for cleaning and isolating the organisms/fouling is a very expensive and prohibitive proposition.

The present invention aims to address these problems and provide improvements upon the known devices and methods.

STATEMENT OF INVENTION

Aspects and embodiments of the invention are set out in the accompanying claims.

In general terms, one embodiment of a first aspect of the invention can provide a method of treating bio-fouling on a water-borne vessel, using a treatment container, the method comprising: heating fluid for treatment of the bio-fouling on

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the vessel; storing heated fluid in a storage container; introducing the vessel into the treatment container; and following introduction of the vessel into the treatment container, transferring heated fluid from the storage container into the treatment container.

In an alternative, following introduction of the vessel into the treatment container, the method comprises mixing/recirculating heated fluid between the storage container and the treatment container.

This pre-heating of the fluid can allow for extremely quick heating of the treatment container or chamber contents, which can be topped up, mixed with, or replaced by the stored heated fluid to attain the required treatment temperature. This therefore provides a much faster and more efficient means of treating the bio-fouling on such vessels, and can allow heat bio-fouling treatment for even very large vessels, possibly within only a small number of hours, which would otherwise be impractical, or last days, rendering such treatment uneconomical. This speed and efficiency may render it possible to treat such vessels within only a small number of hours and even possibly within one to two hours, as this time factor may depend solely on the capacities of the pumps,

Preferably the method comprises, before introduction of the vessel into the treatment container, charging the treatment container with fluid. This means that the treatment container has at least some fluid contained in it, which can then be mixed with or replaced by the stored heated fluid.

More preferably, the step of charging the treatment container with fluid comprises submerging a portion of the treatment container in a body of fluid.

In an alternative embodiment, the treatment container may already be, or may be maintained as, submerged or partially submerged, so that for example the treatment container contains fluid before and after both the heating and treatment

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stages, and for instance also between treatment of separate vessels. Further details of such a container are described later.

Suitably, the method comprises, following introduction of the vessel into the treatment container, enclosing the vessel within the treatment container. This allows the entire hull of the craft to be treated at the same time.

In an embodiment, a volume of the heated fluid transferred from the storage container into the treatment container is comparable to a fluid capacity of the treatment container.

Suitably, the step of introducing the vessel into the treatment container comprises towing, or winching the vessel into the treatment container. In embodiments, the step of introducing comprises warping the vessel into the treatment container (for example, if the winches are not working, or towing if the winches are not working and warping is too slow). Winching is the preferred method, as it has the advantage of safely moving the vessel into, within and out of the treatment container in a controlled and safe manner, and minimizing loss of heated fluid from the container.

In an embodiment, the method further comprises, following introduction of the vessel into the treatment container, removing bio-fouling from the vessel by applying fluid to the vessel in the treatment container, to transfer the bio-fouling from at least one surface of the vessel to the treatment container.

Preferably, the step of applying the fluid to the vessel is undertaken before the step of transferring heated fluid from the storage container. Suitably the method comprises, following application of the fluid to the vessel, removing bio-fouling elements from the treatment container by transferring fluid from the treatment container to a removal container.

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In an embodiment, the step of removing bio-fouling from the vessel comprises generating cavitation in the fluid applied to the vessel in the treatment container.

This allows the removal of fouling debris from the treatment container, which prevents any contamination of the local environment, and in turn potentially allows this method to be completed in normal port areas where such treatment would not normally be allowed, due to the risk of contamination.

Preferably, the removal container is the storage container, and the step of transferring the fluid from the treatment container to the removal container comprises transferring the fluid from the treatment container to the storage container, via a filter.

In embodiments, if the vessel is fouled with macro (animal) fouling and if the port authority permits the cleaning of the hull, the hull can then be cleaned by divers using cavitation cleaning equipment when the fluid is still at ambient temperature, or if cold climates, then the fluid can be heated with the hot fluid from the storage container to provide a comfortable temperature for the divers to work in. In this example, the bio-fouling is dislodged and settles on the floor of the treatment container. After all the macro fouling has been dislodged, hot fluid is mixed with the fluid in the treatment container to bring it to the treatment temperature. At the end of the hot fluid treatment, all the dislodged macro fouling will be killed. This is a safe way of removing all the macro fouling and therefore saving the owner from, for example, higher fuel consumption, and at the same time satisfying the requirements of the port authority in ensuring that all the non-indigenous marine species of macro fouling are killed. The cavitation cleaning method does not affect or remove any of the toxic biocidal paint. It typically only dislodges the macro fouling but may not completely destroy or kill all the macro fouling, which is the reason why in using previously considered systems in which the macro fouling is not contained, it is not accepted as an approved cleaning method in cases of bio-fouling by non-indigenous marine species of macro fouling.

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The dead macro fouling on the floor of the treatment container can be vacuumed using the pumping system by transferring fluid from the treatment container into a removal container.

In an alternative embodiment, to treat bio-fouling on a water-borne vessel using a treatment container, fluid for treatment of the bio-fouling on the vessel is heated, and heated fluid is stored in a storage container. The vessel is introduced into the treatment container, and following the introduction and closing of the gates, heated fluid from the storage container is transferred into the treatment container. The bio-fouling is killed by keeping the vessel immersed in the hot fluid maintained at the minimum required temperature in the treatment container for the minimum required duration. The dead bio-fouling stays 'stuck' to the vessel's hull without dislodging and contaminating local waters, and is safely dislodged subsequently when steaming in a seaway to her next and subsequent destinations.

Suitably, the temperature of the heated fluid in the storage container is higher (it can be as high as 90°C) than a required treatment temperature. Because of the very large capacities of the pumps used to pump and recirculate the hot fluid from and between the storage tanks and the treatment container, the treatment temperature within the treatment container can be obtained in a very short period of time.

In embodiments, the step of transferring heated fluid comprises: measuring a current temperature in the treatment container; and determining on the basis of said current temperature an amount of fluid to be transferred from the storage container to the treatment container, or recirculated between the storage container and the treatment container. These can be done to achieve the required minimum treatment temperature, and the time required to do so.

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One embodiment of a second aspect of the invention can provide a method of treating bio-fouling on a water-borne vessel, the method comprising: removing bio-fouling from the vessel by applying a fluid to the vessel in a treatment container, to transfer the bio-fouling from at least one surface of the vessel to the treatment container; and following application of the fluid to the vessel, removing bio-fouling elements from the treatment container by transferring fluid from the treatment container to a removal container.

Suitably, the step of removing bio-fouling from the vessel comprises generating cavitation in the fluid applied to the vessel in the treatment container.

Preferably, the method further comprises, before introduction of the vessel into the treatment container: heating fluid for treatment of the bio-fouling on the vessel; storing heated fluid in a storage container; and introducing the vessel into the treatment container, and, following said application of the fluid to the vessel and before transferring fluid to the removal container: transferring heated fluid from the storage container into the treatment container.

More preferably, the removal container is the storage container, and wherein the step of transferring fluid from the treatment container to the removal container comprises transferring the fluid from the treatment container to the storage container, via a filter.

One embodiment of a third aspect of the invention can provide an assembly for treating bio-fouling on a water-borne vessel, the assembly comprising: a heater for heating fluid for treatment of the bio-fouling on the vessel; a storage container storing heated fluid; means for introducing the vessel into the treatment container; and at least one conduit for, following introduction of the vessel into the treatment container, transferring heated fluid from the storage container into the treatment container.

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Preferably, the assembly further comprises means for effecting transferral of the heated fluid via the at least one conduit from the storage container into the treatment container.

Suitably, the treatment container is configured to enclose the introduced vessel.

In embodiments, the storage container is disposed adjacent to the treatment container. This can allow the contents of the treatment container to be transferred to the storage container, or recirculated to the storage container by means of an overflow. Fluid thus overflowed to the storage container can then be heated for transferral back to the treatment container.

Suitably, said at least one conduit (for example, a fluid or water conduit) comprises a plurality of conduits, disposed in a lower region of the treatment container. Preferably, each conduit comprises a spout disposed in the lower region of the treatment container, which spout having a cone shape expanding from the conduit to the end of the spout. More preferably, the end of the spout has an oval-shaped cross-section. This allows for easier vacuuming-up of any bio-fouling elements in the container for removal, in addition to its use in the introduction of the heated fluid into the treatment container.

In embodiments, the means for effecting transferral of the heated fluid is configured to: in a normal mode, effect transferral of the heated fluid from the storage container via the at least one conduit into the treatment container; and in a reverse mode, effect transferral of fluid from the treatment container via the conduit to the storage container.

Preferably, the assembly comprises a filter disposed between the treatment container and the storage container for removing bio-fouling elements from fluid transferred from the treatment container via the conduit to the storage container.

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Suitably, the assembly further comprises at least one pipeline for supplying treatment fluid for removing/dislodging bio-fouling from the vessel by applying the treatment fluid to the vessel in the treatment container, to transfer the bio-fouling from at least one surface of the vessel to the treatment container. The application of the treatment fluid may be by cavitation cleaning equipment.

Preferably, the assembly further comprises at least one pipeline for supplying air to a diver applying treatment fluid to the vessel, for example a diver engaged in cleaning the hull of the vessel. For example, such a diver may be using cavitation cleaning equipment to clean the vessel's hull and/or the vessel's propellor.

In embodiments, the treatment container is defined between a dock, which dock containing the storage container, and a pontoon, wherein the treatment container comprises at least one container wall between the dock and the pontoon. In embodiments such as in a graving dock, the treatment container is defined between the two concrete dock walls, which docks contain the storage container, and a concrete floor, and provided with one or two gates for entry and/or exit. The pontoon and/or floor may alternatively/in addition house a storage container.

In an embodiment such as in a floating dock, the treatment container is defined between two double-skinned dock walls, with each dock wall containing a storage container, and sitting on a double-skinned pontoon which also contains a storage container, and is bounded by one or two lock gates for entry and/or exit.

In embodiments, the dock may be defined between two concrete dock walls, which docks contain the storage containers, and a concrete floor below which is a storage container, and be provided with one or two gates for entry and/or exit.

Another embodiment may provide an assembly such as in a graving dock treatment container, wherein the treatment container is defined between a dock,

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which dock containing the storage container, and a pontoon, wherein the treatment container comprises at least one container wall between the dock and the pontoon, the two concrete dock walls, and a concrete floor, and is provided with one or two gates for entry and/or exit. It may contain at least one storage container located within the dock walls, or below the floor of the dock.

Another embodiment may provide an assembly such as in a floating dock treatment container, wherein the treatment container is defined between two double-skinned dock walls, with each dock wall containing a storage container, and sitting on a double-skinned pontoon which also contains a storage container, and wherein the treatment container is bounded by one or two lock gates for entry and/or exit.

Another embodiment may provide an assembly such as in a floating dock treatment container, wherein the treatment container is defined between two double-skinned dock walls, and sitting on a double-skinned pontoon, and is bounded by one or two lock gates for entry and/or exit. It may contain at least one storage container located within the dock walls, or within the pontoon.

Preferably, the dock (for example, one of the dock walls) is extended longitudinally in both longitudinal directions away from the treatment container. This can facilitate quick berthing, and winching the vessel in a safe and controlled manner from an entry berth to an exit berth.

In an embodiment, the treatment container comprises at least one gate disposed between the dock (for example, the two dock walls) and the pontoon, for allowing the vessel into and/or out of the treatment container. Where only one gate is fitted, the other end is permanently walled. Where two gates are fitted for separate entry and exit modes, they are disposed between the two dock walls and the pontoon and fitted at the longitudinal ends of the pontoon floor.

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In an alternative embodiment, the treatment container is defined between a plurality of walls of a dock, and at least one wall of the dock comprises a gate for allowing the vessel into and/or out of the treatment container. This arrangement may be used where a graving dock-type facility is more appropriate than a floating pontoon/dock arrangement.

Suitably, the means for introducing the vessel into the treatment container comprises a winch for winching the vessel into and/or out of the treatment container. In an embodiment, the means comprises at least two winches, and at least one steel mooring trolley. In embodiments, the assembly comprises one or more roller fenders. Suitably, the assembly comprises a plurality of mooring trolleys.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a diagram illustrating a perspective view of an assembly according to an embodiment of the invention;

Figure 2 is a diagram illustrating a plan view of an assembly according to an embodiment of the invention;

Figure 3 is a diagram illustrating a side elevation of the longer dock wall from pontoon to top deck, according to an embodiment of the invention;

Figure 4 is a diagram illustrating a side elevation of the shorter dock wall, from pontoon to top deck, according to an embodiment of the invention;

Figure 5 is a diagram illustrating an end elevation of an assembly according to an embodiment of the invention;

Figure 6 is a diagram illustrating a side view of air and water curtains between the gates, according to an embodiment of the invention; and

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Figure 7 is a diagram illustrating an example of application of the assembly, according to an embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Embodiments of the invention provide methods and assemblies for vessel cleaning which are non-invasive, quick and cost effective, and environmentally friendly as none of the toxins contained in the anti-fouling paint are released into the water, and also none of the biofouling organisms are released into the water after removal.

Methods and assemblies of the invention heat large amounts of fluid, such as seawater for a sea-going vessel, and store it in tanks or containers. The vessel is then introduced into an assembly or treatment container adjacent these containers, and once the assembly/treatment container is sealed the heated water from the storage containers tanks can be used to raise the temperature of the assembly/treatment container water rapidly, typically within minutes rather than hours or days.

This will completely 'kill' all marine biofouling present on the underwater surfaces of vessels, irrespective of the degree of difficulty of access to niche areas and crevices, as the hot water will flow without any hindrance to all those difficult-to-reach areas. Systems of embodiments can have an ample supply of hot water produced economically and held in storage tanks readily available for immediate use, so very little time is wasted before treatment commences, after which the vessel can be ready to depart in less than an hour.

In addition, the pipework used to supply the heated water into the assembly can be used to remove water and the removed bio-fouling from the vessel, preventing local pollution.

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The container in which the treatment is performed may be known as the treatment container, or treatment basin.

Embodiments of the invention relate to methods and systems for treating marine growth on the underwater surfaces of vessels, which term includes all ships, and floating and water-going craft, irrespective of their size and areas of operation, and, particularly, but not exclusively, to a method and apparatus for treating marine biofouling growth on boats and ships hulls and other floating objects, on oceans, seas, rivers, and lakes.

Figure 1 is a diagram illustrating a perspective view of an assembly according to an embodiment of the invention.

The method and apparatus used relates to treating and killing all marine biofouling growth by isolating a vessel for the required duration within an assembly where the water in which the vessel floats in is maintained at a minimum temperature of 40°C. This method can be used with or without hull cleaning by the cavitation method, as noted later in the description.

Essentially, embodiments of the invention provide a fully contained and isolated hot water assembly, similar to a floating dry dock but with watertight gates at one end in which case the other end is a steel wall, or with watertight gates at both ends. This serves as a hot water production, storage, containment and treatment vessel, to kill all marine biofouling, both micro and macro, on the underwater hulls of vessels by floating the vessel for a minimum duration of 20 minutes, in water at a minimum temperature of 40°C.

Methods of the invention heat fluid, such as water, and in most examples herein sea-water, and store it in storage containers or tanks. The water can be heated to given temperatures, as high as 90°C. The temperature and volume of water remaining within the treatment container (after loss of volume due to vessel's

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displacement with both gates closed), and the temperature of the heated water in the storage containers will determine the volume of make-up hot water from storage containers required to be added and mixed to bring the water in the treatment container to a uniform temperature throughout to a minimum of 40 °C.

The vessel is introduced, moved or located into the assembly. In embodiments of the invention, the entire vessel is enclosed within the assembly, so that the entire hull can be treated at the same time, rather than a section at a time. Embodiments use a partially submerged dock (2) and pontoon (3) arrangement, with the treatment container (1) defined between them by gates (4, 5), so that the vessel can be efficiently moved (winched, warped, powered, or towed) into and out of the treatment container. In embodiments, the same medium (e.g. seawater) can be used to bring the vessel in, and to provide the heat treatment – seawater can be taken from the surrounding area to be heated to fill the storage tanks (23), and then used for filling, flushing, mixing with the contents of the assembly/treatment container to raise its temperature.

Note that, in known arrangements of floating docks (which are not treatment arrangements), such docks are not fitted with any gates, as the floating dock typically lifts the vessel clear of the water. In fact, it is common for the vessel when longer than the floating dock to overhang beyond the length of the floating at one and possibly both ends.

The storage tanks can hold a significant and typically very large volume of fluid, which may be comparable to (that is, substantially similar to), or in embodiments greater than, and in other embodiments substantially greater than the amount of fluid enclosed in the treatment container. This means that the storage tanks (23) can be used either to top up, to mix with, or to completely replace the contents of the treatment container with hot water, so as to heat up the water or fluid to the required temperature, possibly in as little as less than an hour due to the huge capacities of the pumps.

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Moreover, multiple vessels can be treated in succession with the large amounts of pre-heated fluid.

In an embodiment, it may be that the process is always conducted by mixing the fluid from the storage tanks with fluid contents of the container, for example in circumstances such as those using a floating dock, where the fluid levels inside and outside the treatment container will usually be the same (hence there should usually be no topping up or replacing fluid).

In embodiments of the invention which involve such mixing (and others), the chamber contents are nevertheless recirculated, by fluid being overflowed, pumped or drawn back to the storage tanks for filtration, reheating, and re-use for heating the assembly contents. The temperature of the water inside the treatment container will continue to rise as more and more hot water is mixed with the chamber contents.

In embodiments, this can be combined with other hull cleaning methods, such as cavitation treatment. Typically this is performed before the heated fluid transfer, so that the macro fouling removed by cavitation treatment but which still remains alive can subsequently be killed by the heat treatment. Cavitation treatment is a process known to the art; in an example, high frequency acoustic waves are used to produce cavitation bubbles in a liquid, which cavitation bubbles dislodge macro-fouling from the applied surfaces.

The debris and killed organisms from these processes can then be removed from the assembly, by reversing the pipework which supplies the hot water from the tanks, to vacuum up that debris. This is then filtered out before the fluid is returned to the tanks for heating.

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A temperature measurement can be made within the assembly, to either instruct a calculation of the amount of heated water to be pumped in, or to monitor the temperature as the fluid is pumped in, and stop when temperature is reached.

A specific embodiment will now be described, with reference to the drawings: Figure 1, a perspective view of the assembly, Figure 2 a plan view, Figure 3 a side elevation of the longer dock wall from pontoon to top deck and Figure 4 a side elevation of the shorter dock wall, Figure 5 an end elevation, Figure 6 a side view of air and water curtains between the gates, and Figure 7, an example of application of the assembly, showing a vessel in the treatment berth.

In this embodiment, the system comprises a floating assembly (1) along the lines of a floating dock (double-hulled at sides and bottom). One of the two dock walls is extended before and after the usual dock wall, and fitted with watertight dock gates at both ends of the middle section. So, effectively the mid-section is bounded on the sides by a long(er) wall (2) and a short(er) (3) wall, and at its ends by an entry gate (4) and an exit gate (5), making it a watertight assembly. The hot water at a minimum temperature of 40 °C is contained within this assembly.

It can also be constructed as a 'fixed assembly', like a graving dock, with gates preferably at both ends (graving docks usually have only one gate, the other end being a concrete wall) for more efficient use of the system. In this embodiment, the graving dock is provided with storage tanks for hot water for immediate use to raise the temperature of the water in the assembly as and when required. A floating dock model may be preferred because of the much lower cost, and the flexibility to relocate the assembly to another position if and when required. It can be sold and relocated to another port, or even another country.

Both the graving dock model and the floating dock model may also be constructed with one gate only with the vessels being treated going in and

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coming out via the same gate. This process will be slower than an assembly fitted with two separate entry and exit gates. In the graving dock model, hot fluid can be mixed into the treatment container after the introduction of the vessel into the treatment container; in such an embodiment it may take around half an hour to bring the temperature of the fluid in the treatment container up to the required temperature before treatment commences.

The system or assembly can be constructed of steel, concrete (pre-stressed or reinforced hybrid) or steel-concrete composite materials. The assembly does not need to be built to the same strength as a floating dry dock as it will not be used to lift a floating structure, such as a ship or barge or other floating structure, clear and dry above the water level. It serves only as a hot water production, storage, containment and marine fouling treatment vessel. The assembly may nevertheless be constructed in accordance with the 'Rules and Regulations for the Construction and Classification of Floating Docks' as laid down by the members of The Association of Classification Societies, for example in order to be eligible for insurance coverage.

The assembly can be secured to the sea bottom by anchors, or to dolphin berths along the longer dock wall, or even to a fixed berth, again along the longer dock wall. The use of 'mooring grippers', or other fastening arrangements which allow unimpeded vertical movements as in the case of floating dry docks may not be required as the assembly/treatment container will always be working at its constant immersion depth or draft, though it will be advantageous in ports/areas with large tidal ranges.

To cater for the treatment of all sizes of vessels, the assembly may be built to accommodate/treat vessels having the maximum length, the maximum beam, and the minimum ballast or working draft, so that the assembly/treatment container can cater to all sizes of vessels currently in service. An alternative embodiment may accept all but the very largest Ultra Large Crude Carriers,

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which are very few in number and it may not be economical to build to cater for them. The longest vessels in operations are the 18,000 TEU container vessels at 400 metres in length. The broadest vessels are the Valemaxes at 65m. And the minimum draft is 14 metres, and this is actually the working draft of a 18,000 TEU container vessel, which is currently the largest size of container vessel.

It is estimated that the assembly will float at a draft of about 22 metres and this is its immersion depth or draft (6) as shown in Figure 1, and includes the 7m height of the pontoon (7) so as to be able to safely accommodate a draft of 14 metres, and also providing under keel clearance for the underwater lights and cameras under the vessel's bottom.

So, for example the size of the treatment container may be 410 metres in length, 65 metres broad between the dock walls and 28 metres high, with immersion depth in water equal to 22 metres. So, the volume of water in the treatment container is about 400,000 m³. The width of the pontoon will be greater than the treatment container (1) as it will also include the width of both dock walls. The most economical size is one that will cater exclusive to one particular typical size of vessel, as then the volume of the water in the treatment container can be as close as possible as the displacement volume of the vessel. This would then mean heating the lowest volume of water to the required treatment temperature, as the vessel would displace most of the water in the assembly/treatment container when contained in the watertight basin. Such an assembly can of course handle smaller ships (but no larger than the maximum size, of course – otherwise the gates would not be sealed). But as different sizes of vessels call at or pass a port, the most practical size would be one that can take in the biggest vessel.

Watertight gates (4, 5) are fitted at the entrance and exit of the assembly. They are hinged at the bottom near the entrance and exit sill, and open outwards, and lie down on an apron (8) below the sill level. The gates, about 25 metres high in

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this case, when in the open position rest on the apron (8) which is a 25-metre extension of the deck of the pontoon. The gates, when in the closed position, are secured to the dock walls by a safety locking hook or pin arrangement, and in this position the assembly is completely watertight as the bottom and the two sides are fitted with rubber seals to make the gates watertight.

The gates are closed when tugs are operating close to the entry and exit of the assembly berthing and un-berthing ships, to prevent loss of the hot water contained within the assembly caused by the tugs' propeller wash. Dock gate winches (9) to raise and lower the dock gates at both ends by means of wire ropes are located on the dock walls on either side of the entrances. Equipment required to operate the assembly such as diesel electricity generators (10), electrical switchboard rooms (11), ballast, fire and cavitation pumps (13), heat pumps (14) air compressors and oil-less air compressors which provide surface-supplied air for divers (15) and air-conditioning room (16) are located in compartments within the side walls immediately below the top deck (22). Large access hatches bolted down with watertight covers are provided in the top deck to these compartments. Compartments inside the side walls also carry fuel (17) for the generators, and fresh water (18) for the crew. Engineers' workshop (12), store rooms (19), crew's rest rooms (20), are also located within the side wall.

The tanks in the dock walls below the safety deck (21), and pontoon tanks are used for water ballast tanks which store the heated water held in reserve for mixing with the hot water in the assembly when required. These are the hot water storage tanks (23) and as noted above provide an important function in the operation of this system, as they store the very large volume of heated water at a temperature as high as 90°C used to mix with the water in the assembly to attain and maintain the treatment temperature. The minimum required temperature is typically a minimum of 40°C for most bio-fouling killing procedures.

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Pumping and pipeline arrangements (24) are provided for the intake and return line of sea water to the heat pump, and for the transfer of the hot water generated by the heat pumps to the water contained inside the hot water storage tanks in the side and bottom tanks of the assembly, and also directly to the water contained in the assembly.

Before hull cleaning operations start, the water in the storage tanks is heated by the heat pump to a maximum of 90 °C, and this could take several days. The number and capacities of the heat pumps will be based on the size of the assembly, the sea water temperature, and the storage volume of the hot water tanks.

The hot water (generated by the heat pump) in the storage tanks could be as high as 90 °C, and the total volume in the pontoon, and in the tanks in the side dock walls to a height of 8 metres above the pontoon deck can be as much as 950,000 m³. Because of this huge standby volume of hot water at a temperature of about 90 °C, this system can be operated successfully even with lower sea water temperatures, and even if in certain circumstances the hot water in the assembly is lost to the sea after each hull cleaning.

On each passage of the biggest vessel that this assembly can accommodate, such as a 18,000 TEU container vessel measuring 400 metres long, 59 metres broad and drawing a draft of 14 metres, about 250,000 m³ of hot water at 40 °C contained in the assembly will be lost to sea via the entry gate. This volume of water is the volume displaced by the floating vessel within the assembly and cannot be avoided. The balance of the 150,000 m³ of water at 40 °C in the assembly is prevented from being lost to the sea as much as is possible by the air and water curtains.

In some cases, much of the hot water in the assembly may be lost to the sea after treating a vessel due to tides, propeller wash from other ships, and the like.

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In an extreme case when all hot water in the treatment container is lost, the required make-up hot water at 90°C from the storage tanks, to circulate through the assembly and raise the assembly water temperature which is then at the same temperature as the surrounding sea water temperature of 30°C to the minimum required treatment temperature of 40°C is about 30,000 m³, and this can be pumped through in 20 minutes or less, when the next vessel is contained within the assembly with both watertight gates closed. At this stage (when the vessel is contained within the assembly with both watertight gates closed), the volume of water at 30°C in the assembly is about 150,000 m³.

When the sea water temperature is 20°C, the volume of make-up hot water at 90°C to raise the assembly water temperature to 40°C is 60,000 m³, and this can be pumped through in about 45 minutes, or less.

Therefore the advantage of this system is the plentiful storage of about 950,000 m³ of hot water at or near 90°C, and pumps capable of pumping combined volumes of 80,000 m³ per hour or even more, the temperature of the water in the assembly can be quickly raised within 20-30 minutes to the required temperature of 40°C by circulating the water at 90°C from the storage tanks through the assembly with the overflow (25) from the assembly draining back to the same or even a different storage tanks. The higher the pumping capacity, the shorter the time required to raise the temperature of water in the assembly to 40°C.

In alternative embodiments it is possible to reduce the required volume of make-up water at 90°C, and the time required to be ready to start the hot water treatment on the next vessel by having a pre-treatment and a post-treatment container, chamber or basin on either side of the treatment container. These may be equal in size to the treatment container. The pre- and post- basins, having gates at both ends, act as buffers such that the temperature of the water in the Treatment Container will not be reduced to the ambient sea temperature of

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30 °C, under any circumstances, as the treatment container will be isolated from the open waters/sea. The required volume of make-up water at 90 °C will hence be lower, leading to shorter pumping/mixing time. Having more than one pre- or post- basins may only increase these advantages by smaller margins.

Another alternative is to provide additional watertight gate(s) along the length of the treatment container, so as to only provide hot water appropriate for the length of the vessel to be treated. As the treatment container in an embodiment is 410 metres long to accommodate the longest vessel, the broadest vessel and the minimum draft, by providing additional gates along the length of the treatment container, the effective size of the container, i.e. the amount of water contained, for shorter vessels will lead to a reduction in the volumes of hot water required and shorter pumping/mixing times. The lengths of other standard sizes of vessels are as follows, and gates can be sited appropriately: Handysize about 180 metres long (a gate at the mid-point of the treatment container would halve the volume of hot water required); Panamax about 225 metres long; Cape about 290 metres long; VLCC about 335 metres long.

For best mixing of the incoming hot water with the water in the assembly, the hot water from the storage tanks is pumped into the assembly through an array of cone shaped nozzles with oval mouths located near the bottom of the assembly via a pipeline network. The nozzles are cone shaped with oval mouths for increased suction area, mainly to facilitate vacuuming any sediment, as this same pipeline network in the assembly can also be used in the suction mode to vacuum the debris sediment which may collect on top of the pontoon deck, filter the debris, and recirculate the water back into the assembly.

All water pumped into or through the storage tanks passes through a 50 micron or smaller filter to prevent any fouling sediment of the treatment process from entering and settling in the hot water storage tanks.

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To minimise/eliminate further loss of the hot water from the Assembly besides the hot water lost due to vessel's displacement, air curtains (26) and water curtains (27) are installed just inside the gates at both ends. The air and water curtains rise from the bottom of the Assembly to the surface of the water. This 'air and water curtain' system is used successfully in certain countries such as The Netherlands in locks to greatly limit ingress of sea water into inland fresh and brackish water areas when the locks are opened for waterborne traffic. The water pumps provide the water injection for the water curtains. Similarly, air compressors provide air injection for the air curtains.

Electricity to power all the equipment will mainly be drawn from the public electricity grid where available. The alternative is power generated by the on-board diesel generators. Where solar energy is sufficiently available to make it an economical proposition, photo voltaic solar panels (28) can be mounted on rooftops about 3-4 metres above the side wall decks to provide electric power. The area available can be as high as 15,000 to 20,000m², which can accommodate panels providing as much as 3.5MW of power, and this may be sufficient for the purposes here, including powering the heat pumps for the generation of hot water. This assembly would be a suitable candidate for installing hybrid solar (PV/T) panel that produces simultaneously electricity (photovoltaic) and hot water (solar thermal). Such a system could produce 2-4 times more energy than a standard photovoltaic installation

Temperature sensors (29) are fitted along both sides and on/near the bottom of the assembly/treatment container, so that a complete and overall temperature condition is known at all times.

The assembly/treatment container is fitted with powerful underwater lights (30) and cameras (31) so as to provide a complete recording of the condition of the sides and bottom of the underwater portions of the water crafts / vessel. This may be accepted towards In-Water-Survey requirements for the extension of the

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vessel's dry-docking interval from 5 years to 7.5 years, which is a big saving for the shipowner.

To facilitate the quick and easy positioning of vessels for entry to and exit from the assembly, one wall of the dock is extended before the assembly and is called the arrival Berth (32). The berth within the assembly/treatment container is called the treatment berth (33). The dock wall extension beyond the assembly is called the departure berth (34). In this example, the dock wall extensions are about 500 metres on each side of the treatment berth. To compensate for this increased weight of this longer wall due to its increased length, the other shorter wall is kept to the same length as the treatment container, but the width of the wall widened such that the volumes, and therefore the weight of the two walls are equal.

Vessels can be and are currently being safely berthed and un-berthed within floating and graving dry docks without these dock wall extensions, but these extensions will greatly expedite such operations of berthing and un-berthing. Also, without these dock wall extensions and their part in the controlled passage of vessels through the assembly, the breadth of the treatment container has to be substantially broader in relation to the beam of the vessel being treated, and that will substantially increase the volume of hot water required. The vessels are berthed to the extension at the entry gate, and un-berthed from the extension at the exit gate by tugs. To facilitate quick movement of vessels through the assembly, roller fenders (35) are fitted along the length of one wall. The roller fenders also help to avoid damaging/dirtying the vessels' painted sides. The usual mooring bollards (36) are also fitted on the deck of the longer dock wall.

To further minimise/eliminate hot water loss when the ships are moved into and out of the assembly, the vessel's engines are not used, but the vessel is pulled into the assembly, through the assembly, and out, using dock winches (37) located at the ends of the longer dock wall. The vessel is berthed by mooring ropes (38) to mooring hooks/bollards on traveling steel trolleys (39) running on rails welded into the deck of the dock wall. Six trolleys are used for each vessel,

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and the distances between the trolleys are 'fixed' by means of pre-determined lengths of wire ropes (40) with eyes at both ends secured to the trolleys by locking pins. This helps to keep the vessel safely in its "moored position alongside the dock wall" as it is being pulled through the assembly, and to maintain complete control as the vessel is pulled through the assembly. As the heaving winch pulls the entire arrangement of the six trolleys through the assembly, the winch at the trailing end maintains the tension between the trolleys, and therefore maintains their relative positions constant. Based on the typical lengths of various sizes of vessels, appropriate sets of pre-determined lengths of wire ropes can be fabricated and kept ready for use as may be required. The lead trolley and the last trolley are connected by wire ropes to winches located at each end of the dock wall. By heaving on the winch located at the arrival berth of the dock wall, and slackening on the winch at the departure berth, the vessel is slowly 'walked' into and through the assembly in a controlled manner. The easiest way to 'walk' the vessel under complete control is by putting both the winches on auto-tension, with the heaving winch on a higher tension. By adjusting the tensions in the two winches, movement can be speeded up, slowed down, and even stopped.

Additional sets of mooring equipment consisting of dock winches, rails, and traveling steel trolleys can be provided if the number of ships requiring treatment is such that the ship berthed at the entry gate is waiting for the mooring equipment to be freed from the ship which has completed treatment and exited the treatment container or has exited from the assembly altogether.

In previously considered dock arrangements, where fitted, only one mooring trolley is provided on each dock wall, and only one winch is provided on each dock wall on the innermost end of the dock walls. Usually these are only provided on graving (basin) docks as normally there is insufficient room for the tugs to exit the dock after positioning the vessel along the centre of the dock. This system is used to guide the vessel's bow into the dock and position the

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vessel along the centre of the dock and directly on top of the keel blocks. This is done with the assistance of tug(s) made fast at the stern of the vessel.

In previously considered floating docks the tugs can pull the vessel via one entrance, and exit via the other entrance after positioning the vessel in the floating dock, and therefore winches and mooring trolleys are not fitted.

In embodiments of the invention, the dock wall extensions, the roller fenders, the dock winch on each end of the dock wall and the array of six mooring trolleys all work together to expedite the operation, for the operation to be carried out in a safe and controlled manner. The dock wall extensions permit faster berthing and un-berthing. The roller fenders prevent damage to the ship's paintwork. The dock winches and the mooring trolleys ensure that the vessel is always alongside the dock wall. The movement of the vessel is also controlled; the result will be catastrophic if for example the vessel is moved along the berth using the vessel's engine and the vessel overshoots due to an engine malfunction or delayed engine response and rams into the exit gate. In a typical operation according to an embodiment, from the time the vessel is berthed at the arrival berth, the vessel can be treated and depart from the departure dock within 60 minutes, and this can be repeated again and again for further vessels, in a safe and controlled manner.

A control room (41) is provided on the Top Deck of the longer dock wall to oversee all the functions and operations of the assembly. Two deck mounted cranes (42) running on rails can be fitted, one on each wall. Stairwells (43 and 44) are provided, one in each wall, with exits as follows: safety deck exit (45 and 46), and the pontoon deck exit (47 and 48).

During the passage of the vessel through the assembly, the vessel can operate all its various cooling water sea intakes so as flush the system with the hot sea water to kill all fouling within the systems; pipelines and heat exchangers.

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Another particularly unique use of this system is the treatment of vessels which arrive into port with macro or animal fouling, as commonly port authorities will not permit cleaning of such a fouled hull without containment, or the assured capability that all the removed fouling can be vacuumed into a receptacle on board the work boats or on the dock.

Using this system, with the vessel contained inside the watertight treatment container with the water temperature adjusted to divers' comfort, the macro fouling can be cleaned by divers using cavitation cleaning technology equipment, and surface supplied air. The propeller(s) can also be polished using cavitation technology equipment. Surface supplied air is at a lower pressure than air in scuba tanks, and is supplied by the oil-less air compressors situated in the dock wall.

Cavitation water pipelines (49) and breathing air pipelines (50), with outlets with valves are provided about every 30 metres or so within the assembly and along its length above the immersion depth of the assembly immediately outside the stairwell exit on the safety deck (43). The pipelines will be protected from damage by the roller fenders and its mountings.

The surface supplied air can also be supplied by portable air compressors running on a gasoline engine or replaceable rechargeable batteries carried on work boats or even on a rubber floatation device to enable a continuous stay underwater until the job is completed.

The underwater paint coating is not affected at all when using cavitation cleaning methods. The use of surface supplied air, as opposed to the use of scuba diving gear which is heavy and cumbersome, will greatly expedite the work. The current methods require the divers having to come out of the water every 45 minutes or

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so to change the scuba tanks or even change the divers. The current method is time consuming, and costs more in terms of labour and cost of equipment.

After the macro fouling has been removed, and the propeller(s) polished, and the divers out of the water, the temperature of the water in the assembly is raised to a minimum temperature of 40°C by circulating Hot Water at about 90°C from the storage tanks through the assembly. The vessel is kept inside the assembly after the water temperature has reached 40°C for a period of about 30 minutes for good measure to ensure that all the macro fouling animals dislodged from the vessel's hull will be killed.

This assembly may convince port authorities to accept the cavitation method of hull cleaning as an approved hull cleaning method without polluting the waters. The cavitation method thoroughly cleans the most fouled hull as quickly and as easily as the lightest fouled hull, but without affecting the very expensive anti-fouling paint coating on the hull. But the animal macro fouling is not all killed by this hull cleaning method, as most or some of them are only dislodged from the hull, but still alive. All the animal macro fouling removed from the hull may only be killed subsequently by its containment within the assembly and by raising the temperature, as described above, to 40°C.

It may be noted that, with reference to embodiments of the invention using the floating dock/assembly, the dock extensions on one wall, the roller fenders, the steel mooring array on rails and the two dock winches, do not appear in combination in previously considered systems. In a previously considered basic floating dock the gates (here used to provide the treatment container) would of course be superfluous. Typically floating docks are used exclusively to lift a vessel clear and out of the water (dry) to enable access to carry out repairs, maintenance and the like to the vessel's underwater hull.

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A normal floating dock is of robust construction as it physically lifts the vessel out of the water. Embodiments of the invention may only call for essentially a steel box to contain water, to provide the treatment container. The container/dock may still be built to Classification Society's rules and regulation for the construction of floating docks, in order to be eligible for insurance coverage.

A normal floating dock is ballasted down to her immersion depth or draft, for example 22 metres, and the vessel is then towed in by tugs and positioned over the blocks on the deck of the dock's pontoon. The floating dock is then de-ballasted to its working draft, when the pontoon deck, with the vessel sitting on the wooden blocks on the deck, is lifted above the water level. In embodiments of the invention, the floating dock/assembly can in contrast always float at its immersion draft, so that no de-ballasting and ballasting cycles are required.

It may also be noted that previously considered graving docks or dry docks are typically constructed exclusively for the purposes of dry docking a vessel, to enable access to carry out repairs, maintenance and the like to the vessel's hull. Therefore the difference in height of water between the sea and the dry dock can be as much as 12 metres or more. Therefore such graving dock gates must be of sufficiently strong construction to withstand the pressure being exerted on the water side. Lock gates can be as heavy as 100 metric tonnes.

In embodiments of the invention, where the water level on both sides are the same, the gates (even when two are fitted) may be made from much more lightweight material, because the pressure on both sides of the gate are equal since the fluid/liquid levels on either side are at the same level.

Typically the floor of a previously considered graving dock is of very robust construction as the vessel comes to rest on the blocks on the dock floor. Embodiments of the invention may only require a floor to isolate the 'dirty' sea-bottom from the treatment container, as the vessel always remains afloat.

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In addition, a previously considered graving dock usually has to pump out the water after introducing the vessel into the dock and closing the watertight gate so that the vessel is sitting on the blocks in a 'dry' dock. It subsequently has to flood the dock on completion of work on the vessel so that the vessel is afloat and the level of the water inside the dock is at the same level as the water outside the dock, after which the gate is opened and the vessel towed out using tugs.

In embodiments of the invention, the water level inside the graving dock is always at the same level as the water level outside the dock, and therefore does not require any pumping to dry the dock, or flooding the dock.

An example of an operational sequence is as follows:

The entry gate is closed (the exit gate is also closed) when tugs are positioning a vessel for entry into the assembly, to prevent the tug's propeller wash to displace the 'hot water' from within the assembly. The vessel (51) is berthed by mooring ropes to mooring hooks/bollards on steel trolleys running on rails built into the deck of the dock wall extension.

Six trolleys are used, and the distances between the trolleys are 'fixed' by means of pre-determined lengths of wire ropes with eyes at both ends secured to the trolleys by locking pins. Based on the typical lengths of various sizes of vessels, appropriate sets of pre-determined lengths of wire ropes can be fabricated and kept ready for use as may be required, for the normal mooring configurations of berthing vessels to the dock wall, similar to when ships berth at cargo working berths.

The entry gate is opened after the departure of the tugs.

The lead trolley and the last trolley are connected by wire ropes to winches located at each end of the dock wall. By heaving on the winch located at the exit

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end of the dock wall, and slacking on the winch at the entry end, the vessel is slowly 'walked' into the assembly in a controlled manner.

The entry gate is closed when the trailing end of the vessel passes into the assembly (Figure 7, showing the entire vessel enclosed within the treatment container).

If the vessel only suffers from micro fouling, such as slime and grass, it may only require the hot water treatment. The temperature of the water in the assembly is then quickly raised to the required temperature of 40 °C by circulating the water at about 90 °C from a storage tank through the assembly with the overflow from the assembly draining back to the same or even a different storage tank.

The vessel stays within the assembly for the minimum required period of 20 minutes, or even 30 minutes for good measure, in water at a minimum temperature of 40 °C.

When the vessel exits out of the assembly after treatment, and is lying alongside the extension of the dock wall, the exit gate is closed.

If vessel's owners require the propeller to be polished, it can be done at the exit berth.

Lines are made fast to tugs waiting to pull her off the wall. The completed vessel is then pulled off the exit dock wall extension. The trolleys are winched back to the original position to make fast to the next vessel which is lying ready at the entry wall. The procedure is then repeated for the next vessel.

It will be appreciated by those skilled in the art that the invention has been described by way of example only, and that a variety of alternative approaches

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may be adopted without departing from the scope of the invention, as defined by the appended claims.

CLAIMS

1. A method of treating bio-fouling on a water-borne vessel, using a treatment container, the method comprising:
 - heating fluid for treatment of the bio-fouling on the vessel;
 - storing heated fluid in a storage container;
 - introducing the vessel into the treatment container; and
 - following introduction of the vessel into the treatment container, transferring heated fluid from the storage container into the treatment container.
2. A method according to Claim 1, comprising, before introduction of the vessel into the treatment container, charging the treatment container with fluid.
3. A method according to Claim 2, wherein the step of charging the treatment container with fluid comprises submerging a portion of the treatment container in a body of fluid.
4. A method according to Claim 1, Claim 2 or Claim 3, comprising, following introduction of the vessel into the treatment container, enclosing the vessel within the treatment container.
5. A method according to Claim 1, Claim 2 or Claim 3, wherein a volume of the heated fluid transferred from the storage container into the treatment container is comparable to a fluid capacity of the treatment container.
6. A method according to Claim 1, Claim 2 or Claim 3, wherein the method further comprises, following introduction of the vessel into the treatment container, removing bio-fouling from the vessel by applying fluid to the vessel in the treatment container, to transfer the bio-fouling from at least one surface of the vessel to the treatment container.

7. A method according to Claim 6, wherein the step of removing bio-fouling from the vessel comprises generating cavitation in the fluid applied to the vessel in the treatment container.
8. A method according to Claim 1, Claim 2 or Claim 3, wherein the temperature of the heated fluid in the storage container is higher than a required treatment temperature.
9. A method according to Claim 1, Claim 2 or Claim 3, wherein the step of transferring heated fluid comprises:
 - measuring a current temperature in the treatment container; and
 - determining on the basis of said current temperature an amount of fluid to be transferred from the storage container to the treatment container.
10. A method of treating bio-fouling on a water-borne vessel, the method comprising:
 - removing bio-fouling from the vessel by applying a fluid to the vessel in a treatment container, to transfer the bio-fouling from at least one surface of the vessel to the treatment container; and
 - following application of the fluid to the vessel, removing bio-fouling elements from the treatment container by transferring fluid from the treatment container to a removal container.
11. A method according to Claim 10, wherein the step of removing bio-fouling from the vessel comprises generating cavitation in the fluid applied to the vessel in the treatment container.
12. A method according to Claim 10 or Claim 11, further comprising, before introduction of the vessel into the treatment container:
 - heating fluid for treatment of the bio-fouling on the vessel;
 - storing heated fluid in a storage container; and
 - introducing the vessel into the treatment container,and, following said application of the fluid to the vessel and before transferring fluid to the removal container:
 - transferring heated fluid from the storage container into the treatment

container.

13. A method according to Claim 12, wherein the removal container is the storage container, and wherein the step of transferring fluid from the treatment container to the removal container comprises transferring the fluid from the treatment container to the storage container, via a filter.

14. An assembly for treating bio-fouling on a water-borne vessel, the assembly comprising:

a heater for heating fluid for treatment of the bio-fouling on the vessel;

a storage container for storing heated fluid;

means for introducing the vessel into the treatment container; and

at least one conduit for, following introduction of the vessel into the treatment container, transferring heated fluid from the storage container into the treatment container.

15. An assembly according to Claim 14, further comprising means for effecting transferral of the heated fluid via the at least one conduit from the storage container into the treatment container.

16. An assembly according to Claim 14 or Claim 15, wherein the treatment container is configured to enclose the introduced vessel.

17. An assembly according to Claim 14 or Claim 15, further comprising at least one pipeline for supplying treatment fluid for removing bio-fouling from the vessel by applying the treatment fluid to the vessel in the treatment container, to transfer the bio-fouling from at least one surface of the vessel to the treatment container.

18. An assembly according to Claim 14 or Claim 15, wherein the treatment container is defined between a dock, which dock containing the storage container, and a pontoon, wherein the treatment container comprises at least one container wall between the dock and the pontoon.

19. An assembly according to Claim 18, wherein the dock is extended longitudinally in both longitudinal directions away from the treatment container.

20. An assembly according to Claim 14 or Claim 15, wherein the treatment container is defined between a plurality of walls of a dock, and wherein at least one wall of the dock comprises a gate for allowing the vessel into and/or out of the treatment container.

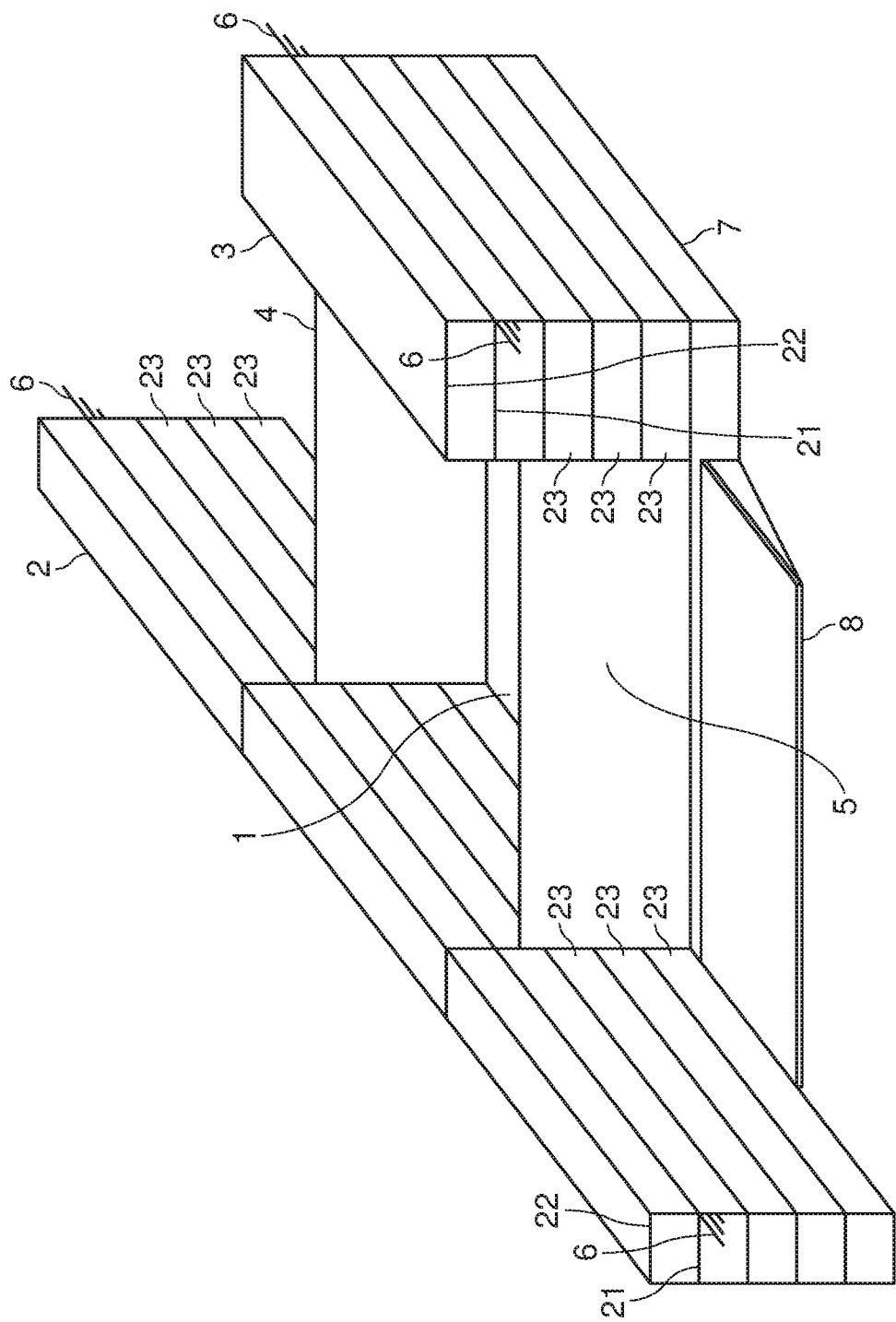


FIGURE 1

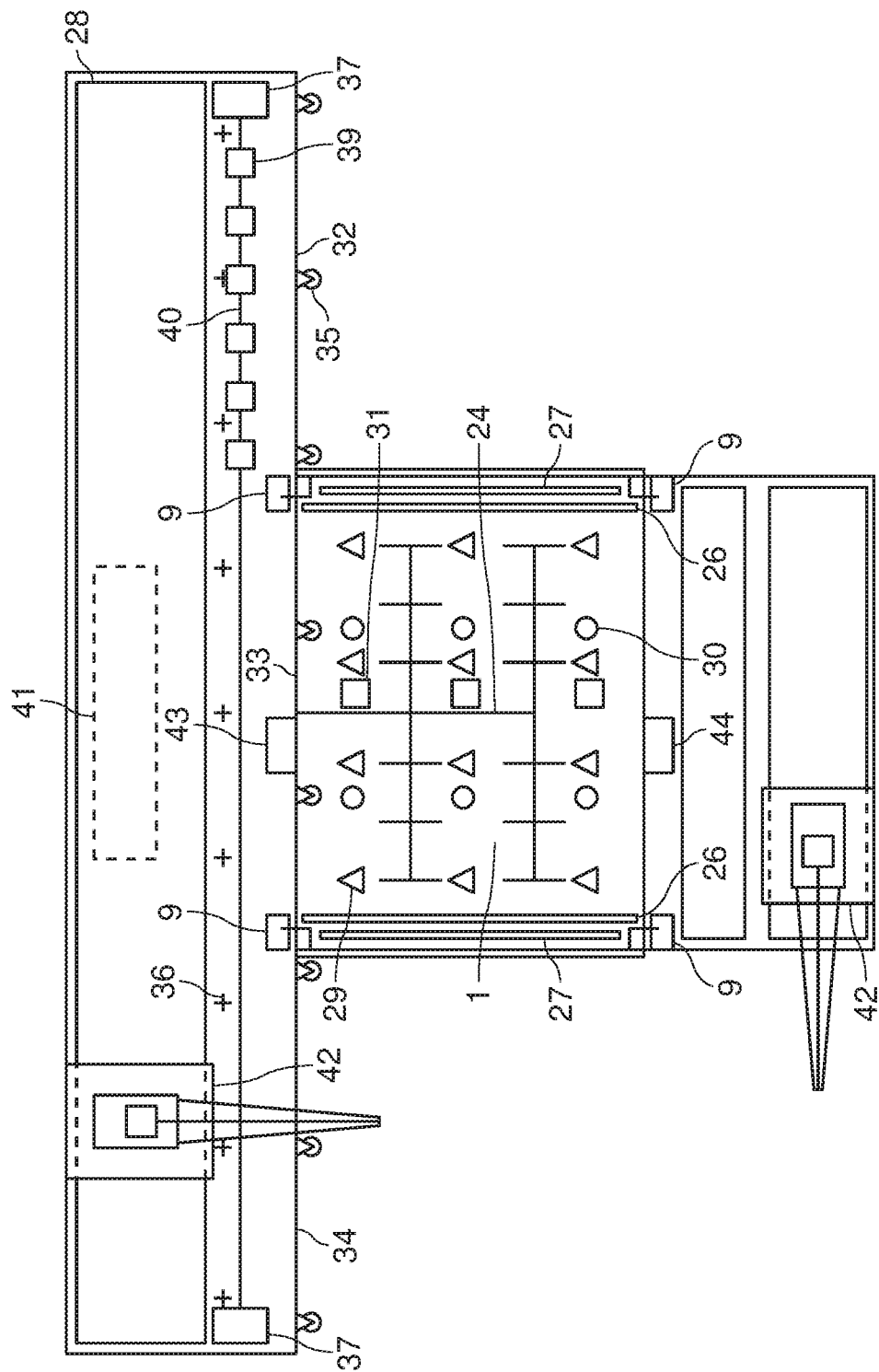


FIGURE 2

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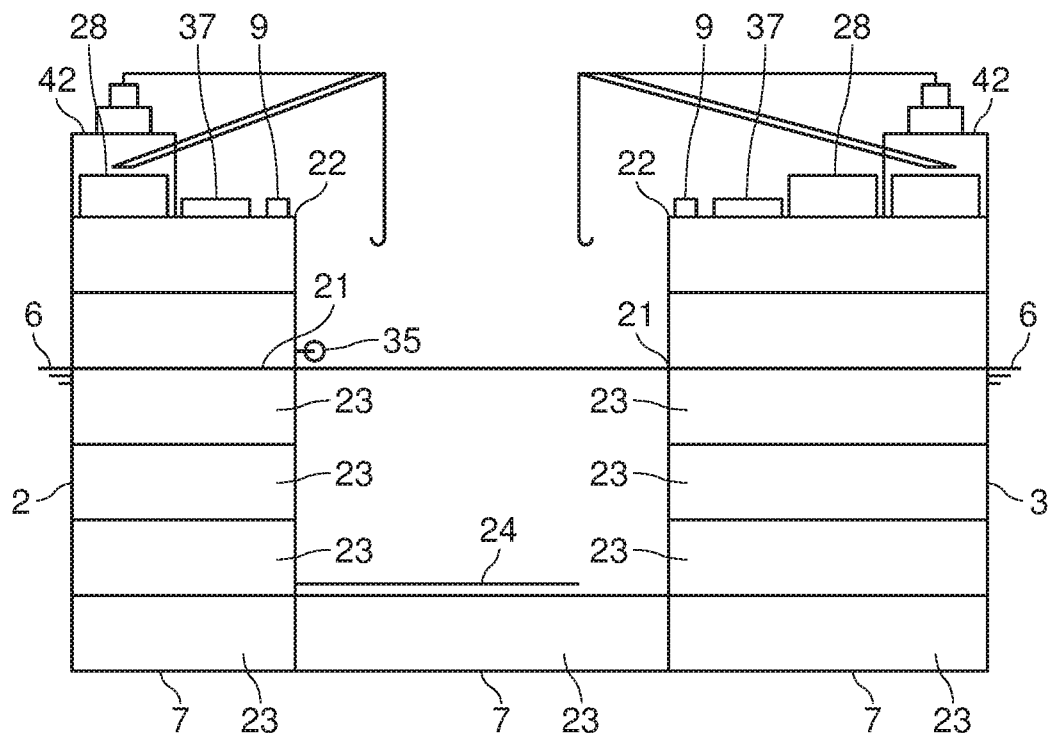


FIGURE 3

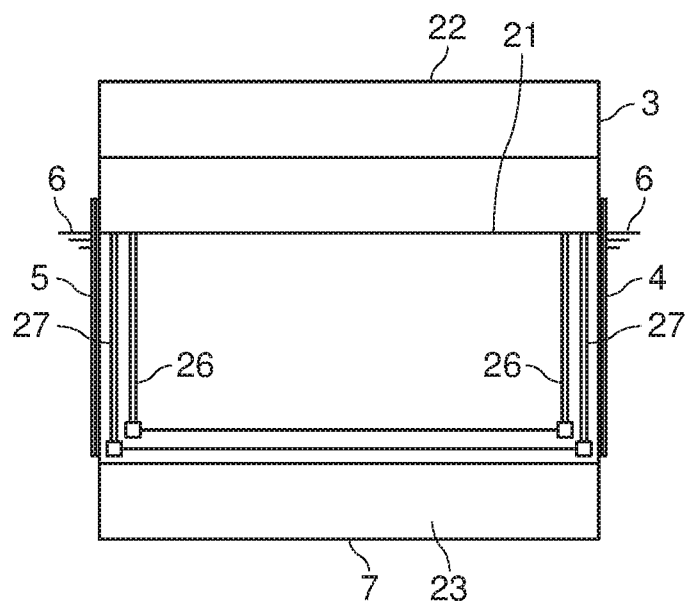


FIGURE 4

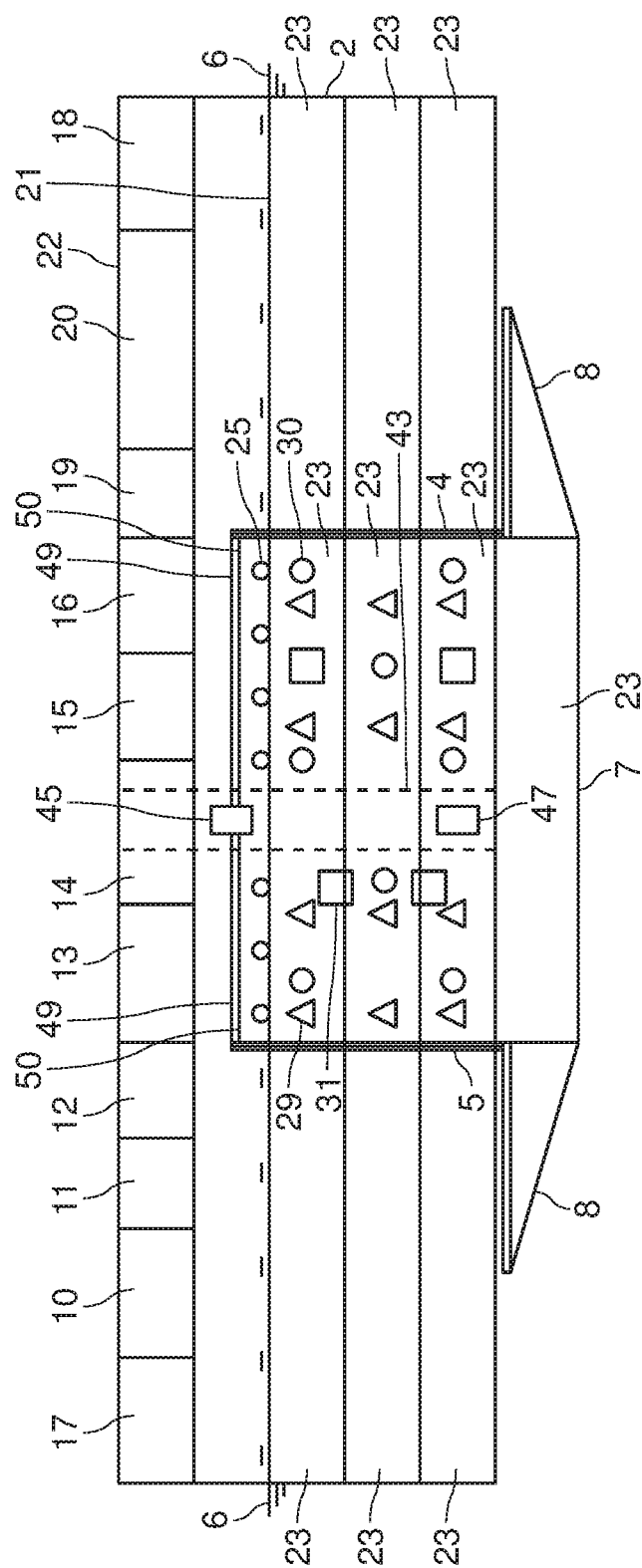


FIGURE 5

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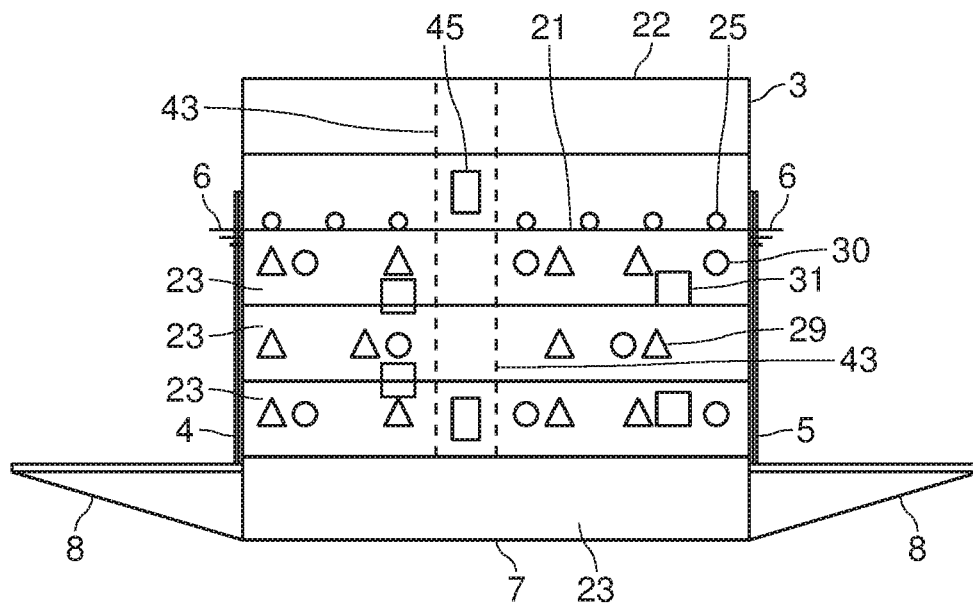


FIGURE 6

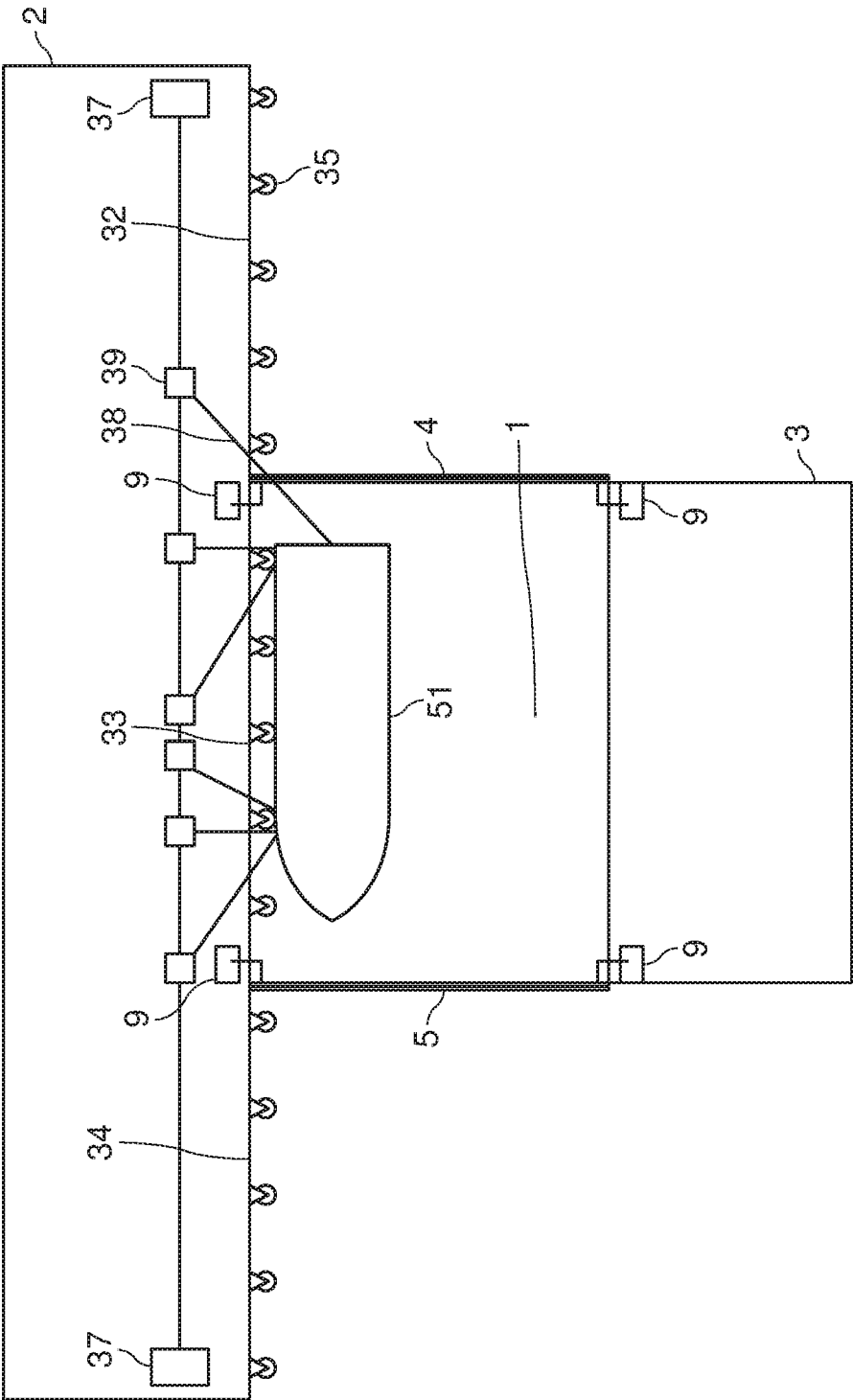


FIGURE 7