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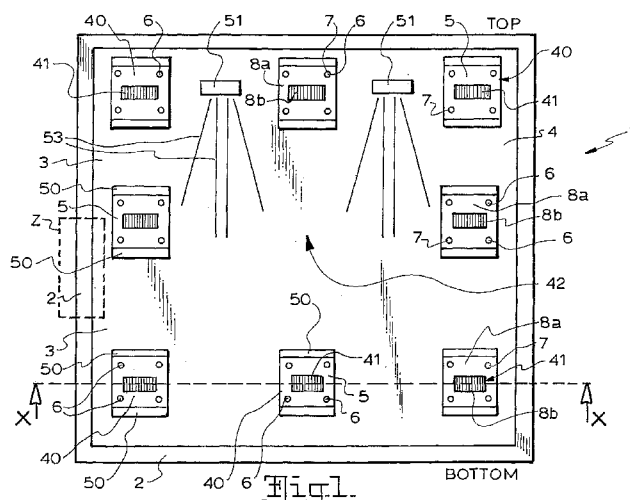
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(54) Title: IMPROVED METHOD AND APPARATUS FOR TREATING MARINE GROWTH ON A SURFACE



(57) Abstract: The present invention relates to an apparatus for treating marine growth on a surface. The apparatus comprises a confinement arrangement which is arranged to confine a volume of heated fluid adjacent a portion of the surface to be treated, such as a ships hull. Fluid is introduced into the volume via an entry port through a wall of the confinement arrangement. In order to facilitate even heating throughout the volume, the entry port is arranged so that the heated fluid is directed in a dispersed fashion.

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**IMPROVED METHOD AND APPARATUS FOR TREATING MARINE GROWTH
ON A SURFACE**

Field of the Invention

5

The present invention relates to a method and apparatus for treating marine growth on a surface, and, particularly, but not exclusively, to a method and apparatus for treating marine growth on boats and ships
10 hulls and other water resident objects.

Background of the Invention

Marine growth on water resident objects such as
15 piers, waterways, oil rigs, water-going vessels, is a significant problem. In water-going vessels, for example, such as ships and boats, marine growth, such as algae weed, invertebrates (mussels, crustaceans) can cause significant cost, for operators of commercial shipping in
20 particular. Marine growth can result in greater wear and tear, significant increase in fuel consumption if not treated (10%-15%) and substantial maintenance costs.

Attempts have been made to address the marine growth problem by using anti-fouling paints on surfaces, such as
25 ships hulls, likely to be affected. Many anti-fouling paints, however, have been found to be damaging to the environment and many countries have banned or are considering implementing bans on the use of such anti-fouling paints and even on entry of ships bearing
30 anti-fouling paints into the country's waterways. Further, anti-fouling paints can be expensive to purchase and apply and require re-application periodically.

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Mechanical scrubbing techniques utilising brush cleaning machines or the like have been used to remove marine growth. Again, however, authorities often ban the use of such equipment due to the environmental effects of infestation of imported marine life in areas where the mechanical cleaning occurs. Further, where a surface has been treated with an expensive surface treatment such as an anti-fouling paint, intensive scrubbing techniques can result in damage to or removal of the surface treatment which can in turn be costly as well as potentially accentuating the environmental damage caused by the scrubbing due to the release of paint toxins into the environment.

In an earlier patent application, International patent application number PCT/AU2004/001642, the disclosure of which is incorporated herein by reference, the present applicants disclose the use of heat treatment for the treatment of marine growth on boats and ships hulls. The earlier application discloses the use of a confinement arrangement, in one embodiment being in the form of a flexible "mat" which is arranged to confine a heated body of water adjacent the surface to be treated, the temperature of the water being sufficient to kill the organic growth. The mat is retained against the surface, regardless of orientation of the surface, by retention means, in one embodiment being magnets, mounted on a mounting means on the underside of the mat (the side facing the surface to be treated). Rollers are also mounted on the underside of the mat, bearing against the surface, so that the mat can be moved across the surface to treat other areas of the surface.

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Summary of the Invention

In accordance with a first aspect, the present invention provides an apparatus for treating marine growth
5 on a surface, comprising a confinement arrangement arranged to confine a volume adjacent a portion of the surface, an entry port arranged to enable introduction of a heated fluid to the volume, the entry port being arranged so that the heated fluid is directed into the
10 volume in such a manner as to facilitate even heating of the volume.

In an embodiment, the entry port is arranged such that the fluid is introduced into the volume in such a manner as to reduce or avoid a Venturi effect tending to
15 cause uneven heating of the volume.

In an embodiment, the entry port is arranged to direct fluid flow downwardly away from the top and towards the bottom of the apparatus in operation. In an embodiment, the entry port is arranged to direct fluid
20 flow to fan outwardly as it leaves the port.

In an embodiment there are a plurality of entry ports.

In an embodiment, the confinement arrangement is movable over the surface to treat other parts of the
25 surface and comprises a cover containing the volume. In an embodiment, the entry port(s) open through the cover. In an embodiment, retaining means are arranged to retain the confinement arrangement proximate the surface, so that it is retained adjacent the surface regardless of the
30 orientation of the surface. In an embodiment, the apparatus comprises bearings arranged to bear against the surface in use. The bearings may comprise one or more bearings and one or more bearing supports mounting the one

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or more bearings.

In an embodiment, the retention means includes one or more magnets. In an embodiment, the magnets may be mounted in the bearing support(s).

5 In an embodiment, the cover is flexible so that it may conform to the surface being treated, so that the confined volume conforms to the surface as the apparatus moves over the surface.

In one embodiment, the bearings are in the form of
10 ball rollers. In one embodiment, the ball rollers enable the apparatus to be moved in any direction across the surface. In another embodiment, the bearings are in the form of casters mounted on gimbles.

The term "marine growth", as used in this document,
15 covers any animal or vegetable matter that may grow on any water going or residing object and is not limited to organisms which only occur in the sea. The term also includes organisms which occur in inland waterways and lakes.

20 In an embodiment, the heated fluid is at a temperature sufficient to kill the marine growth.

In an embodiment, the fluid is heated remotely and passed into the volume from a remote location. Heated fluid may be exhausted from the confined volume as further
25 heated fluid is introduced to the confined volume. The heated fluid may be exhausted into the surrounding environment. In an alternative embodiment, the heated fluid may be further treated within an exhaust means, or may be trapped by a trap arrangement.

30 In one embodiment, the exhaust means comprises a flexible skirt which borders the confinement arrangement. In another embodiment, the exhaust means may be a passageway or duct where marine material is further

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treated. In an embodiment, the exhaust means may exit into a trap for marine material.

In an embodiment, the apparatus may be applied to treat a surface in situ. For example, if the surface is a ships hull, then the apparatus may be applied to treat the ships hull below the water line.

In an embodiment, the cover has a back and sides and an open face, between them forming a cavity. The open face is arranged to be positioned against the surface to be treated, edges of the sides abutting the surface. In an embodiment, the sides are formed by a skirt. The confined volume is defined within the cavity within the cover. In an embodiment, the skirt is flexible and forms a loose seal against the surface in operation.

The apparatus may be moved over the surface being treated in a number of ways. It may be moved manually, for example, by a diver. In another embodiment, however, the apparatus may be moved by a remote control vehicle.

In accordance with a second aspect, the present invention provides a method for treating marine growth on a surface, comprising the steps of confining a volume adjacent a portion of the surface, and introducing heated fluid into the volume in such a manner as to facilitate even heating of the volume.

In an embodiment, the heated fluid is introduced in such a manner as to reduce or avoid a Venturi effect tending to cause uneven heating of the volume.

In accordance with a third aspect, the present invention provides an apparatus for treating marine growth on a surface, including a confinement arrangement arranged to confine a volume adjacent a portion of the surface and an entry port arranged to enable introduction of a heated fluid to the volume, the confinement arrangement

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comprising a skirt providing a seal about the volume, the confinement arrangement being movable over the surface to treat other portions of the surface, the skirt providing a low tension contact against the surface so that when the arrangement is moved over the surface it does not substantially remove marine growth.

In an embodiment, tension of the seal is adjustable.

In an embodiment, the skirt is flexible and has a hollow cross section. In an embodiment the cross section is an "O" ring. In an embodiment the cross section is in the form of a section of a circle. In an embodiment, the cross section is semi-circular.

In an embodiment, the skirt is adjustable in size to adjust the tension against the surface.

In an embodiment, the tension of the skirt against the surface is arranged such that fluid can escape the volume via the seal.

In an embodiment, the apparatus is arranged for operation partly or totally underwater, and, in an embodiment, tension of the skirt against the surface is arranged such that the skirt may hydroplane over the surface as it moves.

In an embodiment, the confinement arrangement is moveable over the surface to treat other parts of the surface and comprises a cover containing the volume. In an embodiment, bearings are provided which in use bear against the surface and support the cover a pre-determined distance from the surface.

In an embodiment, retaining means are provided to retain the confinement arrangement proximate the surface, so it remains adjacent the surface regardless of the orientation of the surface.

This aspect of the invention may include any or all

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of the features of the first aspect of the invention.

In accordance with a fourth aspect, the present invention provides a method for treating marine growth on a surface, comprising the steps of confining a volume
5 against a portion of the surface, heating the volume, and sealing the volume against the surface with a low tension seal such that the volume may move across the surface without substantially dislodging marine growth.

In accordance with a fifth aspect, the present
10 invention provides an apparatus for treating marine growth on a surface, comprising a confinement arrangement arranged to confine a volume adjacent a portion of the surface, an entry port arranged to enable introduction of a heated fluid to the volume, and an exhaust arrangement
15 arranged to exhaust fluid from the volume and reduce or eliminate escape of marine growth matter into the environment.

In an embodiment, the apparatus is arranged to prevent or reduce the escape of live marine growth matter
20 into the environment. Treatment of the marine growth matter within the volume kills substantially all the marine growth. In an embodiment, the exhaust arrangement includes an arrangement which results in further treatment of marine growth entering the exhaust means,
25 advantageously killing any marine growth which may still be alive.

In an embodiment, the exhaust arrangement comprises a trap for trapping marine growth matter and preventing it from exiting into the surrounding environment.

30 In an embodiment, the exhaust arrangement comprises a passageway which is arranged to receive exhaust fluid from the confinement arrangement. In an embodiment, the exhaust fluid is still at elevated temperatures sufficient

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to treat marine growth within the passageway. In the embodiment where the exhaust means comprises a trap, the trap comprises a net or fine mesh which the passageway exits into. The net or fine mesh advantageously allows
5 fluid to escape into the external environment but reduces or eliminates escape of treated marine growth into the environment.

In an embodiment, the confinement arrangement is moveable over the surface to treat other parts of the
10 surface and comprises a cover containing the volume.

In an embodiment, the apparatus comprises a retaining means arranged to retain the confinement arrangement proximate the surface, so it remains adjacent the surface regardless of the orientation of the surface.

15 In an embodiment, this fifth aspect of the invention may include any or all of the features of any of the first to fourth aspects of the invention discussed above.

In accordance with a sixth aspect, the present invention provides a method for treating marine growth on
20 a surface, comprising the steps of confining a volume against a portion of the surface, introducing heated fluid into the volume, exhausting the heated fluid from the volume and preventing or reducing the escape of marine growth matter into the environment from the volume during
25 exhaustion.

In accordance with a seventh aspect, the present invention provides an apparatus for treating marine growth on a surface, including a confinement arrangement arranged to confine a volume adjacent a portion of the surface, the
30 confinement arrangement including a cover for containing the volume, the cover being provided with an entry port arranged to enable introduction of a heated fluid to the volume, the confinement arrangement being movable over the

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surface to treat other portions of the surface, the apparatus including components which are mounted substantially externally of the cover, substantially outside of the confined volume, whereby to enable the
5 depth of the confined volume to be optimised.

In one embodiment, the components include a bearing support mounting one or more bearings. At least a portion of the one or more bearings extends into the covering and in use is arranged to bear against the surface. In an
10 embodiment, the one or more bearings may be mounted entirely within the covering. In an alternative embodiment, a portion of the one or more bearings may extend within the covering and another portion may not extend within the covering.

15 In one embodiment, the components include a retention means, which is operable to retain the confinement arrangement against the surface being treated. In one embodiment, the retention means includes one or more magnets. In an embodiment, the entire retention
20 means is mounted within the cover. In an alternative embodiment, the portion of the retention means extends into the cover and another portion of the extension means does not extend into the cover.

In one embodiment, the components include one or
25 more bearings and one or more retention means, the retention means and bearings are mounted by the bearing support. In an embodiment, the portion of the retention means extends externally of the cover.

The cover is, in one embodiment, of flexible
30 material, so that it may conform to the surface being treated, so that the confined volume conforms to the surface as the apparatus moves over the surface.

In one embodiment, the entry port for heated fluid

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is positioned so that in use it is situated at the lower part of the cover, so that heated fluid introduced into the confined volume will naturally flow upwardly through the confined volume. In one embodiment, there are a
5 plurality of entry ports in the form of holes in the cover extending along the bottom part (in use) of the cover. The plurality of holes may be provided in a line extending at intervals along the bottom part of the cover.

In one embodiment, the bearings are in the form of
10 ball rollers. In one embodiment, the ball rollers enable the apparatus to be moved in any direction across the surface.

In an embodiment, the heated fluid is at a temperature sufficient to kill the marine growth.

15 In an embodiment, the fluid is heated remotely and passed into the volume from the remote location. Heated fluid may be exhausted from the confined volume as further heated fluid is introduced to the confined volume. The heated fluid may be exhausted into the surrounding
20 environment.

In an embodiment, a depth dimension of the confined volume is relatively small in magnitude. The heated fluid introduced into the confined volume may form a layer over the portion of the surface, the layer being of relatively
25 small thickness. Advantageously, this is energy efficient as it means that the amount of heated fluid required to treat the surface is minimised, and therefore the amount of energy utilised is minimised. The actual depth dimension will in many cases depend upon the magnitude of
30 the confined volume which may vary from application to application. In the embodiment, however, the depth dimension may be in a range of 2-50mm, in an alternative embodiment in a range of 2-15mm, in a further alternative

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embodiment in a range of 2-10mm. In a further alternative embodiment, the range is 2-8mm. In a further embodiment, it is between 3-7mm. In one embodiment, the depth dimension is 6mm.

5 In an embodiment, the apparatus may be applied to treat a surface in situ. For example, if the surface is a ship's hull, then the apparatus may be applied to treat the ship's hull below the water line.

10 In an embodiment, an exhaust means enables heated fluid that has been introduced into the volume to be exhausted from the volume. The exhaust means may exhaust the heated fluid into the surrounding environment. In an embodiment, the exhaust means is a flexible skirt which borders the confinement arrangement.

15 In an embodiment, the cover has a back and sides and an open face, between them forming a cavity. The open face is arranged to be positioned against the surface to be treated, edges of the sides abutting the surface. The confined volume is defined within the cavity within the
20 cover. The sides, in an embodiment, are formed at least partially of a flexible skirt which forms a loose seal against the surface in operation.

 As discussed above, the apparatus may be moved over the surface being treated in a number of ways. It may be
25 moved manually, for example, by a diver. In another embodiment, however, apparatus such as the apparatus of the first aspect of the invention may be moved by a remote control vehicle.

 In accordance with a eighth aspect, the present
30 invention provides a motive arrangement for moving an apparatus for treating marine growth on a surface over the surface, the motive arrangement comprising a remote control vehicle and winch assembly, the remote control

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vehicle having means arranged to secure the vehicle to the surface being treated, and a winch arrangement including at least one line arranged to be attached to the apparatus for treating the marine growth, the vehicle being movable
5 across the surface and the winch being operable to adjust the length of the line, whereby to enable the apparatus for treating marine growth to be moved across the surface in a desired direction.

The apparatus for treating marine growth in one
10 embodiment includes a housing which is arranged to mount a means for applying heat to the surface. In one embodiment, the apparatus also includes a retaining means for retaining the housing proximate the surface. The means for applying heat may be a heated fluid and the
15 housing may include a confinement arrangement which is arranged to confine a volume of the heated fluid. The confinement arrangement may also have an entry port arranged to allow the introduction of heated fluid into the volume.

20 The motive arrangement may be arranged for operation with an apparatus in accordance with any of the above aspects of the invention, but is not limited to operation with such apparatus. The motive arrangement may be used with any apparatus which is arranged for the treatment of
25 marine growth. Apparatus such as disclosed in the applicant's earlier referenced PCT application may be used with the motive arrangement of this aspect of the invention, for example.

Apparatus which includes a housing mounting a
30 heating means (such as a heating element) may be driven by the motive arrangement of this aspect of the invention, for example.

Apparatus including a conveyor belt of a material

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which retains heated fluid may also be used with the motive arrangement of this aspect of the invention, for example.

In accordance with a ninth aspect, the present invention provides a method of moving an apparatus for treating marine growth on a surface over the surface, the method comprising the steps of operating a remote control vehicle which is connected to the apparatus and arranged to move the apparatus under remote control.

In accordance with a tenth aspect, the present invention provides a system for treating marine growth on a surface, the system comprising a motive arrangement in accordance with the eighth aspect of the invention, and an apparatus for treating marine growth in accordance with any one of the first, third, fifth or seventh aspects of the invention.

In the above embodiments, the heated fluid is introduced in order to treat the marine growth. The apparatus of the above embodiments may also be suitable for introducing any fluid or substance that may treat the marine growth, and may not necessarily be heated. For example, a chemical may be introduced by the apparatus to treat the marine growth.

Brief Description of the Drawings

Features and advantages of the present invention will become apparent from the following description of embodiments thereof, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is an underside view of an apparatus in accordance with an embodiment of the present invention;

Figure 1A is an underside view of an entry port 51

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for introducing fluid into the apparatus of Figure 1;

Figure 1B is a detail view of an alternative entry port 51;

Figure 2 is a cross section along line XX of
5 Figure 1;

Figure 3 is a detail on ZZ of Figure 1;

Figure 4 is a cross section on YY of Figure 3;

Figure 5 is a diagram illustrating operation of the embodiment of Figure 1;

10 Figure 6 is an underside view of an apparatus in accordance with a further embodiment of the present invention;

Figure 7 is a rear view of the apparatus of Figure 6;

15 Figure 8 is a side view of the apparatus of Figure 6;

Figure 9 is a detailed exploded view of an apparatus in accordance with a further embodiment of the invention;

Figure 10 is a rear view of the apparatus of
20 Figure 9;

Figure 11 is an underside view of the apparatus of Figure 9;

Figure 12 is a section on line EE of Figure 10;

Figure 13 is a perspective view from the underside
25 of the apparatus of Figure 9;

Figure 14 is a perspective view from the rear of apparatus of Figure 9;

Figure 15 is a detailed exploded view of an apparatus in accordance with a further embodiment of the
30 invention;

Figure 16 is a rear view of the apparatus of Figure 15;

Figure 17 is a section on line EE of Figure 16;

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Figure 18 is a detail of Figure 17;

Figure 19 is a perspective view from the underside of the apparatus of Figure 15;

Figure 20 is a perspective view from the rear of the apparatus of Figure 15;

Figure 21 is a plan view of an apparatus in accordance with a further embodiment of the invention;

Figure 22 is a cross section along the line XX of Figure 21;

Figure 23 is a detail of a bearing support of the apparatus of Figure 21; and

Figure 24 is a diagram illustrating a motive arrangement in accordance with an embodiment of the present invention, being utilised with an apparatus in accordance with the embodiment of Figure 1.

Detailed Description of Embodiments

Figures 1 to 4 are views of an embodiment of an apparatus in accordance with the present invention. The apparatus, generally designated by reference numeral 1 is in the form of a confinement arrangement 1 arranged to confine a volume of fluid adjacent a portion of the surface to be treated for marine growth. In this example embodiment, the confinement arrangement 1 includes a flexible cover 42, comprising sides 2 and a back 3 arranged to define a space 4 within the sides 2 and back 3 for confining the volume of fluid.

In operation, the fluid is heated and the heat of the fluid operates to treat the marine growth (with sufficient heat to kill the marine growth).

Heated fluid is introduced by a means of an entry port 51 (in the embodiment of Figures 1 to 4 there are two

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entry ports 51, positioned towards the TOP of the apparatus in use). In operation, the entry port is arranged such that heated fluid is directed into the volume in such a manner as to facilitate even heating of
5 the volume.

In more detail, the apparatus 1 includes a plurality of bearing support 40. Each bearing support in this example comprises a mounting block 5 mounting four ball bearings 6. The ball bearings 6 are retained within
10 depressions 7 within the mounting block 5. In use, the ball bearings 6 bear against the surface being treated.

The mounting block 5 also mounts a retention device 41, which operates to retain the apparatus 1 against the surface to be treated, notwithstanding the
15 orientation of the apparatus 1. For example, a ship's hull in the water can be treated by the apparatus 1, the retention devices 41 operating to retain the apparatus 1 against the side of the ship's hull.

In this embodiment, the retention devices 41 are
20 rare earth magnets, and each of the mounting blocks 5 mounts a rare earth magnet 41. The magnet 41 does not make any contact with the ship's surface. The distance between the magnet 41 and the surface can be adjusted via the mounting block 5 in order to vary the desired holding
25 force. In Figure 1 the magnets 41 are shown mounted by the mounting blocks 5. In an embodiment, the magnets 41 may be mounted totally within the mounting block 5 and may not be able to be seen. In many cases, when operating in corrosive conditions, such as sea water, it may be
30 preferable to have the magnets 41 sealed within the mounting block 5. In an embodiment, this may be done by covering the mounting block 5 with a base plate (not shown in this embodiment, but shown in later embodiments), which

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has holes for receiving the bearings, but covers and seals the magnets 41.

The mounting block 5 comprises a polyethylene block body which is constructed by assembling one or more polyethylene sections 8 together into a block and securing them together via a screw or bolt (not shown in Figures 1 to 4). Other suitable materials could be used for the block.

The use of sections 8 enables flexibility of design of the embodiment. For example, if a larger magnet 41 is required, two or more magnet housing sections 8a may be used in the mounting block 5. The magnet housing sections 8a include a cavity 8b to receive the magnet 41.

The distance between the magnet 41 and the surface to be treated may be adjusted. A base plate 10 may be provided to go over the magnet 41 in the mounting block 5 (as discussed above). This is shown in Figure 2 and in later embodiments. Base plates 10 of different thickness may be provided in order to adjust the distance between the magnet 41 and the surface to be treated. For example, in one embodiment, the base plate 10 is a 3mm thick aluminium plate. In another embodiment, a 1mm or 2mm stainless steel plate may be used as the base plate.

The volume 4 confined by the apparatus 1 may also be adjusted by adjusting the number of polyethylene sections 8 in each mounting block 5. The more sections 8 provided, the greater the operating distance between the back 3 of the cover and the surface being treated. In one embodiment, the operating distance between the inside of the cover 42 and the surface being treated may be in the range of 30-50mm, in an embodiment 35-45mm, in an embodiment 35-40mm, in an embodiment 35-38mm. In some embodiments, the arrangement may be "low profile", and the

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distance between the cover and surface in use may be in the range of 2-15mm, 2-10mm, 2-8mm or 3-7mm.

In some embodiments, a greater distance may be required, particularly where the surface being treated is heavily encrusted. In this case, the rollers may be required to be of larger size, and the distance between the cover and surface being treated could be 50mm or more, or even 100mm or more.

Note that mounting block 5 may not necessarily be an assembly of sections 8 as in this embodiment. In an alternative embodiment, for example, the mounting block 5 may be formed by moulding plastics incorporating the magnets and roller ball assemblies. Mounting block 5 may be any suitable material, and is not limited to plastics.

Note that it is preferable the magnets be protected from the environment (e.g. a salt water environment) so as to avoid deterioration. Mounting the magnets 41 in a mounting block, such as a mounting block of this embodiment, facilitates protection of the magnets 41.

In this embodiment, the cover 42 is a sheet of 3mm HDPE (polyethylene) and is quite flexible. Other suitable materials may be used for the cover, including marine carpet, rubberised insertion sheeting and Perspex. Any exotic flexible synthetic may be utilised, formed into a single sheet. Some insulating sheeting (e.g. neoprene) may be added to improve the thermal containment properties. The thickness of the sheet is not restricted to 3mm, and it may be 4mm or 4.5mm or any convenient thickness.

In this embodiment, the ball bearings 6 are 25mm stainless steel balls. The roller balls 6 allow the apparatus to be moved in any direction over the surface, as they are multi-directional. The invention is not

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limited to the use of ball bearings. Any suitable bearing arrangement may be used in other embodiments. For example, cylindrical rollers may be used as the bearings. Any other convenient bearing arrangement may be utilised.

5 In an embodiment, the bearings may comprise casters mounted on gimbles for motion in any direction.

In this embodiment, there are four ball bearings 6 mounted on each mounting block 5. There may be less or more than four bearings. For example, in an embodiment, 10 three casters mounted on gimbles may be arranged on each mounting block 5 in a triangular arrangement. There may be less or more bearings than this.

It may be advantageous to have the least amount of bearing contact with the surface being treated, so as to 15 avoid dislodging marine material.

In this embodiment, the mounting blocks include sloped sides 50 such that when the confinement arrangement 1 is moving upwards or downwards (towards TOP or towards the BOTTOM in the Figure) the mounting blocks 20 may move easily over obstacles. Note that the sloped sides may extend all around the mounting blocks 5 and not just on opposing sides. Further, the mounting blocks 5 may be of different shape, such as circular, with a tapered circumference, or any other shape.

25 For the ingress of heated fluid, two entry ports 51 are mounted towards the top of the confinement arrangement 1 in operation. The entry ports 51 provide downwardly projecting nozzles in use to direct fluid downwards into the volume and also to "fan" outwards, as 30 illustrated by lines 53. As can be seen from Figure 1A, the profile of the entry port 51 is such as to form a narrow slot 51a, from which the water egresses. When ejected from the slot like aperture 51a, the introduced

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fluid fans out as illustrated by lines 53.

This has the effect of facilitating heating of the entire volume 4. Heated fluid injected at the bottom of this embodiment may tend to travel upwardly and can give rise to a Venturi effect, resulting in the volume being heated unevenly and in particular the bottom part of the volume may be cool relative to the top part. The Venturi effect can result in cool fluid being dragged from the external environment (e.g. external sea water). By injecting from the top, as shown in Figure 6, any Venturi effect is reduced and heating of volume 4 is facilitated. The effect of injecting down and outwards may neutralise the thermal rise of the fluid as it would naturally tend to do. It also creates eddies and currents which reduce the chances of a Venturi effect occurring. Further, the mounting blocks 5 within the confinement arrangement 1 may act as fluid flow baffles, further reducing chances of formation of a Venturi effect dragging cool fluid in from the external environment.

In operation, the "fan" affect of the introduced fluid may spread out at any desired angle from the inlet 51a. In this embodiment, the fan may spread out so that the angle is approximately between 45° and 145° at the base of the fan. It may be between 55° and 130° , or 70° and 110° , or 85° and 95° .

In another embodiment, the inlets may be placed mid-way between the top and the bottom and the inlet arranged so that fluid fans out over 360° .

Figure 1A shows the underside view of a variation of the inlet. It comprises an outer washer 51b and an inner washer 51c which includes a cut-out in it 51d which causes the water from the inlet 51e to fan out at an angle. The

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angle shown here may be varied, as discussed above.

Note that in other embodiments there may be less or more than two inlets and they may be placed at different positions within the apparatus 1.

5 In this embodiment, the sides 2 of the confinement arrangement 1 are formed by a polymeric material skirt having a deformable "O" ring cross section (see Figures 3 and 4). The point of contact P (Figure 2) with the surface in this embodiment forms a relatively low tension
10 contact with the surface. The size of the skirt 2 (i.e. its depth and width) and the force of the magnets 41 are chosen to provide an appropriate tension. An appropriate tension is where the skirt contacts the surface and makes a low tension seal but allows for
15 hydroplaning as water is ejected from the confinement arrangement 1 under the skirt, so that the apparatus 1 can easily move over the surface. In this embodiment, tension may be adjusted by releasing a bar 60 via screws 61
20 (Figure 3 and Figure 4) to allow the cross section of the skirt to be reduced or increased. A plurality of transverse slots 63 are provided in the skirt 2. The slots 63 receive the bodies of the screws 61 therethrough and adjustment is by moving the slots 63 transversely relative to the screw position to vary the size of the
25 cross section of the skirt 2 and therefore the applied tension, and then tensioning the screws 61.

 Note that in other embodiments, the tension of the seal may not be adjustable but may be preset. The skirt cross section in this case may be a predetermined set
30 size.

 Tension of the seal against the surface is ideally relatively low so that it easily moves over the surface without removing dead or live marine matter.

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In this embodiment, heated fluid exhausts via the flexible skirt 2. In another embodiment, the skirt 2 is a simple, single membrane flexible skirt. In this embodiment as discussed above, the skirt is a hollow type skirt similar to a car door type seal. This "O" ring type seal may be useful providing an "aquaplane" effect as hot water escapes from this seal and also may reduce friction against the surface being treated. It also advantageously reduces or avoids marine growth being removed by the skirt as the skirt moves over the surface, which is not desirable as this would leave the marine growth in the vicinity (for example, it is undesirable to have marine growth removed from a ship in a harbour).

An operation of apparatus 1 is illustrated in the Figure 5 diagram, the surface to be treated being the surface of a ship's hull 20. The roller balls 6 contact the surface of the hull 20. Because of the multi-directionality of the roller balls 6, the apparatus 1 can be moved in any direction over the surface of the hull 20. The magnets 41 attractive force retains the roller balls 6 and cover 42 against the surface 20.

As illustrated in Figure 5, the cover 42 encloses a volume adjacent a portion 21 of a surface of the ship's hull 20. The flexible skirt 2 forms a flexible seal against the surface portion 21. A hot water heater J on a service boat 22 supplies heated water via a flexible insulated hose K to inlet ports I. As further hot water is supplied to the volume 4 excess hot water is evacuated via the flexible sides 2 into the water 23. Note that hot water need not be provided from a service boat. The heater may be mounted on the ship itself, or elsewhere.

Water is provided at a temperature of greater than 50°C and preferably greater than 60°C for a predetermined

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period in order to effectively kill any organic growth on the ship's hull 20 in the portion 21. Note that temperatures and rate of application may vary depending on environmental conditions.

5 On an initial application, temperatures and rates of application of fluid may be varied until an ideal rate and temperature is selected.

 The heated water heated by the heater J may be environmental water 23 pumped into the heater J. The
10 environmental water may be sea water, for example.

 To treat other portions of the ship's hull 20 surface, the apparatus 1 is moved over the surface. Motion may be implemented by a diver pushing the cover 1 over the surface. Alternatively, an automated arrangement
15 may be implemented, such as a motive arrangement in accordance with an embodiment of the present invention (see later description).

 In the embodiment, the water is an "open" system. That is, water is pumped by hose K and exhausted into the
20 environment via the flexible skirt 2. In an alternative embodiment, water may be provided in a closed system, where it is returned back to the heater J by a further hose.

 One of the advantages of the arrangement 1 of this
25 embodiment is that when it is moved over the surface of the ship's hull 20 after treating the organic growth, it does not significantly abrade the surface so that the organic growth, although dead, is substantially retained on the surface and is not dropped immediately into the
30 surrounding environment. When the ship is underway, however, the marine growth eventually sheds from the surface and into the environment, preferably when the ship is in the open sea, away from port.

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In embodiments of the present invention, there is a possibility that rollers (ball bearings or what ever rollers are used) may dislodge some bacterial material. This bacterial material will generally be killed within
5 the volume of the apparatus 1 anyway. To increase the likelihood of kill, instead of allowing the fluid to be expelled from the sides of the apparatus (under the seals) the apparatus may be modified as illustrated in the following embodiment described with reference to
10 Figures 6, 7 and 8.

In the embodiment of Figures 6, 7 and 8 the same reference numerals are used for the same components as described with reference to the above embodiments, and no further description will be given of these components.

15 In this embodiment, the bearing supports 5 are positioned in a staggered formation relative to each other, to facilitate motion of the arrangement 1 along the surface. Note that this is one way only of staggering the rollers relative to each other and there may be many other
20 patterns which could be implemented. Also, it will be appreciated that with this and other embodiments, the invention is not limited to eight bearing supports, but there could be any number.

The skirt 2 is of the same construction as the
25 skirt 2 of the embodiment of Figures 1 through 4 and the tension of the contact of the skirt against the surface can be adjusted in the same manner.

A hot water hose 100 is provided for connection to a heated fluid supply, such as a heated fluid supply from a
30 boiler on a support vessel. The hose 100 may be insulated by way of an air jacket. The hose 100 feeds pipes 101, 102 which, in turn, feed heated fluid through the anti-Venturi nozzles 51.

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In this embodiment, the tension of the skirt 2 against the surface is adjusted such that the seal between the skirt and the surface resists escape of fluid water from the volume confined by the confinement arrangement 1, but still allows for movement over the surface without substantially removing marine growth.

In this embodiment, instead of fluid escaping via the seal, an exhaust arrangement 103 is provided, for exhausting the fluid and at the same time preventing or reducing the escape of marine growth.

The exhaust arrangement 103 comprises a perforated hose 104 which extends around the inner periphery of the confinement arrangement 1. Exhaust fluid perforates through the holes 105 in the hose 104 and is then transported along the passageway formed by the hose 104. End portions 106, 107 of the hose 104 extend through ports 108, 109 in the back 3 of the confinement arrangement 1. These hose lengths 106, 107 have open ends 110, 111 from which exhaust fluid is ejected.

All marine growth that is treated within the volume confined by the confinement arrangement 1, will generally be killed. By far the majority of the marine growth will remain adhered to the ship's hull until the ship gets underway. It therefore may then fall off in the open ocean, for example. It is possible that some dead marine growth may fall off within the confinement arrangement, and this will then be exhausted via the exhaust arrangement and exit via ports 110, 111. A fine mesh net or material 120 is fastened to the back 3 of the confinement arrangement 1. This catches any marine material which does escape from the confinement arrangement.

The mesh 120 may be attached to the back 3 of the

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arrangement 1 in a removable fashion e.g. by Velcro or some other type of fastener, so that it may be periodically replaced. The mesh 120 allows water to escape but advantageously retains any marine growth.

5 In the unlikely event that live marine growth escapes from the confined volume, the fluid within the hose 104, 106, 107 will operate to kill the marine growth as it travels along the hose 104. The hose could be made longer e.g. by coiling the sections 106, 107 in order to
10 further ensure that no live marine growth is exhausted.

 As can be seen from Figure 8, the hose 104 exits at the bottom side of the mat 103 when the mat is being used (e.g. when the mat is being used on the surface of a ship it will generally be substantially vertical in
15 orientation, corresponding to the hull orientation as the ship sits in the water). The end portions 106, 107 thus extend upwardly in use towards the ports 110, 111. As hot fluid tends to rise, the fluid flowing in the hose lengths 106, 107 tends to form a convection heat pump, assisting
20 in pulling fluid into the hose 104 via the perforations 105.

 In some embodiments, the length of the end portions 106, 107 can be extended in order to accentuate the heat pump effect. The portions 106, 107 may be fastened to the
25 back of the mat 1.

 There may be cases where the seal of the apparatus 1 separates from the surface being cleaned e.g. where the surface is uneven. The effect of the heat pump formed by extensions 106 and 107 will tend to maintain a suction
30 into the hose 104, rather than allowing water from inside the mat to escape. The convection heat pump therefore tends to prevent escape of unfiltered water into the environment.

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Some unfiltered water may escape into the environment, but it will generally be only small amounts.

In the above-described embodiment, the exhaust arrangement 103 has holes 105 for drawing-in fluid from the volume 4. In an alternative embodiment, the holes may be replaced by slits spaced along the hose 104.

Other ways of ensuring that marine growth remains on the surface or is prevented from escaping to the environment are as follows:

1. A closed circulation system may be applied. That is, fluid input to the volume may be ejected from the volume via a line at the back of the volume and returned to the fluid source. A filter may be placed in the closed circulation system in order to remove marine material.
2. The temperature of the fluid may be raised, for example, to 75° or 80°.

A further embodiment of an apparatus in accordance with the present invention will now be described with reference to Figures 9 to 14. In these figures, the same reference numerals have been used for components that are the same or similar to components in previously described embodiments, and no further description will be given of these components.

The embodiment of Figures 9 to 11 function in a similar manner to previous embodiments, except that fluid that has been introduced into the volume 4 is subsequently returned to a suction reclamation pump and filtration system, which may be located elsewhere e.g. on a boat.

The exploded view of Figure 9 shows in detail how this embodiment of the present invention is constructed. The back 3 of the cover is made up essentially of two parts. These include a backing plate 200 and a insulating backing material part 201, both of which are flexible to

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allow the apparatus to conform when it is moving over the surface to be treated. A rubber retainer frame 202 is secured to the back 3 by screws 203, washers 204 and wing nuts 205.

5 The skirt 2 in this embodiment is formed by two vertical skirt portions 206 and 207, and two horizontal portions 208 and 209. The skirt 2 has a hollow cross section, as described in preceding embodiments. The skirt 2 is retained by skirt retainer frame 208 which has
10 screw holes to receive the screws 203.

The bearing supports 5 comprise a magnet section 8a, retaining the magnet, a base plate 10 sealing the magnet, and a facing plate 11 which is mounted to the back. Roller bearings 6 are also provided.

15 Fluid injectors 51 are mounted to the back 3 by a cam lock fitting 210 and retaining cap 211, and screws 212.

A support bar and cable arrangement 213 supports the apparatus 1 in use.

20 In this embodiment, the exhaust arrangement 103 comprises a series of perforated pipes 104 which run within the volume 4. The perforations are in the form of slots (not shown). An outlet 220 from the hoses 104 is secured by a cam lock fitting 221 to a reclamation
25 hose 222 (see Figure 12).

The operation of this embodiment is the same as that of previous embodiments, except that reclaimed fluid is pumped-up to a filtration system located remotely from the apparatus 1, via the hose 222. Any escaping marine
30 material is therefore filtered remotely.

A further embodiment of the invention will now be described with reference to Figures 15 to 20. The same components as the embodiment of Figures 9 to 14 have been

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given the same reference numerals in Figures 15 to 20 and no further description will be given of these components.

This embodiment also reclaims heated fluid from the volume 4 via exhaust means 103, comprising hoses 104. An outlet 250 (best shown in the detailed Figure 18), feeds into a filtration trap 251. The motive force for pulling the fluid into the outlet 250 in this embodiment is a Venturi effect created by injecting fluid via a Venturi injection point 252 which injects fluid into the outlet in the desired direction of flow. The diameter of the Venturi tube 252 in this embodiment is approximately 3.5mm feeding into a 38mm diameter outlet 250 from the exhaust means 103. A pump pushes approximately 22 litres per minute into the Venturi point 252 which causes a Venturi effect to draw out fluid from the volume 4 at about 37 litres per minute in this embodiment. Some water escapes outside the skirts 2 (about 50 to 55 litres per minute is pumped into the volume 4 via the injectors 51). In operation, this can be tuned to recover all of the 50 to 55 litres per minute or less of it, as required.

The fluid from the outlet 250 enters the trap 251 and is filtered by the fine gauze trap to remove any marine growth particles. It is likely that such particles would be dead anyway, because of the hot water treatment.

The trap 251 comprises a sediment filter basket 251 and a sediment filter bag of fine gauze 251a.

A further embodiment of the invention will now be described with reference to Figures 21 to 23. The same reference numerals have been given to designate components which are the same as in previous embodiments. This apparatus provides a "low profile" of the volume 4, so that a low amount of fluid is consumed by the apparatus.

As can be seen from the drawings, apart from the

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cover 42, the apparatus includes a number of other components, including mainly the bearing supports 5. In order to maintain a low profile of the space 4 (so as to limit the amount of heated fluid required to fill the volume), these other components are mounted substantially externally of the cover 42 in use.

Each component 5, in this embodiment includes a bearing support in this example being a mounting block 5 mounting four ball bearings 6. The ball bearings 6 are mounted within depressions 7 within the mounting block 5. The ball bearings extend through the cover 42 and, in use, bear against the surface being treated. In this embodiment, the only components which extend within the space 4 on the underside of the cover 42 are the projecting parts of the ball bearings 6 which bear against the surface being treated.

The mounting block 5 also mounts a rare earth magnet 41, which operates to retain the apparatus against the surface to be treated, notwithstanding the orientation of the apparatus 1.

The distance between the magnet 41 and the surface can be adjusted via the mounting block 5 in order to vary the desired holding force.

In this embodiment, the mounting block 5 comprises a polyethylene block body which is constructed by assembling a plurality of polythene sections 8 together into a block and securing them together via a screw or bolt 19 (as shown in Figure 23). Other suitable materials could be used for the block.

The use of polythene sections 8 enables flexibility of design of the embodiment. For example, if a larger magnet 41 is required, two or more magnet housing sections 8a may be used in the mounting block 5. The

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magnet housing sections 8a include a cavity 8b to receive the magnet 41.

The distance between the magnet 41 and the surface to be treated may also be adjusted. Plates 10 and 11 are provided at the base and the top, respectively, of the mounting block 5. the base plate 10 may be selected to be a predetermined thickness in order to adjust the distance of the magnet 41 with respect to the surface being treated. For example, in one embodiment, the base plate 10 is a 3mm thick aluminium plate. In another embodiment, a 1mm or 2mm stainless steel plate may be used as a base plate 10, so that the magnet 41 is closer to the surface being treated.

Note that mounting block 5 may not necessarily be an assembly of sections 8 as in this embodiment. In an alternative embodiment, for example, the mounting block 5 may be formed by moulding plastics incorporating the magnets and roller ball assemblies. Mounting block 5 may be any suitable material, and is not limited to plastics.

Note that it is preferable the magnets be protected from the environment (e.g. a salt water environment) so as to avoid deterioration. Mounting the magnets in a mounting block, such as a mounting block of this embodiment, facilitates protection of the magnets 41.

Positioned adjacent one side 2A of the mat (see Figure 21) are a plurality of hot water inlets I, which in this embodiment are in the form of a holes in the cover 42. In operation, heated fluid, such as hot water, is introduced via the inlets I into the space 4. In operation, the side 2A is positioned towards the bottom of the apparatus when the apparatus is orientated vertically or substantially vertically in use. Heated fluid introduced into the inlets I, therefore has a natural

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tendency to migrate upwards into the confined volume.

Note there may be more or less holes than are illustrated in the Figure. In one alternative embodiment, there may be single inlet, for example. Further, in
5 alternative embodiments, the holes may be positioned in other areas of the cover 42. In this embodiment, the inlets I are positioned quite close to the flexible "skirt" which forms the sides of the cover 42. In some cases this may result in heated fluid escaping too early,
10 and in an alternative embodiment, the inlets I may be placed further away from the skirt 42.

In an alternative embodiment, heated fluid may be introduced via inlets in the top part of the volume 4, as in previous embodiments, which cause fluid to fan out.

15 A motive arrangement in accordance with an embodiment of the present invention is illustrated in Figure 5 and is generally designated by reference numeral 50. In this embodiment, the motive arrangement includes a remote control vehicle 51, which in this
20 example is a track vehicle which has tracks 52 and means 61 for securing the vehicle to a surface of any orientation e.g. vertical, and a winch arrangement 56. In this embodiment, the means for securing 61 are two powerful magnets 61 which are placed on the underside of
25 the motive arrangement 50 (the top side of the motive arrangement 50 is represented in the drawings and the shaded areas 61 indicate where the magnets 61 are placed on the opposite, underside of the vehicle 51).

In this embodiment, the winch arrangement 56 mounts
30 a single line 53 which supports a spreader bar 62, in turn mounting via a pair of lines 63, 64 attached to mounting blocks 5, an apparatus 1 for removing marine growth. In this embodiment, the apparatus 1 is in accordance with the

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embodiment described above in relation to Figures 1 to 4.[~]
Remote controller 59 is connected via a cable 60 to
operate the winch 56 and remote control vehicle 51. Note
that the remote controller 59 may be wireless and
5 therefore the cable 60 would not be required.

In operation, the remote control vehicle 51 can be
moved across the surface and the winch 56 may be operated
to raise and lower the apparatus 1 as the vehicle 51 moves
across the surface. Movement of the apparatus 1 can
10 therefore be controlled remotely. In this embodiment, the
vehicle 51 is positioned above the water line 65.
Equipment operated above water generally can be more
reliable and cheaper (as it does not have to operate in
salt water). It would be possible, however, to have an
15 embodiment of the vehicle 51 which did operate under
water. In a further alternative embodiment, the
apparatus 1 for removing marine growth may incorporate
integral motive means, such as a motor and caterpillar
tracks.

20 The motive arrangement may be driven by an
electronic motor. In one embodiment, however, the motive
arrangement is driven by compressed air generated by a
compressed air motor. The vehicle 51 may be moved via
compressed air (i.e. compressed air driving the compressed
25 air motor driving the tracks 52) and the winch
arrangement 56 may also be operated by compressed air.

The motive arrangement 50 may be used with other
types of apparatus for treating marine growth, such as
those described in the above-referenced PCT application by
30 the present applicant and also the embodiments described
below in this document.

Embodiments of the present invention have equal
application to marine growth above and below the water

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line. For example, ships could be treated when they are in dry dock as well as when they are in water.

In the above embodiments of the apparatus for treating marine growth, the magnets 41 are mounted in mounting blocks. In an alternative embodiment, the roller balls 6 may be of magnetic material. The magnets 41 may then be dispensed with. In such an embodiment, the balls 6 may be coated with a material that resists corrosion so as to protect the magnets from degradation by seawater. The material may be, for example, some form of plastics or rubber coating.

In the above embodiments, the mounting blocks 5 are arranged so that the rollers are inline as the apparatus 1 travels along the surface. In another embodiment, mounting blocks are slightly staggered relative to each other so that the rollers are not in line. This eases the motion of the apparatus along the surface and reduces the possibility of the apparatus getting stuck by a weld, or other defect, for example.

Note that the apparatus 1 can be of any convenient size. It can be 1.5 x 1 metres, but may be any other size, larger or smaller, depending on application required.

In the above described embodiments, water is heated by a separate boiler and introduced into the mat via an umbilical from the boiler. The umbilical may be insulated in order to reduce energy loss. Insulation of the umbilical may be by way of an air jacket, running between a double membrane hose. In an embodiment, sea water may be used as the heated fluid. Fresh water may be used to heat copper tubing in the boiler containing the sea water to be heated. In the above embodiments the system is "open" in that the heated water is exited into the

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environment. Alternatively, the system may be "closed", with a return umbilical to the boiler carrying exhausted fluid from the mat.

In any of the above embodiments, spacers, such as plastic spacers, e.g. perspex spacers, may be mounted within the confinement volume in order to reduce the volume and therefore require less fluid.

In any of the embodiments discussed above, appropriate insulation may be provided to the backing to reduce heat. The backing may be covered with a layer of insulating material, such as neoprene, for example.

In any of the embodiments, weights may be added to the arrangement e.g. metal plates, in order to adjust buoyancy as appropriate. Slight negative buoyancy may be applied so that the confinement arrangement 1 is biased downwardly in the water. Buoyancy may be varied by varying the number and/or size of weights.

In the above embodiments, a single skirt is mounted about the outside of the arrangement. More than one skirt could be mounted, for example, two skirts.

The temperature of the fluid and the amount of heat that the marine growth is exposed to is important. The temperature is preferably above 50, preferably between 50 and 60. It may be higher if required. Fluid consumption for a 1.5m x 1.2m arrangement such as shown in Figures 6 through 9 may be between 50 and 150 litres per minute, between 60 and 140 litres per minute, between 80 and 120 litres per minute, between 90 and 110 litres per minute.

The confinement arrangement may be of any suitable dimensions and is not limited to 1.5m x 1.2m.

In the above embodiments, treatment of marine growth is by introducing a heated fluid (for example heated water) into the volume confined by the apparatus. The

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invention is not limited to using heated fluids. In an alternative embodiment, for example, a fluid containing a chemical which can be used to treat the marine growth may be used. Such a fluid may not necessarily be heated. The
5 apparatus of all embodiments of the present invention may be used to introduce any fluid or substance for treatment of marine growth, whether heated or not.

In the above embodiment, the arrangement may be moved by way of the vehicle disclosed with reference to
10 Figure 4. It may be moved in other ways, however. It may be moved by a diver, for example, or a different type of motive arrangement.

In the above embodiments, magnets are used to retain the arrangement against the surface being cleaned. Other
15 devices may be used. For example, water jets may be used to force the arrangement against the surface. Water driven propellers may be used to force the arrangement against the surface. Any other appropriate arrangement may be used.

20 Embodiments of the present invention are not limited to application on ships hulls. They can be used for any surfaces which are subject to marine growth e.g. piers, oil rig pylons etc.

It will be appreciated by persons skilled in the art
25 that numerous variations and/or modifications may be used to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as
30 illustrative and not restrictive.

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CLAIMS:

1. An apparatus for treating marine growth on a surface, comprising a confinement arrangement arranged to
5 confine a volume adjacent a portion of the surface, an entry port arranged to enable introduction of a heated fluid to the volume, the entry port being arranged so that the heated fluid is directed into the volume in such a manner as to facilitate even heating of the volume.
- 10 2. An apparatus in accordance with Claim 1, wherein the entry port is arranged such that the fluid is introduced into the volume in such a manner to reduce or avoid a Venturi effect tending to cause uneven heating of the
15 volume.
3. An apparatus in accordance with Claim 1 or Claim 2, wherein the entry port is arranged to direct fluid flow downwardly away from the top and towards the bottom of the
20 apparatus in operation.
4. An apparatus in accordance with Claims 1, 2 or 3, the entry port being arranged to direct fluid flow to fan outwardly as it leaves the port.
- 25 5. An apparatus in accordance with any one of Claims 21 to 4, comprising a plurality of entry ports.
6. An apparatus in accordance with any one of the
30 preceding claims, wherein the confinement arrangement is moveable over the surface to enable the treatment of other portions of the surface, the confinement arrangement comprising a cover for containing the volume.

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7. An apparatus in accordance with Claim 6, wherein the entry port opens through the cover.

5 8. An apparatus in accordance with Claim 6 or Claim 7, further comprising a retaining means arranged to retain the confinement arrangement proximate the surface so that the volume remains adjacent the surface, regardless of the orientation of the surface.

10

9. A method for treating marine growth on a surface, comprising the steps of confining a volume adjacent a portion of the surface, and introducing heated fluid into the volume in such a manner as to facilitate even heating
15 of the volume.

10. A method in accordance with Claim 9, wherein the step of introducing heated fluid comprises the step of introducing the fluid into the volume in such a manner as
20 to reduce or avoid a Venturi effect tending to cause uneven heating of the volume.

11. A method in accordance with Claim 10, wherein the step of introducing the heated fluid comprises directing
25 fluid flow downwardly in the volume in operation.

12. A method in accordance with Claim 11, wherein the step of directing the fluid comprises directing the fluid to fan outwardly within the volume.

30

13. An apparatus for treating marine growth on a surface, including a confinement arrangement arranged to confine a volume adjacent a portion of the surface and an

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entry port arranged to enable introduction of a heated fluid to the volume, the confinement arrangement comprising a skirt providing a seal about the volume, the confinement arrangement being movable over the surface to treat other portions of the surface, the skirt providing a low tension contact against the surface so that when the arrangement is moved over the surface it does not substantially remove marine growth.

10 14. An apparatus in accordance with Claim 13, wherein the tension of the seal is adjustable.

15 15. An apparatus in accordance with Claim 13 or Claim 28, wherein the skirt is flexible and has a hollow cross section.

16. An apparatus in accordance with Claim 15, the skirt being adjustable in size to adjust the tension against the surface.

20 17. An apparatus in accordance with any one of Claims 13 to 16, wherein the tension of the skirt against the surface is arranged in use such that fluid can escape the volume via the seal.

25 18. An apparatus in accordance with any one of Claims 13 to 17, arranged for operation partly or totally underwater, and where the tension of the skirt against the surface is arranged in use such that the skirt may hydroplane over the surface as it moves.

30

19. An apparatus in accordance with Claim 18, wherein the confinement arrangement comprises a cover containing

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the volume, and one or more bearings arranged in use to bear against the surface and maintain the cover a predetermined distance from the surface.

5 20. An apparatus in accordance with Claim 19, comprising a retaining means arranged to retain the confinement arrangement proximate the surface, so it remains adjacent the surface regardless of the orientation of the surface.

10 21. A method for treating marine growth on a surface, comprising the steps of confining a volume against a portion of the surface, heating the volume, and sealing the volume against the surface with a low tension seal such that the volume may move across the surface without
15 substantially dislodging marine growth.

22. A method in accordance with Claim 21, wherein the tension of the seal against the surface is adjustable.

20 23. A method in accordance with Claim 21 or Claim 22, wherein the tension is arranged in use such that fluid can escape the volume via the seal.

24. An apparatus for treating marine growth on a
25 surface, comprising a confinement arrangement arranged to confine a volume adjacent a portion of the surface, an entry port arranged to enable introduction of a heated fluid to the volume, and an exhaust arrangement arranged to exhaust fluid from the volume and reduce or eliminate
30 escape of marine growth matter into the environment.

25. An apparatus in accordance with Claim 24, arranged to prevent or reduce the escape of live marine growth

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matter into the environment.

26. An apparatus in accordance with Claim 25, wherein the exhaust arrangement includes an arrangement which
5 results in further treatment of marine growth entering the exhaust arrangement.

27. An apparatus in accordance with any one of Claims 24 to 26, wherein the exhaust arrangement comprises a trap
10 for trapping marine growth matter and preventing it from exiting into the surrounding environment.

28. An apparatus in accordance with any one of Claims 24 to 27, wherein the exhaust arrangement comprises a
15 passageway which is arranged to receive exhaust fluid from the confinement arrangement.

29. An apparatus in accordance with any one of Claims 24 to 27 wherein the exhaust arrangement operates to create a
20 heat pump in order to facilitate flow of fluid into the exhaust arrangement.

30. An apparatus in accordance with any one of Claims 24 to 28, wherein the apparatus comprises a Venturi arranged
25 to facilitate flow of fluid into the exhaust arrangement.

31. An apparatus in accordance with any one of Claims 24 to 30, wherein the confinement arrangement comprises a
cover containing the volume, the exhaust means comprises a
30 duct mounted about a inner periphery of the cover.

32. An apparatus in accordance with Claim 31, the confinement arrangement being moveable over the surface to

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treat other parts of the surface.

33. An apparatus in accordance with Claim 32, further comprising a retaining means arranged to retain the
5 confinement arrangement proximate the surface, so it remains adjacent the surface regardless of the orientation of the surface.

34. A method for treating marine growth on a surface,
10 comprising the steps of confining a volume against a portion of the surface, introducing heated fluid into the volume, exhausting the heated fluid from the volume and preventing or reducing the escape of marine growth matter into the environment from the volume during exhaustion.

15

35. An apparatus for treating marine growth on a surface, including a confinement arrangement arranged to confine a volume adjacent a portion of the surface, the confinement arrangement including a cover for containing
20 the volume, the cover being provided with an entry port arranged to enable introduction of a heated fluid to the volume, the confinement arrangement being movable over the surface to treat other portions of the surface, the apparatus including further components which are mounted
25 substantially externally of the cover, substantially outside of the confined volume, whereby to enable the depth of the confined volume to be optimised.

36. An apparatus in accordance with Claim 35, wherein
30 the components include at least one bearing support mounting one or more bearings.

37. An apparatus in accordance with Claim 36, wherein at

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least a portion of the one or more bearings extends into the cover and in use bears against the surface.

38. An apparatus in accordance with Claim 36 or
5 Claim 37, wherein the bearings are in the form of ball rollers.

39. An apparatus in accordance with any one of Claims 35
to 38, wherein the components include a retention means,
10 which is operable to retain the confinement arrangement against the surface being treated.

40. An apparatus in accordance with Claim 39, wherein
the retention means includes one or more magnets.

15

41. An apparatus in accordance with Claim 35, wherein
the components include one or more bearings and one or
more retention means, the retention means and bearings
being mounted by a bearing support.

20

42. An apparatus in accordance with any one of Claims 35
to 41, wherein the cover is flexible, whereby it may
conform to changes in shape of the surface being treated.

25 43. An apparatus in accordance with any one of Claims 35
to 42, wherein the entry port for heated fluid is
positioned so that in use it is situated at the lower part
of the cover, so that the heated fluid introduced into the
confined volume will naturally flow upwardly through the
30 confined volume.

44. An apparatus in accordance with Claim 43, wherein
there are a plurality of entry ports in the form of holes

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in the cover extending along the bottom part (in use) of the cover.

45. An apparatus in accordance with Claim 44, wherein
5 the plurality of holes are positioned in a line extending at intervals along the bottom part of the cover.

46. An apparatus in accordance with any one of Claims 35 to 45, wherein the depth dimension of the confined volume
10 is relatively small in magnitude.

47. An apparatus in accordance with Claim 46, wherein the depth dimension may be in the range of 2-50mm, or in a range of 2-15mm, or in a range of 2-10mm, or in a range of
15 2-8mm, or in a range of 3-7mm.

48. An apparatus in accordance with Claim 47, wherein the depth dimension is 6mm.

20 49. A motive arrangement for moving an apparatus for treating marine growth on a surface over the surface, the motive arrangement comprising a remote control vehicle and winch assembly, the remote control vehicle having means arranged to secure the vehicle to the surface being
25 treated, and a winch arrangement including at least one line arranged to be attached to the apparatus for treating the marine growth, the vehicle being movable across the surface and the winch being operable to adjust the length of the line, whereby to enable the apparatus for treating
30 marine growth to be moved across the surface in a desired direction.

50. A motive arrangement in accordance with Claim 49,

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wherein the remote control vehicle is arranged to be powered by compressed air.

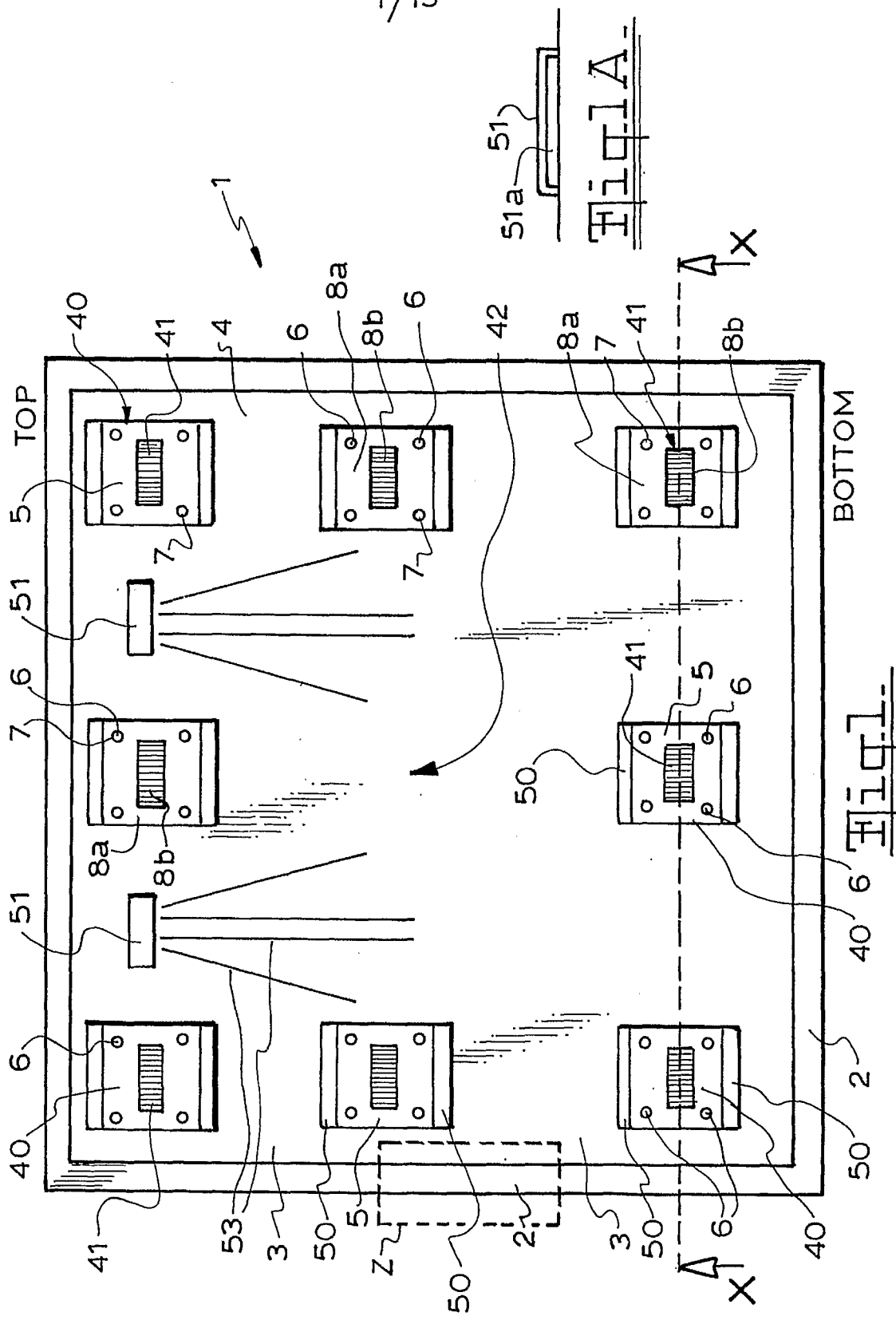
51. A motive arrangement in accordance with Claims 48,
5 49 or 50, wherein the apparatus for treating marine growth comprises an apparatus in accordance with any one of Claims 1 to 8, or 13 to 20, or 24 to 33, or 35 to 48.

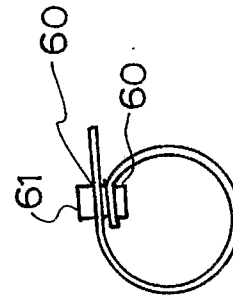
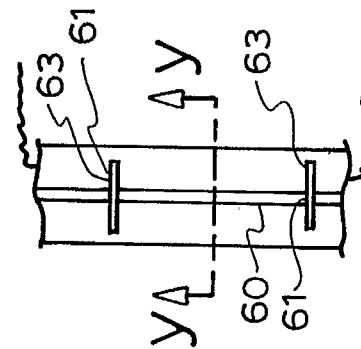
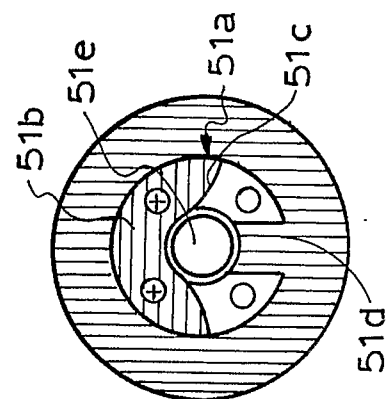
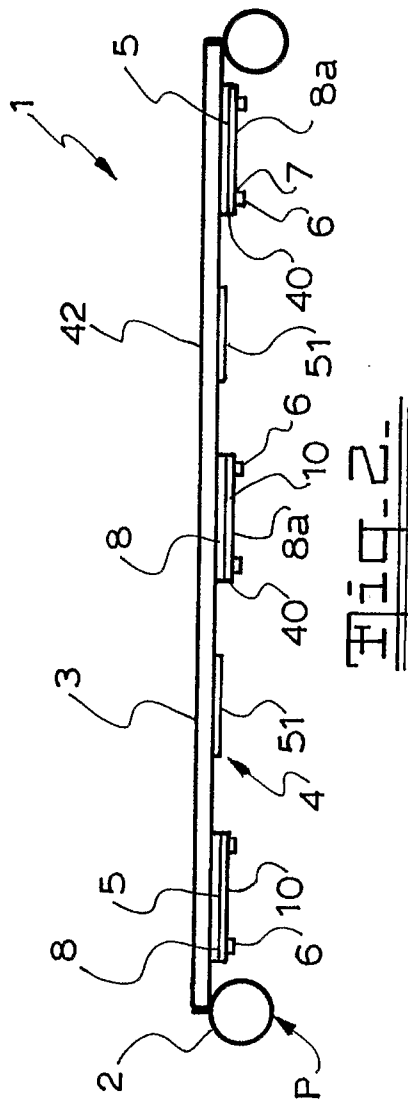
52. A motive arrangement in accordance with Claim 49 or
10 Claim 51, wherein the winch arrangement is arranged to be powered by compressed air.

53. A method of moving an apparatus for treating marine growth on a surface over the surface, the method
15 comprising the steps of operating a remote control vehicle which is connected to the apparatus and arranged to move the apparatus under remote control.

54. A system for treating marine growth on a surface,
20 the system comprising a motive arrangement in accordance with any one of Claims 49 to 53 and an apparatus for treating marine growth.

55. A system in accordance with Claim 19, wherein the
25 apparatus is the apparatus of any one of Claims 1 to 8, 13 to 20, 24 to 33 or 35 to 48.





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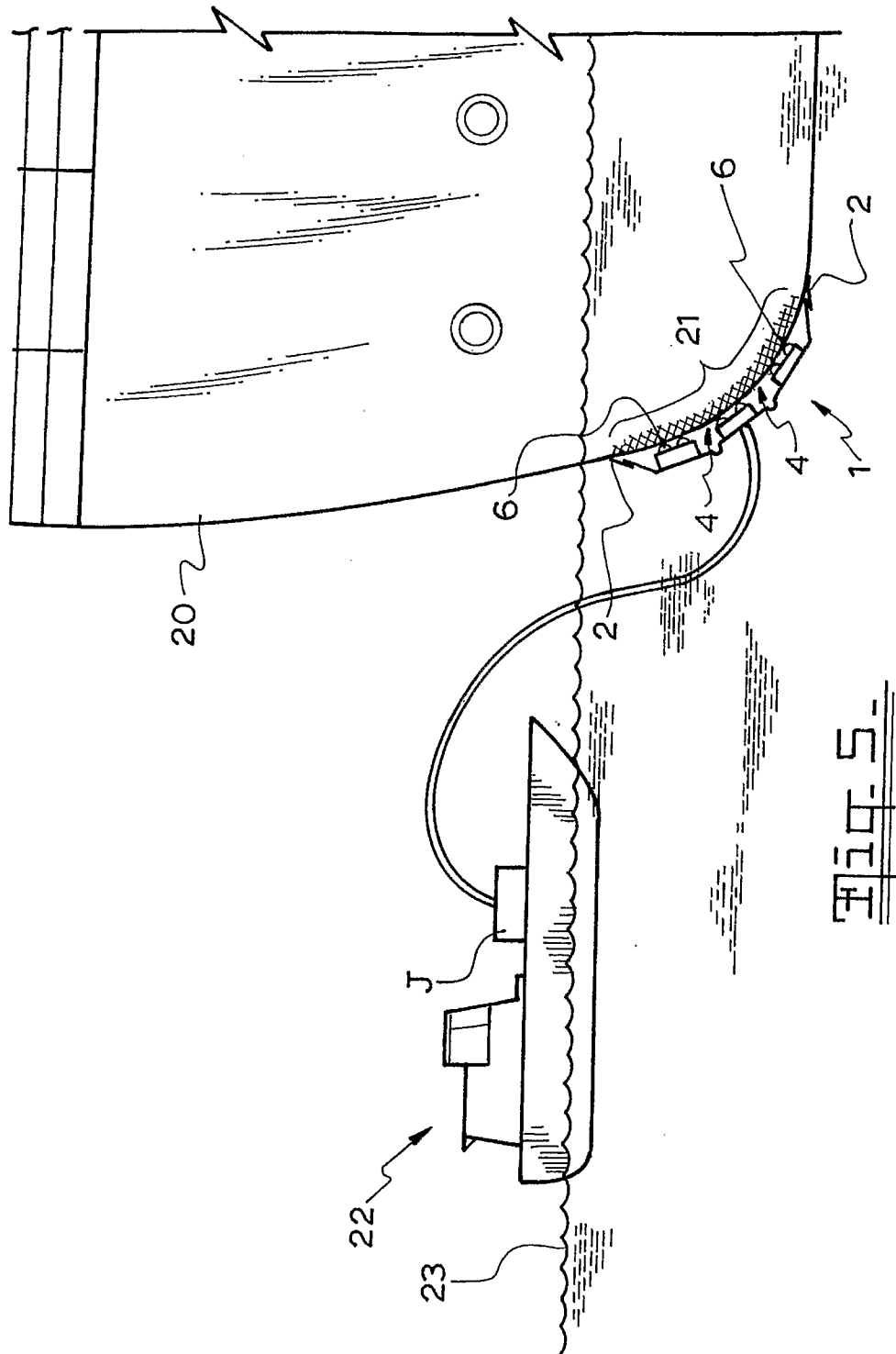
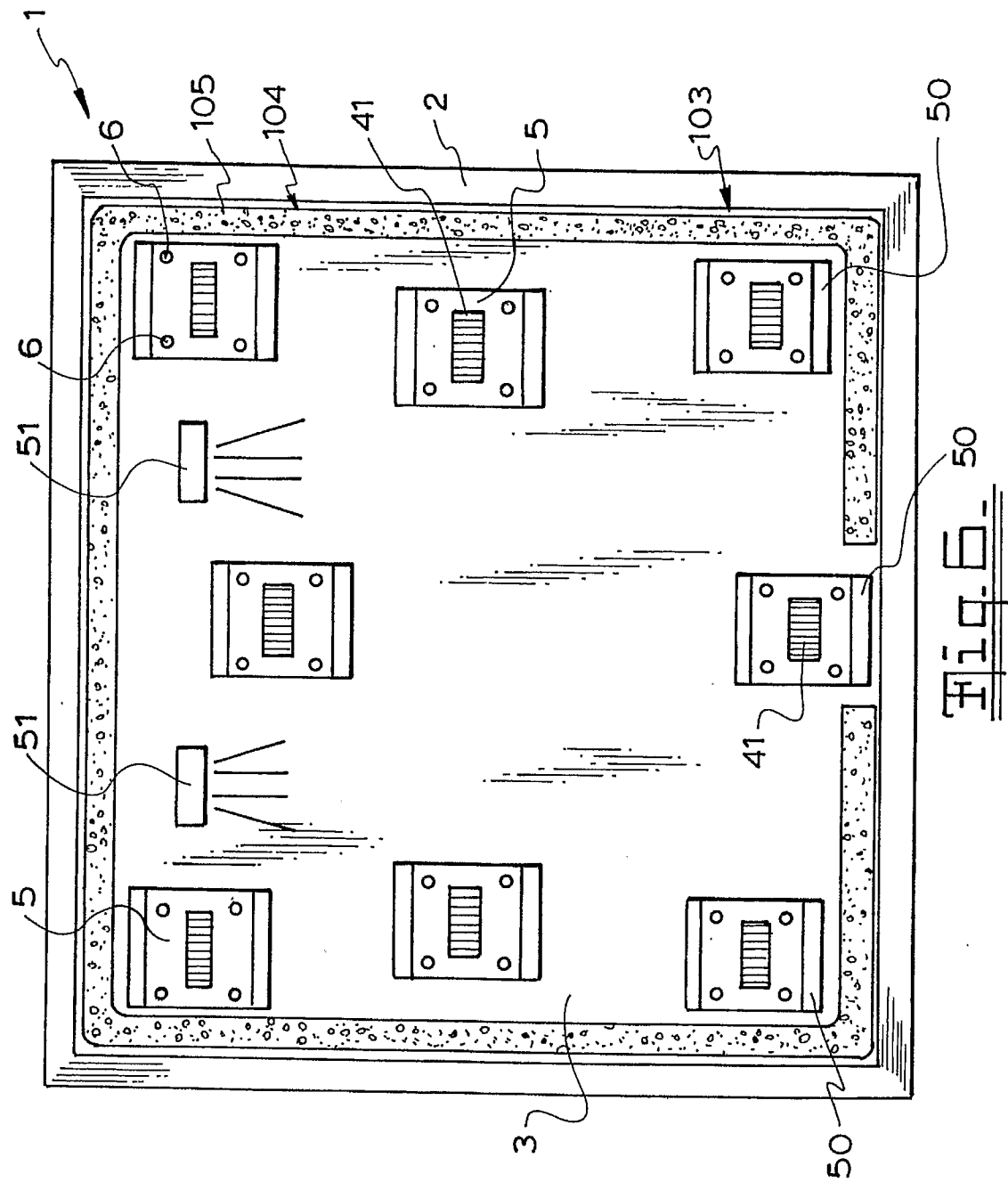


Fig. 5-

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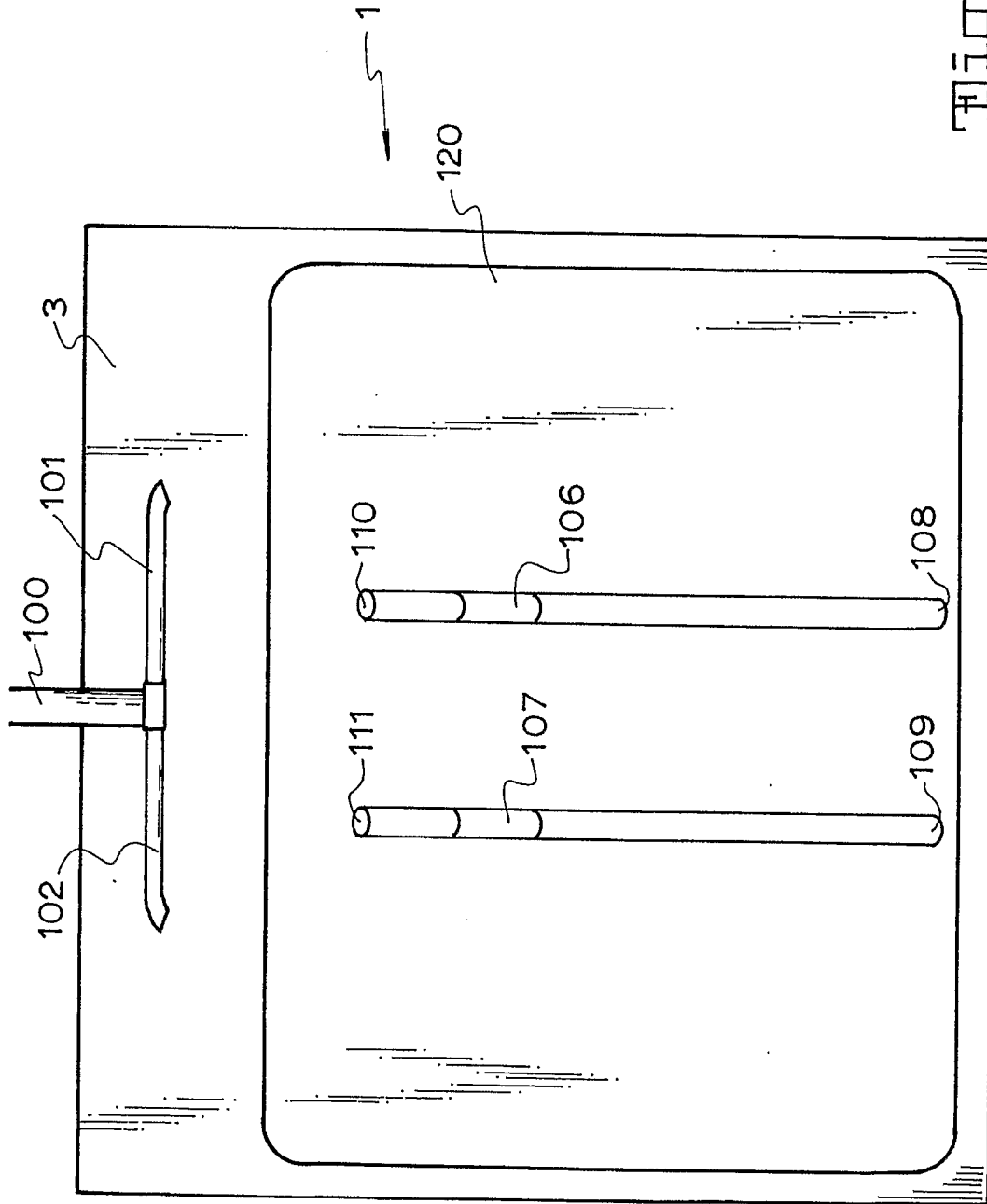


Fig. 7

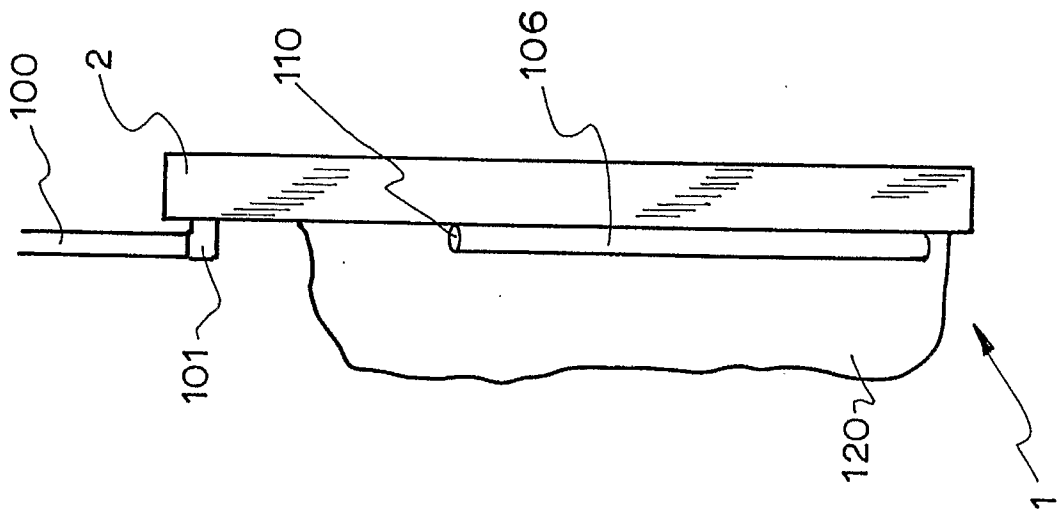
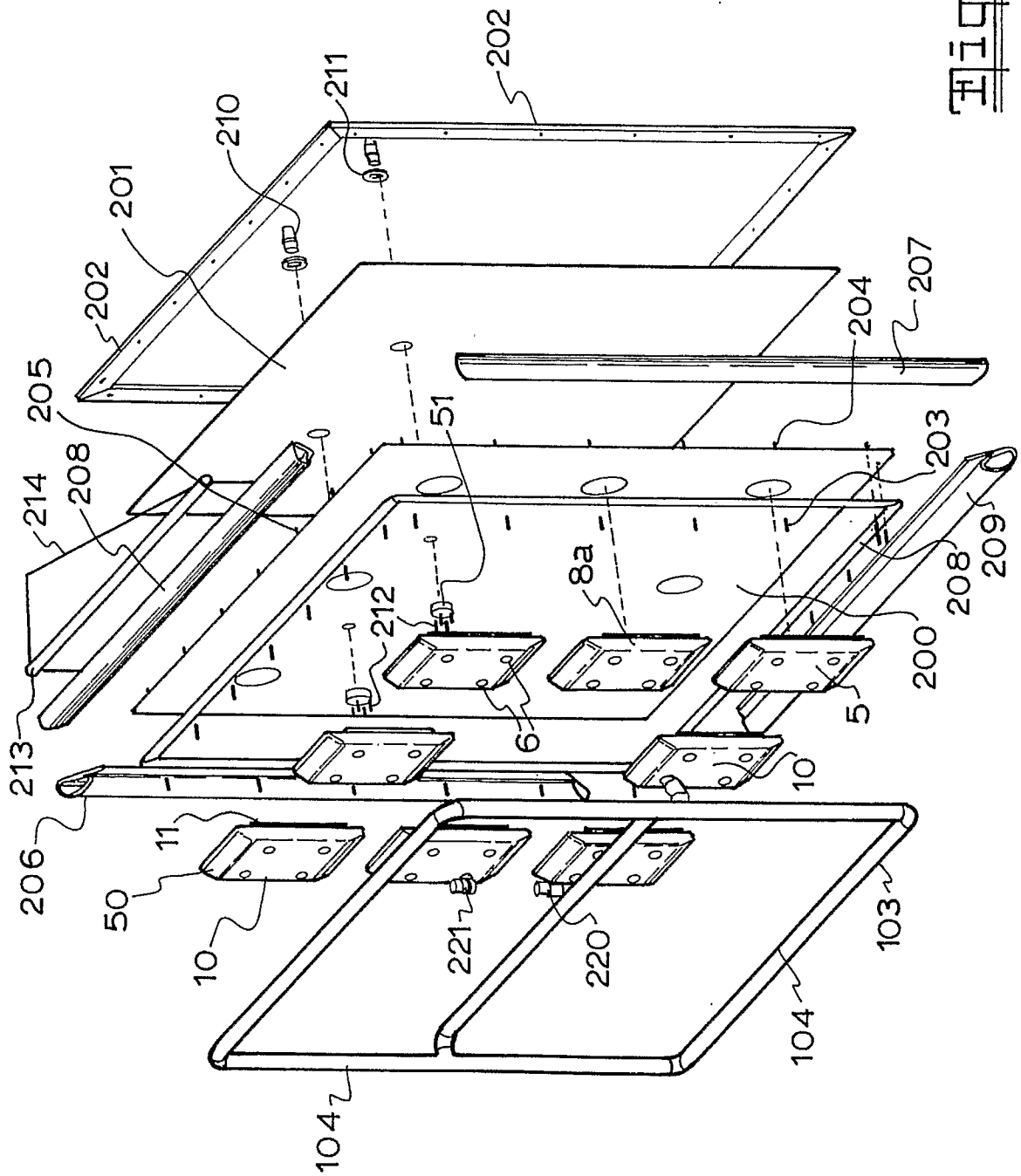
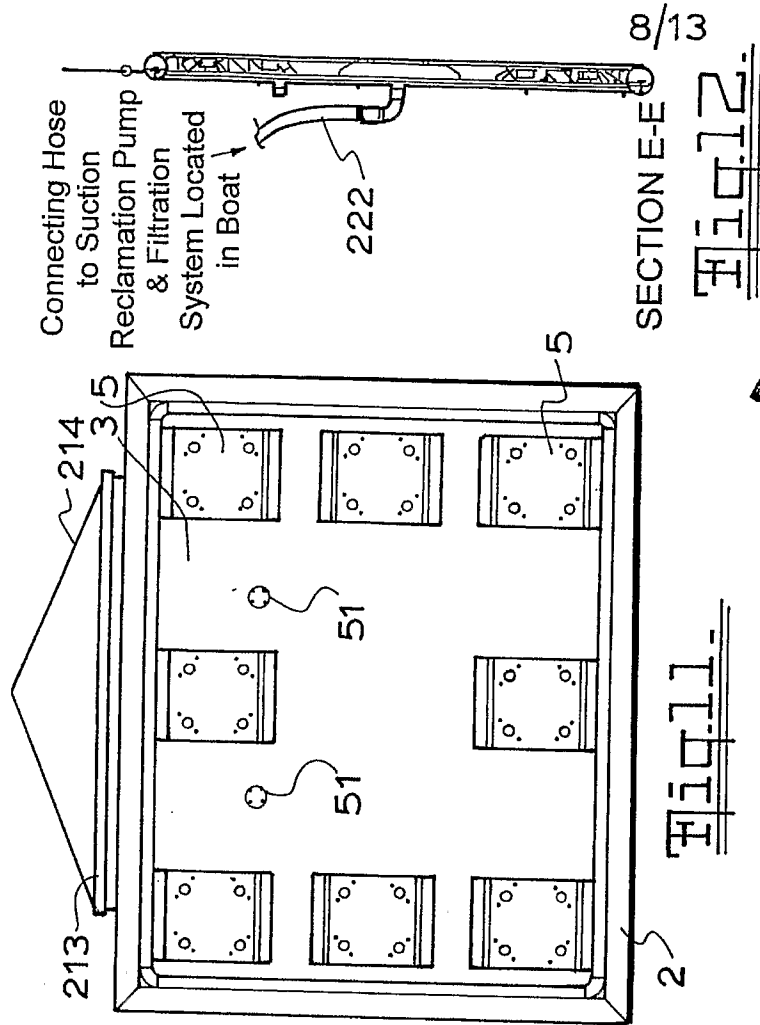
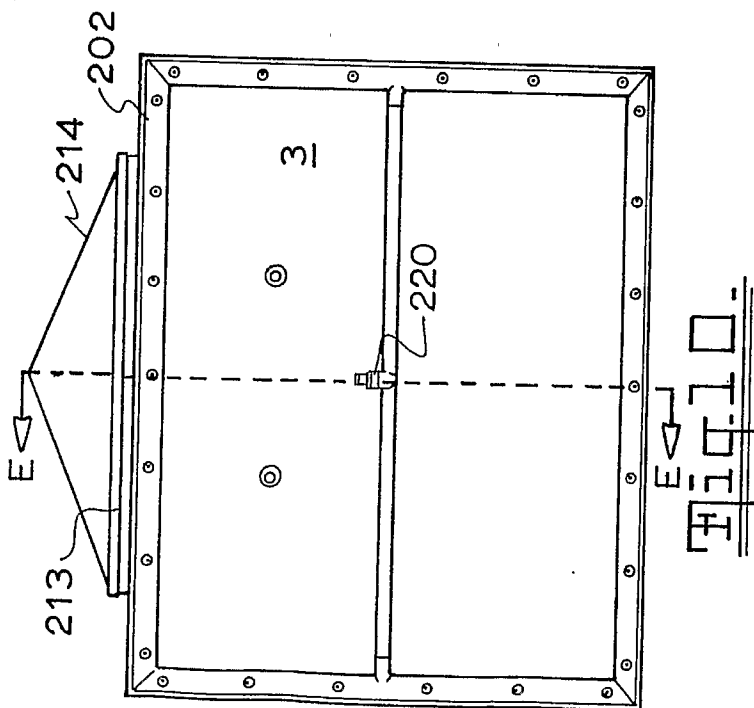


Fig. 6.

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Fig. 9

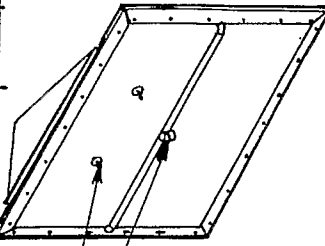




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SECTION E-E

Fig. 12

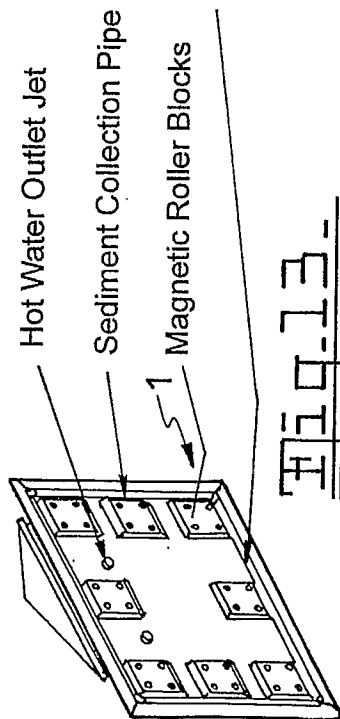


Hot Water Inlet Connection

Sediment Collection Attachment Point

Suction Draws Sediment Into Pipe Through A Series of Slots Along the Inside Edges

Fig. 14



Hot Water Outlet Jet

Sediment Collection Pipe

Magnetic Roller Blocks

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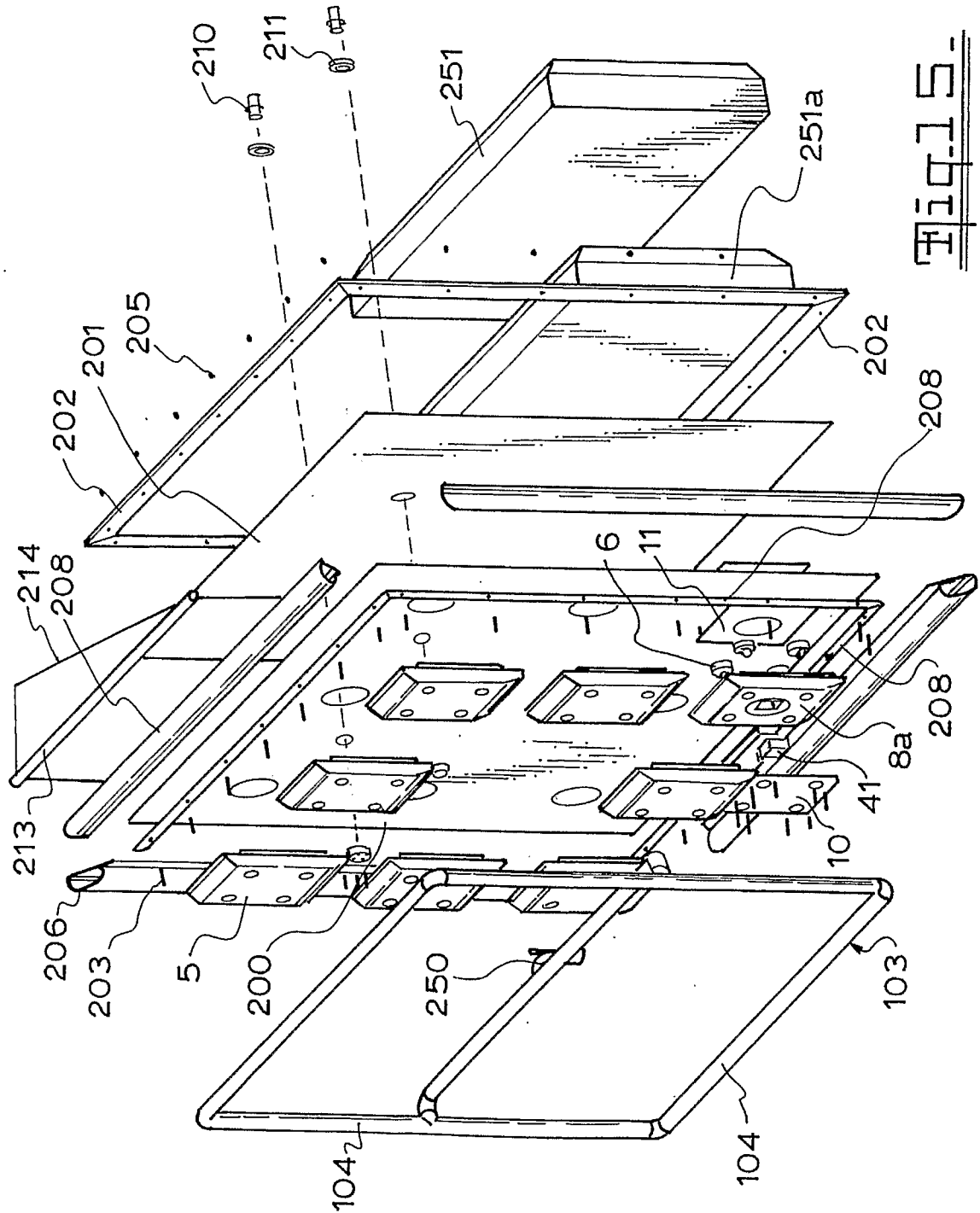
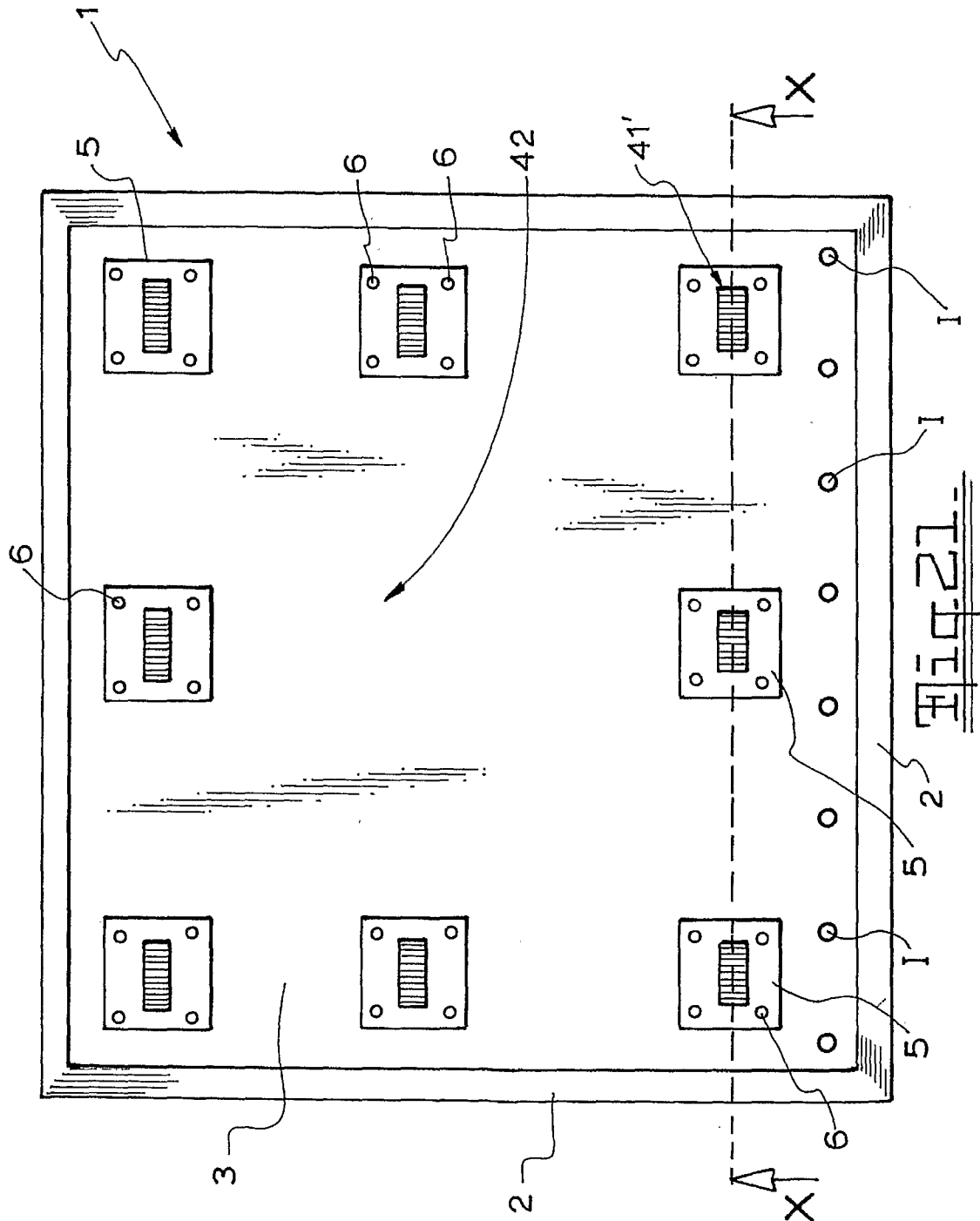


Fig. 5



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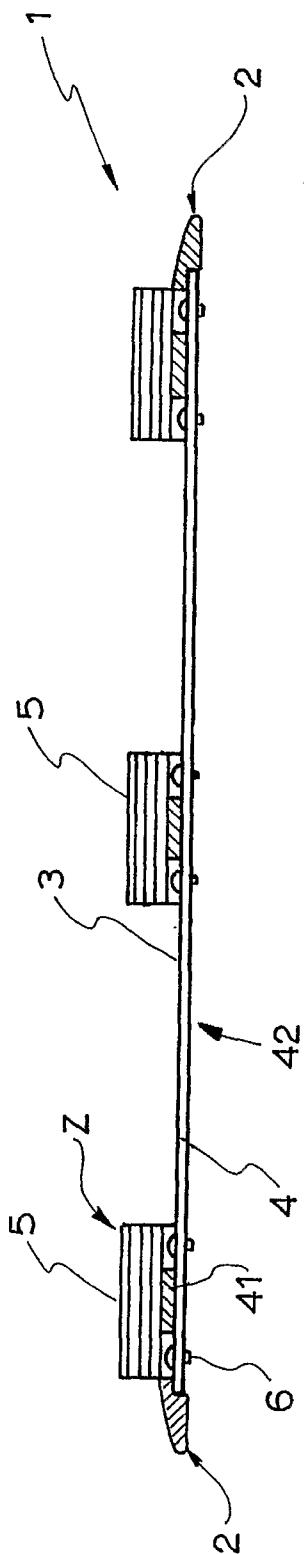


Fig. 22-

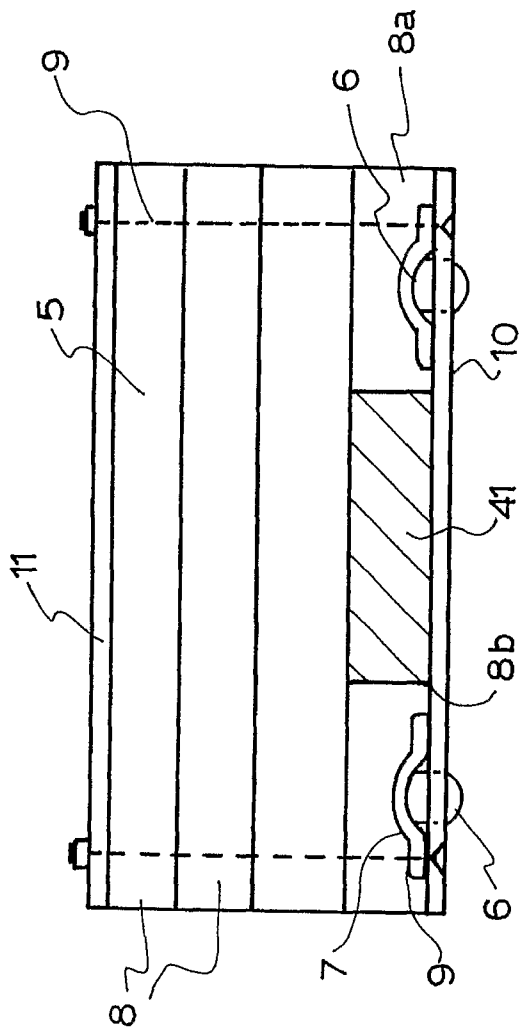


Fig. 23-

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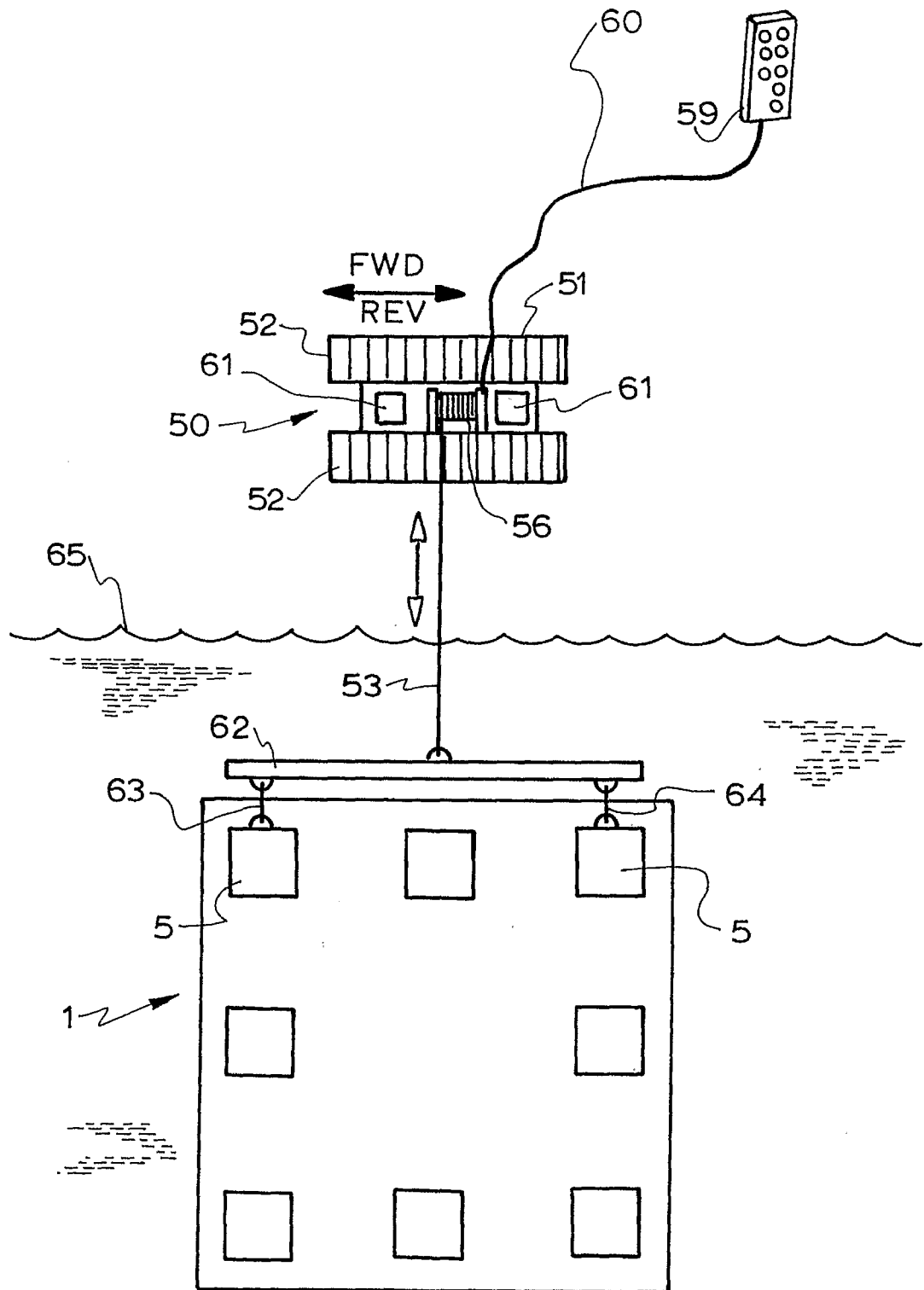


Fig. 24

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2009/000575

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

B63B 59/08 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

REFER TO ELECTRONIC DATABASES CONSULTED BELOW.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI: IPC A01M21/00, A01M21/04, A01M19/00, B63B59/00, B08B17/00, E04H4/16 & keywords (marine, sea, water, aquatic, heat, hot, warm, temperature, thermal, steam) & like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/056382 A1 (JOHNSON ET AL.) 23 June 2005 Figures 1-5, page 4, lines 26-29, Page 9, lines 8-15, 6, lines 1-31, page 7, lines 1-13	1-12
X	FR 2700240 A1 (IVALDI) 13 July 1994 (machine translation, retrieved 25 August 2009 from Internet: esp@cenet) URL: http://ep.espacenet.com/advancedSearch?locale=en_EP Figure 2, page 2 of the English translation	1-12
X	US 5389266 A (CLUM ET AL.) 14 February 1995 Figures 1-10, column 3, lines 55-68, column 4, lines 1-31, column 5, lines 29-68, column 6, lines 1-52	1-4, 6-12

☒ Further documents are listed in the continuation of Box C
 ☒ See patent family annex

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

 Date of the actual completion of the international search
 26 August 2009

 Date of mailing of the international search report
 4 September 2009 - 8 SEP 2009

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2009/000575

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1545232 A (LARSON) 2 May 1979 Figures 1-9, page 2, lines 60-115	1-12
A	WO 2000/068070 A1 (MASON) 16 November 2000 Figures 1-3	1-12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2009/000575

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please refer to Supplemental Box

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-12

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Supplemental Box

(To be used when the space in any of Boxes I to IV is not sufficient)

Continuation of Box No III, Observations where unity of invention is lacking ...

This International Searching Authority has found that there are different inventions as follows:

- Invention 1: Claims 1 to 12 are directed to treating marine growth on a surface. It is considered that a confinement arrangement, arranged to confine a volume and adjacent a portion of the surface, an entry port arranged to enable introduction of a heated fluid to the volume to facilitate even heating of the volume comprises a first distinguishing feature.
- Invention 2: Claims 13 to 20 are directed to treating marine growth on a surface. It is considered that a confinement arrangement, arranged to confine a volume adjacent a portion of the surface, an entry port arranged to enable introduction of a heated fluid to the volume, *the confinement arrangement comprising a skirt providing a seal about the volume, the confinement arrangement being movable over the surface to treat other portions of the surface, the skirt providing a low tension contact against the surface so that when the arrangement is moved over the surface it does not substantially remove marine growth* comprises a second distinguishing feature.
- Invention 3: Claims 21 to 23 are directed to treating marine growth on a surface. It is considered that confining a volume against a portion of the surface, heating the volume, *sealing the volume against the surface with a low tension seal such that the volume may move across the surface without substantially dislodging marine growth* comprises a third distinguishing feature.
- Invention 4: Claims 24 to 34 are directed to treating marine growth on a surface. It is considered that a confinement arrangement arranged to confine a volume adjacent a portion of the surface, an entry port arranged to enable introduction of a heated fluid to the volume, and *an exhaust arrangement arranged to exhaust fluid from the volume and reduce or eliminate escape of marine growth matter into the environment* comprises a fourth distinguishing feature.
- Invention 5: Claims 35 to 48 are directed to treating marine growth on a surface. It is considered that a confinement arrangement arranged to confine a volume adjacent a portion of the surface, the confinement arrangement including *a cover for containing the volume, the cover being provided with an entry port arranged to enable introduction of a heated fluid to the volume, the confinement arrangement being movable over the surface to treat other portions of the surface, the apparatus including further components which are mounted substantially externally of the cover, substantially outside of the confined volume, whereby to enable the depth of the confined volume to be optimised* comprises a fifth distinguishing feature.
- Invention 6: Claims 49 to 52, 54, and 55 are directed to a motive arrangement for moving an apparatus for treating marine growth on a surface over the surface, the motive arrangement comprising *a remote control vehicle and winch assembly, the remote control vehicle having means arranged to secure the vehicle to the surface being treated, and a winch arrangement including at least one line arranged to be attached to the apparatus for treating the marine growth, the vehicle being movable across the surface and the winch being operable to adjust the length of the line, whereby to enable the apparatus for treating marine growth to be moved across the surface in a desired direction* comprises a sixth distinguishing feature.
- Invention 7: Claim 53 is directed to a method of moving an apparatus for treating marine growth on a surface over the surface, the method comprising the *steps of operating a remote control vehicle which is connected to the apparatus and arranged to move the apparatus under remote control* comprises a seventh distinguishing feature.

Continued in Supplemental Box I ...

Supplemental Box I

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Supplemental Box:

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

Inventions 1 to 5:

The only features common to all the claims in inventions 1 to 5 is treating marine growth on a surface by a confinement arrangement to confine a volume and heated fluid in the volume. However this concept is not novel in the light of:

D1: WO W005/056382 A1 (JOHNSON ET AL.) 23 June 2005

D2: FR 2700240 A1 (IVALDI) 11 January 1993

D3: US 5389266 A (CLUM ET AL.) 14 February 1995

This means that the common feature can not constitute a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art.

Because the common feature does not satisfy the requirement for being a special technical feature it follows that it cannot provide the necessary technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention *a posteriori*.

Inventions 6 and 7:

Each of the abovementioned groups of claims has a different distinguishing feature and they do not share any feature which could satisfy the requirement for being a special technical feature. Because there is no common special technical feature it follows that there is no technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention *a priori*.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2009/000575

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
WO	2005056382	AU	2004296891	CA	2548946	CN	1902085
		EP	1704086	KR	20070000427	US	2009127203
FR	2700240	NONE					
US	5389266	US	5294351				
GB	1545232	BE	847452	DE	2647070	DK	471076
		ES	452526	FR	2328521	JP	52053394
		NL	7611488	NO	763559	PT	65725
		SE	7511712				
WO	2000/068070	AU	47861/00	BR	0010351	CN	1358149
		EP	1187759	US	6488572		
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.							
END OF ANNEX							