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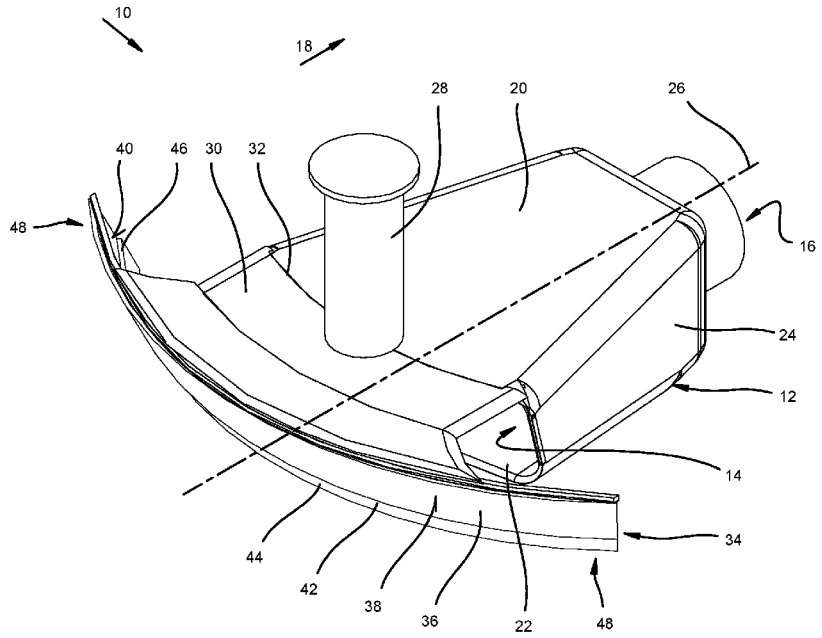
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(54) Title: A CLEANING HEAD FOR A MARINE CLEANING SYSTEM

Figure 1



(57) Abstract: A cleaning head for a marine cleaning system used for cleaning a submerged surface includes a body configured to be disposed adjacent to and moved relative to the submerged surface during use. The body defines at least one suction aperture being in fluid communication with a suction region surrounding the body. A support arm extends from the body, which support arm in turn supports a cleaning element that is configured to cause material on the submerged surface to separate from the submerged surface and become suspended in the suction region during use. The material separated from the submerged surface is drawn away from the suction region through the suction aperture. The support arm extends from a junction with the body so that the cleaning element is supported in a spaced relation laterally away from the junction with the junction being disposed operatively forward of the cleaning element during use.

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A cleaning head for a marine cleaning system

TECHNICAL FIELD

The present disclosure relates to a cleaning head for a marine cleaning system.

More particularly, the present disclosure relates to a cleaning head for connection to a marine cleaning system used for cleaning a submerged surface, for example to clean an underwater portion of a ship hull or other structure, such as a dock pier or piling.

BACKGROUND

When a structure is submerged underwater for extended lengthy periods, and especially in sea water, it is common for the structure to become covered by plant and animal growth, e.g. seaweed and various types of barnacles. In many cases, this growth can remain undisturbed. However, in the case of ship hulls, the growth constitutes biological fouling and is detrimental in various aspects. Significant problems can occur if the fouling is not removed from the ship hull, including damage to the hull itself or to the antifouling coating thereon and potentially causing a reduction in the ship's seafaring performance and increased fuel consumption.

Antifouling coatings are applied to a vessel hull as the primary defence against biological fouling. Silicon based coatings are generally used on high-speed vessels and on infrequently stopping vessels, e.g. military navy vessels, which compound inherently minimises any biological fouling. In slow-speed vessels, such as container ships, the antifouling coating includes an active ingredient or pesticide, such as tin, zinc or copper oxides, to minimise adhesion by the biological fouling. It will be appreciated that applying such antifouling coatings to large vessels is generally commercially expensive to apply and to repair if damaged.

Antifouling coatings containing copper oxide can experience leaching during its underwater lifespan, resulting in the leached layer becoming relatively loosely attached to the antifouling coating. Over time the leached layer becomes increasingly less active and progressively higher amounts of biological fouling can adhere to the coating.

In addition, some living organisms can be noxious and, if transported to other locations while the ship traverses the world's oceans between various ports, can be dangerous to local species. These problems can be reduced or avoided by cleaning the ship hull to remove the biofouling. In many cases, the cleaning of a ship hull is performed in a dry-dock to prevent polluting the environment, but this approach is often expensive and time consuming.

Uncontrolled in-water cleaning may release cleaning chemicals or biological contaminants polluting the local sea water. For example, some submerged cleaning and maintenance platforms (SCAMPs) utilize an integrated impeller to destroy the biological fouling and any harmful invasive marine species therein. However, in additional to the biological fouling, the cleaning residue can also include bits of hull coatings and corrosion by-products, all of which is then simply discharged directly into the surrounding sea water. As mentioned above, most antifouling coatings include heavy metals such as Cu and Zn as biocides that are then released during cleaning operations at levels that can exceed water quality criteria, e.g. if the loosely adhered leached layers of the antifouling coatings are scraped off from the hull. Additionally, the removal of the fouling may stimulate the plant or animal growths to release reproductive propagules, or plant and animal fragments capable of further growth or regeneration.

It is therefore preferable to first filter the cleaning water and fouling residue before discharge to the environment. An example of such a system is disclosed in US 9,550,552 wherein a cleaning head has a body, and a skirt extending around a periphery of the body, whereby the skirt functions to seal the body to the ship hull and define a cleaning chamber. The cleaning head also includes a scraper for dislodging the fouling from the hull inside the cleaning chamber, and at least one suction pipe in fluid communication with the cleaning chamber. During use the dislodged fouling is water-borne and drawn away from the cleaning head through the suction pipe to a filtration unit (which may be surface mounted) before the cleaned sea water is returned to the environment.

The above prior art systems are relatively large platforms / vehicles that cannot always be directed into tight corners or hard-to-reach areas, e.g. around the ship's propellers. They are also cannot be effectively used to clean smaller areas, e.g. smaller boat hulls

or dock piers or pilings. In such cases a hand operated cleaning head is often more useful.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

SUMMARY OF THE DISCLOSURE

According to a first aspect of the disclosure, there is provided a cleaning head for a marine cleaning system used for cleaning a submerged surface, the cleaning head comprising

a body being configured to be disposed adjacent to and moved relative to a submerged surface;

at least one suction aperture being in fluid communication with a suction region around the body during use;

at least one support arm extending from the body, the support arm extending from a junction with the body;

a cleaning element supported by each support arm, whereby the cleaning element is configured to cause material on the submerged surface to separate from the submerged surface and become suspended in the suction region during use when the body is moved in an operative direction relative to the submerged surface, and whereby the material separated from the submerged surface is drawn away from the suction region through the suction aperture; and

wherein the cleaning element is spaced laterally away from the junction so that the junction is disposed operatively forward of the cleaning element during use.

The body may be substantially tubular with the suction aperture being provided at one end of the body and with an open mouth being provided at an opposed end of the body. The mouth may have a larger cross-sectional area than that of the suction aperture so that the body converges from the mouth towards the suction aperture.

The body comprises a floor that may be inclined relative to the cleaning element so that orientating the floor substantially parallel to the submerged surface during use assists in orientating the cleaning element at a preselected operative cleaning inclination angle. In one embodiment the body comprises one or more magnets embedded within

the floor with the magnets being configured to slidably hold the floor against a ferromagnetic submerged surface.

The cleaning element may include a scraper body and a scraper blade. The scraper blade may be an integral part of the scraper body. Alternatively, the scraper blade may be a separate part and releasably joined to the scraper.

The cleaning element may have a flat planar shape.

In one embodiment the cleaning element has an arcuate shape having its concave face directed towards the body. In this embodiment the cleaning element may have an arched shape so that a central part of the cleaning element is raised above the opposed outer parts of the cleaning element.

The cleaning element may have a transverse width being substantially wider than the transverse width of the body, whereby the cleaning element defines opposed wings that project laterally beyond the body.

The cleaning head may include opposed channels provided between the cleaning element and the body on opposed sides of the body, the channels being configured to allow fluid flow from a suction region around the cleaning head towards the suction aperture. The channels may define a venturi type constriction being configured in use to cause an increased flow rate of fluid from the suction region into the suction aperture. The cleaning element may be movably supported relative to the body thereby permitting adjustment of a cross-sectional area of the channels.

In one example, the body may comprise a rotatable disc and the suction aperture comprises one or more apertures extending transversely through the disc. The cleaning head may comprise a number of cleaning elements arranged at discrete spaced circumferential intervals on the body.

In one embodiment the support arm is flexibly attached to the body to allow movement of the cleaning element closer to or further away from the body. The cleaning head may include a biasing member configured to bias the support arm and cleaning element away from the body. The biasing member may be a spring, resilient plastics material or resilient foam material.

The cleaning element may be angled towards the junction so that, during use, the cleaning element operatively aligned relative to the submerged surface at a preselected operative cleaning inclination angle. In one example the inclination angle is 130°-140°. In one example the inclination angle is 135°.

According to a second aspect of the disclosure there is provided a method of cleaning a submerged surface, the method comprising

providing a cleaning head having

a body;

at least one support arm extending from the body, the support arm extending from a junction with the body; and

a cleaning element supported by each support arm, wherein the cleaning element is spaced laterally away from the junction so that the junction is disposed operatively forward of the cleaning element;

locating the cleaning head against the submerged surface so that the body is disposed adjacent to and movable relative to the submerged surface;

applying a suction force to a suction region around the body; and

moving the cleaning head in an operative direction relative to the submerged surface so that the cleaning element causes material on the submerged surface to separate from the submerged surface and become suspended in the suction region,

whereby the material separated from the submerged surface is drawn away from the suction region through the suction aperture.

BRIEF DESCRIPTION OF DRAWINGS

The above and other features will become more apparent from the following description and with reference to the accompanying schematic drawings. In the drawings, which are given for purpose of illustration only and are not intended to be in any way limiting:

Figure 1 is a front perspective view of a first embodiment of a cleaning head for a marine cleaning system that is configured for manual use;

Figure 2 is a rear perspective view of the cleaning head shown in Figure 1;

Figure 3 is a side view of the cleaning head shown in Figures 1;

Figure 4 is a top plan view of the cleaning head shown in Figures 1;

Figure 5 is an upper perspective view of a second embodiment of a cleaning head for a marine cleaning system that is configured for use in an automated cleaning platform;

Figure 6 is a lower perspective view of the cleaning head shown in Figure 5;
Figure 7 is a bottom plan view of the cleaning head shown in Figure 5;
Figure 8 is a side view of the cleaning head shown in Figure 5; and
Figure 9 is a rear perspective view of a further embodiment of a cleaning head.

DETAILED DESCRIPTION

The present disclosure relates to a cleaning head 10 for connection to a marine cleaning system used for cleaning a submerged surface, for example for cleaning an underwater portion of a ship hull or other structure, such as a dock pier or piling. Although the present embodiment will be described in relation to cleaning a ship hull, it should be understood that other applications are envisaged.

Figures 1 to 4 show one embodiment of the cleaning head 10. The cleaning head 10 includes a tubular body 12 having an open mouth 14 at one end thereof and having a suction aperture 16 at an opposed end thereof. The suction aperture 16 is configured to be joined to a suitable suction pipe (not shown) and therefore may have the shape of a cylindrical spout to which the suction pipe can be clamped.

The body 12 is configured to be disposed adjacent to and moved in an operative direction relative to the submerged surface during use. The operative direction is indicated by arrow 18 wherein the body 12 is moved from in a direction from the mouth 14 towards the suction aperture 16.

It should be understood for the purposes of the description below that the terms “forward” and “rearward” refer to operative direction of movement. Thus “forward” is used herein to refer to a feature or part of the cleaning head 10 that is closest or proximal to the suction aperture 16 or to a position towards the right of the cleaning head 10 as shown in Figures 1 to 3. Conversely, “rearward” is used herein to refer to a feature or part of the cleaning head 10 that is furthest or distal to the suction aperture 16 or to a position towards the left of the cleaning head 10 as shown in Figures 1 to 3.

In the exemplary embodiment the body 12 has a generally quadrilateral cross-section having a roof 20 that is joined to a floor 22 by opposed side walls 24.

The cleaning head 10 has a central axis 26 that will normally extend centrally from the suction aperture 16. The exemplary embodiment of the cleaning head 10 is mirror symmetrical about a symmetry plane extending vertically through the central axis 26, i.e. whereby the symmetry plane extends centrally through the roof 20 and floor 22.

The body 12 is generally trapezoidal in shape when seen in plan view so that the roof 20 has a larger transverse dimension α towards the mouth 14 and has a smaller transverse dimension β towards the suction aperture 16 (see Figure 4). Accordingly, the mouth 14 has a larger cross-section area than that of the suction aperture 16 so that the body 12 converges from the mouth 14 towards the suction aperture 16.

As can be seen more clearly in Figure 3, the roof 20 is orientated substantially parallel relative to the central axis 26, whereas the floor 22 is inclined relative to the central axis 26. The floor 22 is therefore also inclined relative to the roof 20, whereby the floor 22 is located closer to the roof 20 at or near the mouth 14, while the floor 22 is spaced further away from the roof 20 at or near the suction aperture 16.

The body 12 includes one or more magnets embedded within the floor 22. In use, and when the submerged surface is ferromagnetic such as is typically found in a ship hull, the magnets are configured to hold the floor 22 against and in slidable contact with the submerged surface.

The cleaning head 10 includes a manoeuvring mounting provided on the body, which manoeuvring mounting is configured to allow a manoeuvring force to be applied to the body 12. In the exemplary embodiment shown in Figures 1 to 4, the manoeuvring mounting is a handle 28 joined to the roof 20 of the body 12. The handle 28 is a cylindrical pillar projecting outwardly from the roof 20. In some instances, the handle 28 can project orthogonally from the roof 20. However, it should be appreciated that the handle 28 merely functions to allow a user to hold and manoeuvre the cleaning head 10 and thus the handle 28 can also be provided in other shapes, such as being a spherical knob, an arc-shaped bow handle, or a U-shaped or L-shaped bar handle. In still other examples, the manoeuvring mounting can comprise a recess in the body 12, such as one or more finger recesses that can be gripped by the operator's hand.

A support arm 30 extends from the body 12, whereby the support arm 30 is joined to the roof 20 at a junction 32. The support arm 30 extends axially beyond the floor 22 so

that the support arm 30 overhangs the mouth 14. In the exemplary embodiment the support arm 30 is aligned to be co-planar with the roof 20 and in essence forms an integral extension of the roof 20. However, in other embodiments the support arm 30 may be offset from or angled relative to the roof 20.

A cleaning element 34 depends from the support arm 30 with the cleaning element 34 being spaced laterally away from the junction 32 so that the junction 32 is disposed operatively forward of the cleaning element 34 during use. The cleaning element 34 is in a spaced relation laterally rearward of the mouth 14 and is also located rearward of the handle 28. The cleaning element 34 is angled forwardly / inwardly towards the mouth 14 so that, during use, the cleaning element 34 will be operatively aligned relative to the submerged surface (and accordingly to the floor 22) at an angle θ of 130°-140° (see Figure 3). In one example the angle θ is 135°.

In the exemplary embodiment the cleaning element 34 comprises a scraper body 36 having an outer face 38 facing away from the mouth 14, an inner face 40 facing towards the mouth 14, and a lower edge 42. The scraper body 36 can be integral with the support arm 30. The scraper body 36 is provided with an integral scraper blade 44 extending along and beyond its lower edge 42. The scraper blade 44 lies inwardly proud of the scraper body 36 so that a top edge of the scraper blade 44 defines a ridge 46 extending along the inner face 40. The ridge 46 acts as a strengthening formation to strengthen the scraper body 36 and mitigate any flexing thereof that may occur during use.

Although the exemplary embodiment shows the scraper body 36 and scraper blade 44 being integral, in other embodiments the scraper blade 44 can be separate from the scraper body 36 and releasably joined thereto by suitable means. In one example, the scraper blade 44 can be bolted to the scraper body 36. In another example, the scraper blade 44 may be configured to be received and frictionally held within a complementary sized slot provided in the scraper body 36.

In the exemplary embodiment the scraper body 36 and the scraper blade 44 have concentric curved or arcuate shapes when seen in plan view, wherein their concave faces are directed towards the body 12 – this is more clearly seen in Figures 1 and 2. In some examples, the scraper body 36 and the scraper blade 44 can be concentrically spherically shaped.

The scraper body 36 is spaced rearwardly away from the mouth 14 and depends for a sufficient distance so that the scraper blade 44 lies opposed to the floor 22. In one example a bottom edge of the scraper blade 44 lies co-planar with the floor 22. The bottom edge of the scraper blade 44 is sharpened. In the embodiments wherein the scraper blade 44 is arcuate, the scraper blade 44 can also be arched so that a central part of the scraper blade 44 lies above and closer to the roof 20 than the opposed outer parts of the scraper blade 44.

The cleaning element 34 has a transverse width being substantially wider than the transverse width of the body 12 at its mouth 14. The exemplary embodiment shows the cleaning element 34 being about 50% wider than the body 12. In one example the body 12 has a transverse width at the mouth 14 of about 200 mm while the cleaning element 34 has a transverse width of about 300 mm. The cleaning element 34 therefore defines opposed wings 48 that project laterally beyond the body 12.

The cleaning head 10 defines opposed side channels 50 that are located forwardly of the wings 48 between the cleaning element 34 and the mouth 14. In the exemplary embodiment the channels 50 have a height being equivalent to a height of the mouth 14.

In one example the channels 50 have a width that is adjustable so that the cross-sectional area of the channels 50 can be increased or decreased. In this regard the cleaning element 34 can be movably supported relative to the body 12 so that the cleaning element 34 can be moved axially closer to or further from the body 12, thereby to adjust the width of the channels 50. In the exemplary embodiment the support arm 30 is extendable so that the cleaning element 34 can be moved axially closer to or further from the body 12. In another example the is support arm 30 is telescopic. In another example the support arm 30 is slidably joined to and supported by the roof 20. In yet a further example the cleaning element 34 is slidably joined to and supported by the support arm 30. After the cleaning element 34 is positioned at the desired distance away from the body 12, i.e. once the desired width of the channel 50 has been set, the support arm 30 and/or cleaning element 34 can be secured in position to prevent further undesired movement thereof during use, e.g. by using suitable bolts, clips or split pins.

The channels 50 are configured to allow fluid flow from a suction region around the cleaning head 10 towards the suction aperture 16, whereby in use water surrounding the body 12 (being predominantly water located laterally outside the body 12) is sucked through the channels 50 and the mouth 14 into the body 12 and then through the suction aperture 16. Adjustment of the cross-sectional area of the channels 50 allows an operator to maintain an optimum flow rate of fluid flow through the channels 50.

Each of the channels 50 has a cross-section dimension Φ that is smaller than the transverse dimension α of the mouth 14 (see Figure 4). In one embodiment the cross-section dimension Φ of the channels 50 is less than half the transverse dimension α, so that $\alpha > 2\Phi$. In this way the channels 50 are configured to provide a venturi type constriction being configured to cause an increased flow rate of water from the outer environment surrounding the body 12 through the channels 50 and into the mouth 14.

In another embodiment of the cleaning head as shown in Figure 9, the cleaning element 34 can have a flat planar shape when seen in plan view.

The exemplary embodiment of the cleaning head 10 is an integral single piece that is made of a plastics material or of metal. In one example the cleaning head 10 can be made of polyurethane or nylon plastics material. In one example the cleaning head 10 can be made of steel, aluminium or suitable alloys of these metals.

In use, activating the marine cleaning system causes suction through the suction pipe, resulting in a low pressure within the body 12 which then causes water to be sucked into the body 12 through the channels 50 and the mouth 14.

An operator can grip the handle 28 and locate the cleaning head 10 adjacent to a submerged surface of a ship hull to be cleaned such that the floor 22 lies substantially flush against the submerged surface. The magnets within the floor 22 assist in holding the cleaning head 10 against the submerged surface and thereby reduces the amount of force pressure needed to maintain the cleaning head 10 in contact with the submerged surface. The inclination angle of the floor 22 is configured to optimally align the scraper blade 44 on relative to the submerged surface, e.g. at an inclination angle θ of 135°.

The operator can then move the cleaning head 10 in forward-rearward directions lying substantially along the central axis 26 to scrape off biological fouling from the submerged surface. It will be appreciated that moving the cleaning head 10 in a forward direction, that is in a direction towards the suction aperture 16, constitutes the active removal stroke direction. In contrast, moving the cleaning head 10 in a rearward direction, that is in a direction towards the cleaning element 34, constitutes the return stroke direction. This is because of the inclination angle θ of the scraper blade 44.

In conjunction with its inclination angle θ, the sharpened bottom edge of the scraper blade 44 operates to lift (e.g. slice or peel) the biological fouling away from the hull. This prevents the biological fouling debris from being dragged along the hull and potentially causing additional damage to any antifouling coating applied thereon.

In some instances, the biological fouling can be hard and difficult to remove so that it does not necessarily separate from the submerged surface after a single pass of the cleaning head 10. In such case the scraper blade 44 will ride up and over the biological fouling causing the cleaning head 10 to move away from the submerged surface for short distances. The location of the handle 28 operatively forward of the scraper blade 44 results in the downward pressure and forward forces applied by the operator being operatively in advance of the spacer blade 44. This assists in permitting the scraper blade 44 to ride up and over any non-removed biological fouling.

In contrast thereto, in other systems wherein the downward force and forward forces are applied either substantially above or operatively rearward of their scraper blades, the scraper blades tend to get stuck or embedded within the biological fouling and this often results in the scraper blade tending to buckle or pivot over the biological fouling – often causing damage to the blade so that it no longer operates correctly.

As the biological fouling is separated from the submerged surface, together with any loosely attached leached layers of any antifouling coating that may separate from the hull during the scraping operation, the material becomes entrained in the surrounding water causing a slurry of “dirty” water around the cleaning head 10. This slurry is sucked through the channels 50 and mouth 14 into the body 12 for removal via the suction aperture 16 and suction pipe for further treatment and filtration before the cleaned water is returned to the environment.

The increased flow rate caused by the smaller openings of the channels 50 increases the suction region range from which the surrounding water is capable of being sucked into the cleaning head 10. This results in substantially all the removed biological fouling being captured by the cleaning head 10 without any of the biological fouling dispersing to the environment.

Figures 5 to 8 show a second embodiment of a cleaning head 110. The cleaning head 110 is configured to be used in an automated marine cleaning system, e.g. such as in the system described in US 9,550,552 wherein the cleaning head 110 is configured to be rotatably mounted within the housing (140) thereof and moved along the submerged surface. The cleaning head 110 is configured to be disposed adjacent to and rotated in an operative direction relative to the submerged surface during use. The operative direction is indicated by arrow 112. In this embodiment the drive shaft functions as the manoeuvring mounting being configured to allow a manoeuvring force to be applied to the cleaning head 110.

It should be understood for the purposes of the description below that the terms “forward” and “rearward” refer to operative direction of movement. Thus “forward” is used to refer to a feature or part of the cleaning head 110 that is rotationally in advance of another feature or part. Conversely, “rearward” is used to refer to a feature or part of the cleaning head 110 that rotationally follows another feature or part.

The cleaning head 110 comprises a disc shaped body 114. A number of suction apertures 116 extend transversely through the body 114, through which suction apertures 116 the suction from the suction pipe can be applied and through which the slurry of water and biological fouling can be removed during use.

The cleaning head 110 further comprises a number of cleaning members 118 arranged at discrete spaced circumferential intervals on the body 114. Each cleaning member 118 includes an attachment bracket/junction 120 configured to be fixed to the body 114, such as by screws or bolts 122. A support arm 124 extends rotationally rearwardly from the bracket 120 with the support arm 124 carrying a cleaning element 126 depending from its opposed end, i.e. the bracket 120 is disposed operatively forward of the cleaning element 126 during use.

The support arm 124 is flexibly attached to the body 114 at the bracket 120 so that the support arm 124 is capable of flexing to allow movement of the cleaning element 126 closer to or further away from the body 114. A biasing member 128 is provided to bias the support arm 124 and cleaning element 126 away from the body 114. In the illustrated example, the biasing member 128 is provided between the body 114 and the support arm 124. The biasing member 128 can be a spring, such as a compression spring, or it can be a pillar of resilient plastics or foam material.

Each cleaning element 126 is angled forwardly / inwardly towards the bracket 120 so that, during use, the cleaning element 126 will be operatively aligned relative to the submerged surface at an angle θ of 130°-140° (see Figure 8). In one example the angle θ is 135°.

In this embodiment the cleaning element 126 comprises a scraper body 130 having an outer face 132 facing away from the bracket 120, an inner face 134 facing towards the bracket 120, and a lower edge 136. The scraper body 130 is integral with the support arm 124.

The scraper body 130 supports a scraper blade 138 extending along and beyond its lower edge 136. In this example the scraper blade 138 lies outwardly proud of the scraper body 130 so that a top edge of the scraper blade 138 defines a ridge 140 extending along the outer face 132. The ridge 140 acts as a strengthening formation to strengthen the scraper body 130 and mitigate any flexing thereof that may occur during use.

In this example the scraper body 130 and the scraper blade 138 have a flat planar shape when seen in plan view. Further, the scraper blade 138 is fixed to the scraper body 130 by bolts 142.

In use, when the scraper blade 138 encounters hard to remove biological fouling, the scraper blade 138 will ride up and over the biological fouling. This movement is permitted through flexing of the support arm 124 and correlated compression of the biasing member 128. Once the obstacle is traversed, the biasing member 128 urges the scraper blade 138 back into contact with the submerged surface.

The location of the bracket 120 operatively forward of the scraper blade 138 results in the downward and lateral forces applied by the body 114 being operatively in advance of the scraper blade 138. This assists in allowing the scraper blade 138 to ride up and over any non-removed biological fouling, which mitigates any tendency of the scraper blade 138 buckling or pivoting over the biological fouling and thereby reducing the likelihood of damage to the scraper blade 138.

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

In the claims which follow and in the preceding description, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in a non-limiting and an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in the various embodiments. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the elements is present, unless the context clearly requires that there be one and only one of the elements.

Reference numerals

10	cleaning head	110	cleaning head
12	body	112	arrow (operative direction)
14	mouth	114	body
16	suction aperture	116	suction apertures
18	arrow (operative direction)	118	cleaning members
20	roof	120	junction / bracket
22	floor	122	bolts
24	side walls	124	support arm
26	central axis	126	cleaning element
28	handle	128	biasing member
30	support arm	130	scraper body
32	junction	132	outer face
34	cleaning element	134	inner face
36	scraper body	136	lower edge
38	outer face	138	scraper blade
40	inner face	140	ridge
42	lower edge	142	bolts
44	scraper blade		
46	ridge	α	larger transverse dimension of body
48	wings	β	smaller transverse dimension of body
50	channels	θ	inclination angle of cleaning element
		Φ	cross section dimension of channel

CLAIMS

1. A cleaning head for a marine cleaning system used for cleaning a submerged surface, the cleaning head comprising

a body being configured to be disposed adjacent to and moved relative to a submerged surface;

at least one suction aperture being in fluid communication with a suction region around the body during use;

at least one support arm extending from the body, the support arm extending from a junction with the body;

a cleaning element supported by each support arm, whereby the cleaning element is configured to cause material on the submerged surface to separate from the submerged surface and become suspended in the suction region during use when the body is moved in an operative direction relative to the submerged surface, and whereby the material separated from the submerged surface is drawn away from the suction region through the suction aperture; and

wherein the cleaning element is spaced laterally away from the junction so that the junction is disposed operatively forward of the cleaning element during use.

2. A cleaning head as claimed in claim 1, wherein the body is substantially tubular with the suction aperture being provided at one end of the body and with an open mouth being provided at an opposed end of the body.

3. A cleaning head as claimed in claim 2, wherein the mouth has a larger cross-section area than that of the suction aperture so that the body converges from the mouth towards the suction aperture.

4. A cleaning head as claimed in any one of claims 1 to 3, wherein the body comprises a floor that is inclined relative to the cleaning element, whereby orientating the floor substantially parallel to the submerged surface during use assists in orientating the cleaning element at a preselected operative cleaning inclination angle.

5. A cleaning head as claimed in claim 4, wherein the body comprises one or more magnets embedded within the floor and being configured to slidably hold the floor against a ferromagnetic submerged surface.

6. A cleaning head as claimed in any one of claims 1 to 5, wherein the cleaning element comprises a scraper body and a scraper blade, and wherein the scraper blade is an integral part of the scraper body or wherein the scraper blade is a separate part and releaseably joined to the scraper.

7. A cleaning head as claimed in any one of claims 1 to 6, wherein the cleaning element has a flat planar shape.

8. A cleaning head as claimed in any one of claims 1 to 6, wherein the cleaning element has an arcuate shape having its concave face directed towards the body.

9. A cleaning head as claimed in claim 8, wherein the cleaning element has an arched shape so that a central part of the cleaning element is raised above the opposed outer parts of the cleaning element.

10. A cleaning head as claimed in any one of claims 1 to 9, wherein the cleaning element has a transverse width being substantially wider than the transverse width of the body, whereby the cleaning element defines opposed wings that project laterally beyond the body.

11. A cleaning head as claimed in any one of claims 1 to 10, further comprising opposed channels provided between the cleaning element and the body on opposed sides of the body, the channels being configured to allow fluid flow from a suction region around the cleaning head towards the suction aperture.

12. A cleaning head as claimed in claim 11, wherein the channels comprise a venturi type constriction being configured in use to cause an increased flow rate of fluid from the suction region into the suction aperture.

13. A cleaning head as claimed in claim 11 or 12, wherein the cleaning element is movably supported relative to the body thereby permitting adjustment of a cross-sectional area of the channels.

14. A cleaning head as claimed in claim 1, wherein the body comprises a rotatable disc and the suction aperture comprises one or more apertures extending transversely through the disc.

15. A cleaning head as claimed in claim 14, which comprises a number of cleaning elements arranged at discrete spaced circumferential intervals on the body.

16. A cleaning head as claim in claim 14 or 15, wherein the support arm is flexibly attached to the body to allow movement of the cleaning element closer to or further away from the body.

17. A cleaning head as claimed in claim 16, which comprises a biasing member configured to bias the support arm and cleaning element away from the body.

18. A cleaning head as claimed in claim 17, wherein the biasing member comprises a spring, resilient plastics material or resilient foam material.

19. A cleaning head as claimed in any one of claims 1 to 18, wherein the cleaning element is angled towards the junction so that, during use, the cleaning element operatively aligned relative to the submerged surface at a preselected operative cleaning inclination angle.

20. A cleaning head as claimed in claim 19, wherein the inclination angle is 130°-140°.

21. A cleaning head as claimed in claim 19 or 20, wherein the inclination angle is 135°.

22. A method of cleaning a submerged surface, the method comprising

providing a cleaning head having

a body;

at least one support arm extending from the body, the support arm extending from a junction with the body; and

a cleaning element supported by each support arm, wherein the cleaning element is spaced laterally away from the junction so that the junction is disposed operatively forward of the cleaning element;

locating the cleaning head against the submerged surface so that the body is disposed adjacent to and movable relative to the submerged surface;

applying a suction force to a suction region around the body; and

moving the cleaning head in an operative direction relative to the submerged surface so that the cleaning element causes material on the submerged surface to separate from the submerged surface and become suspended in the suction region,

whereby the material separated from the submerged surface is drawn away from the suction region through the suction aperture.

23. A method as claimed in claim 23, wherein the cleaning head is a cleaning head as claimed in any one of claims 1 to 21.

Figure 1

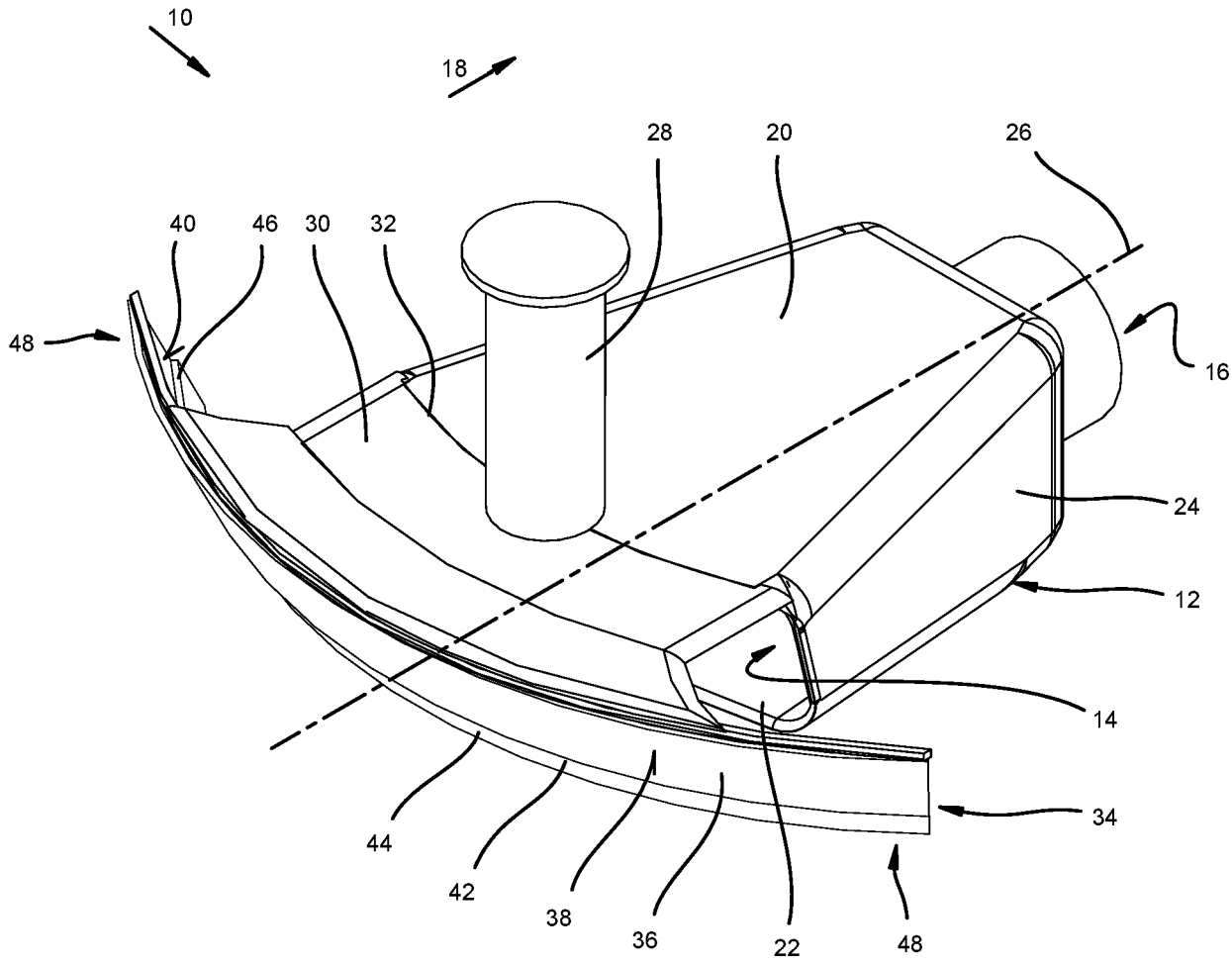


Figure 2

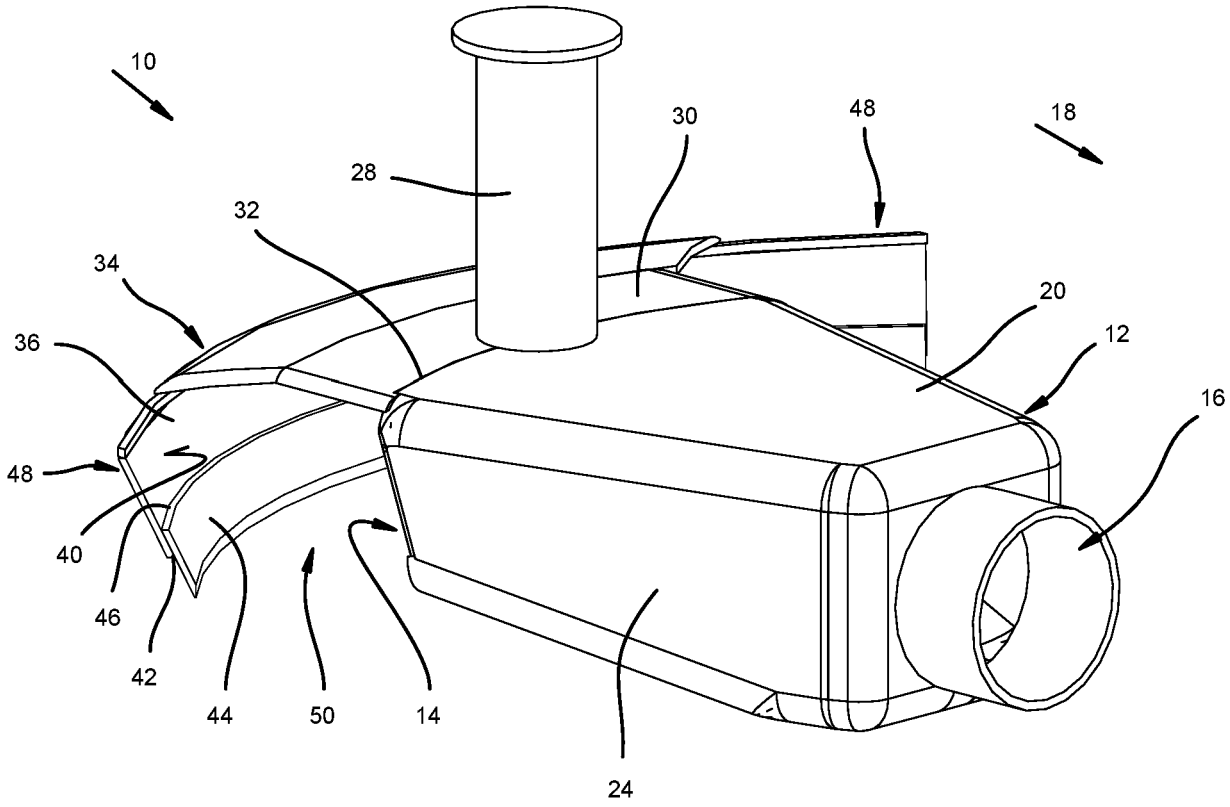


Figure 3

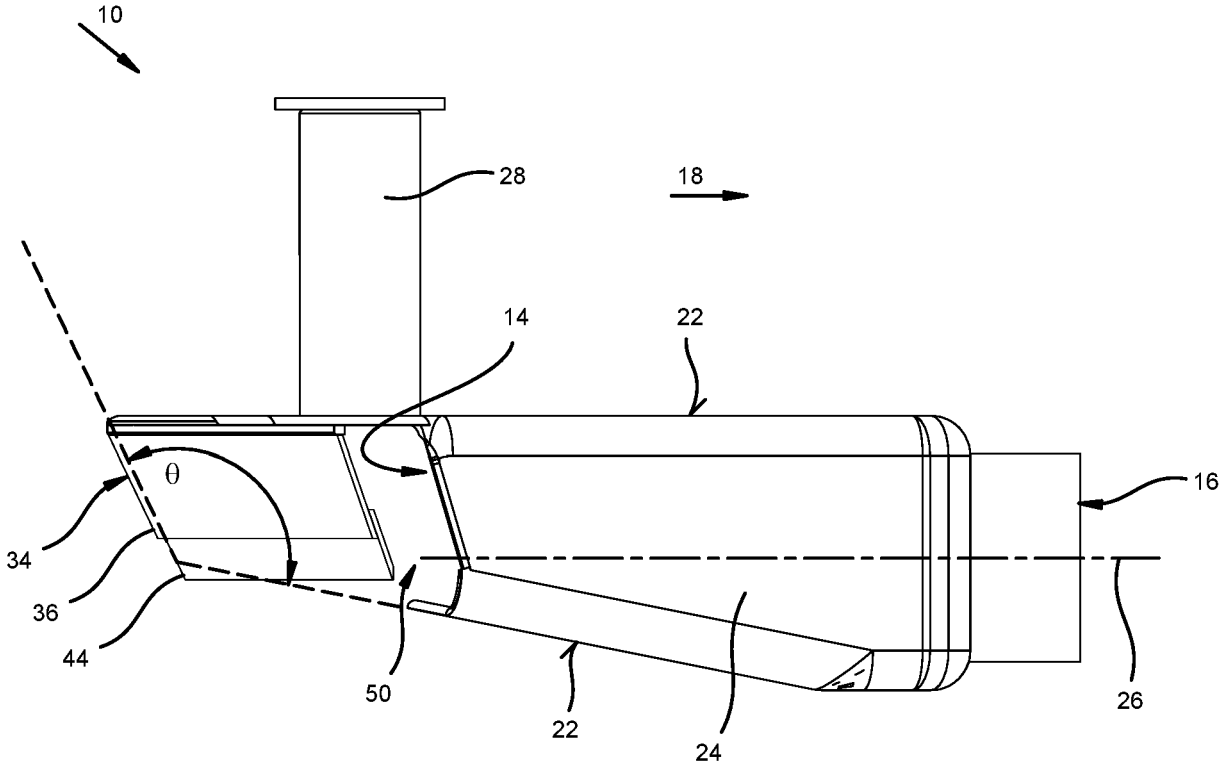


Figure 4

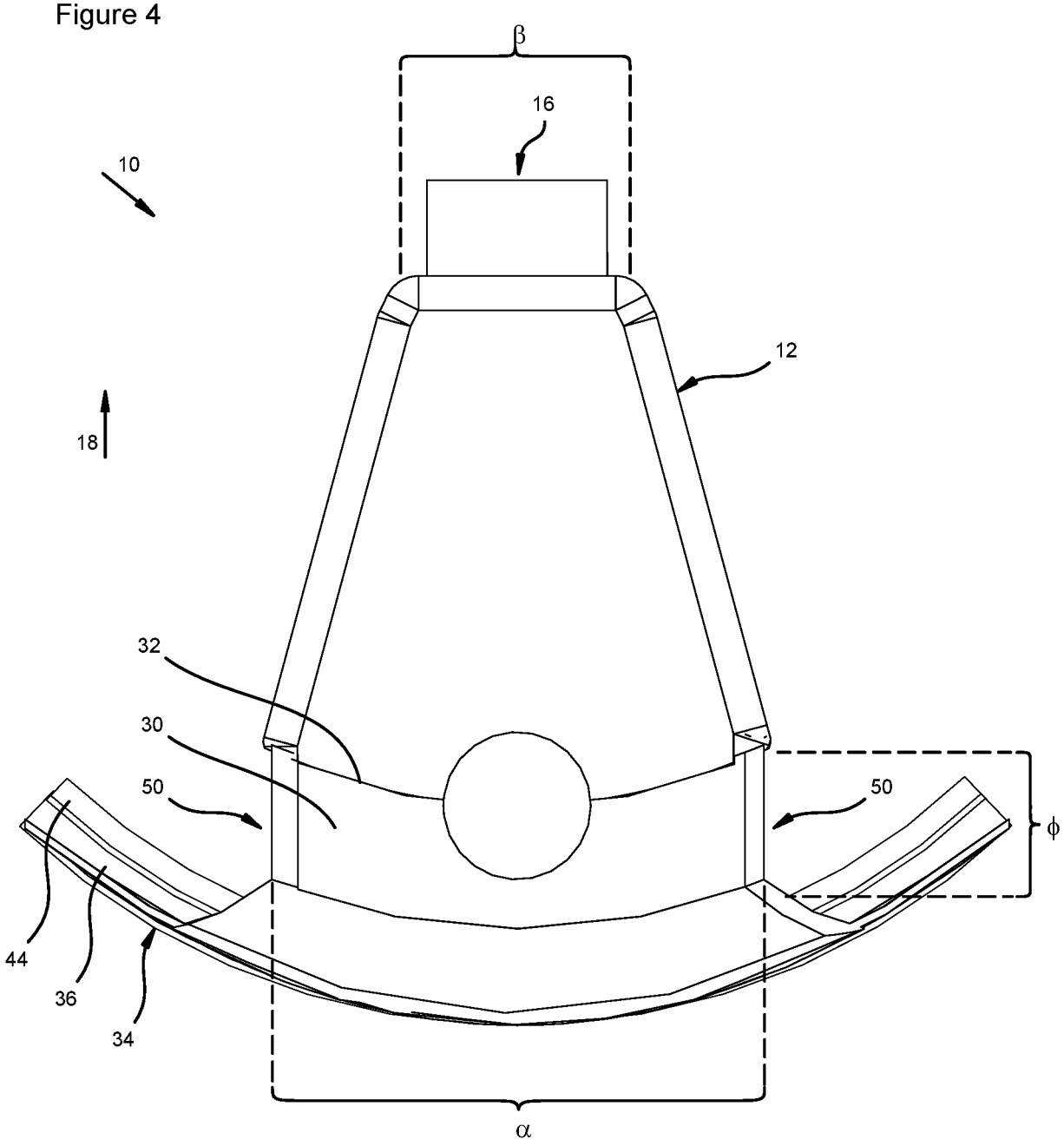


Figure 5

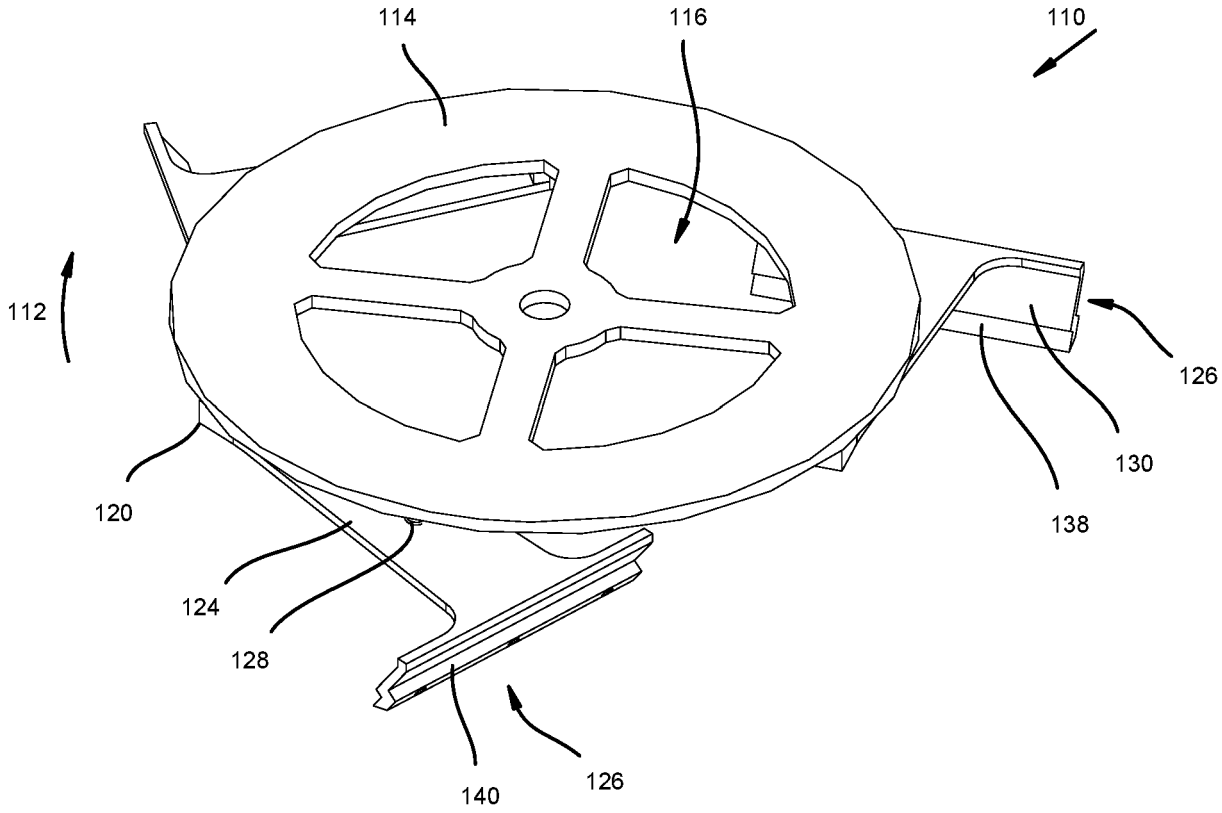


Figure 6

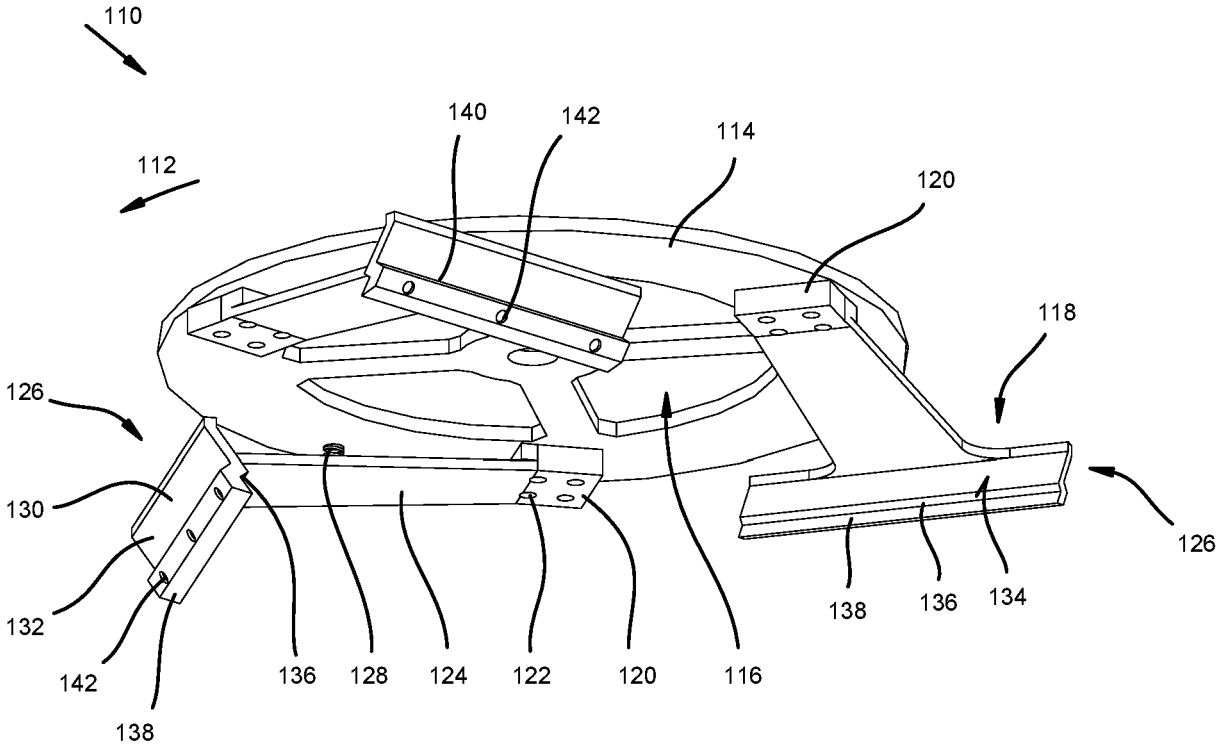


Figure 7

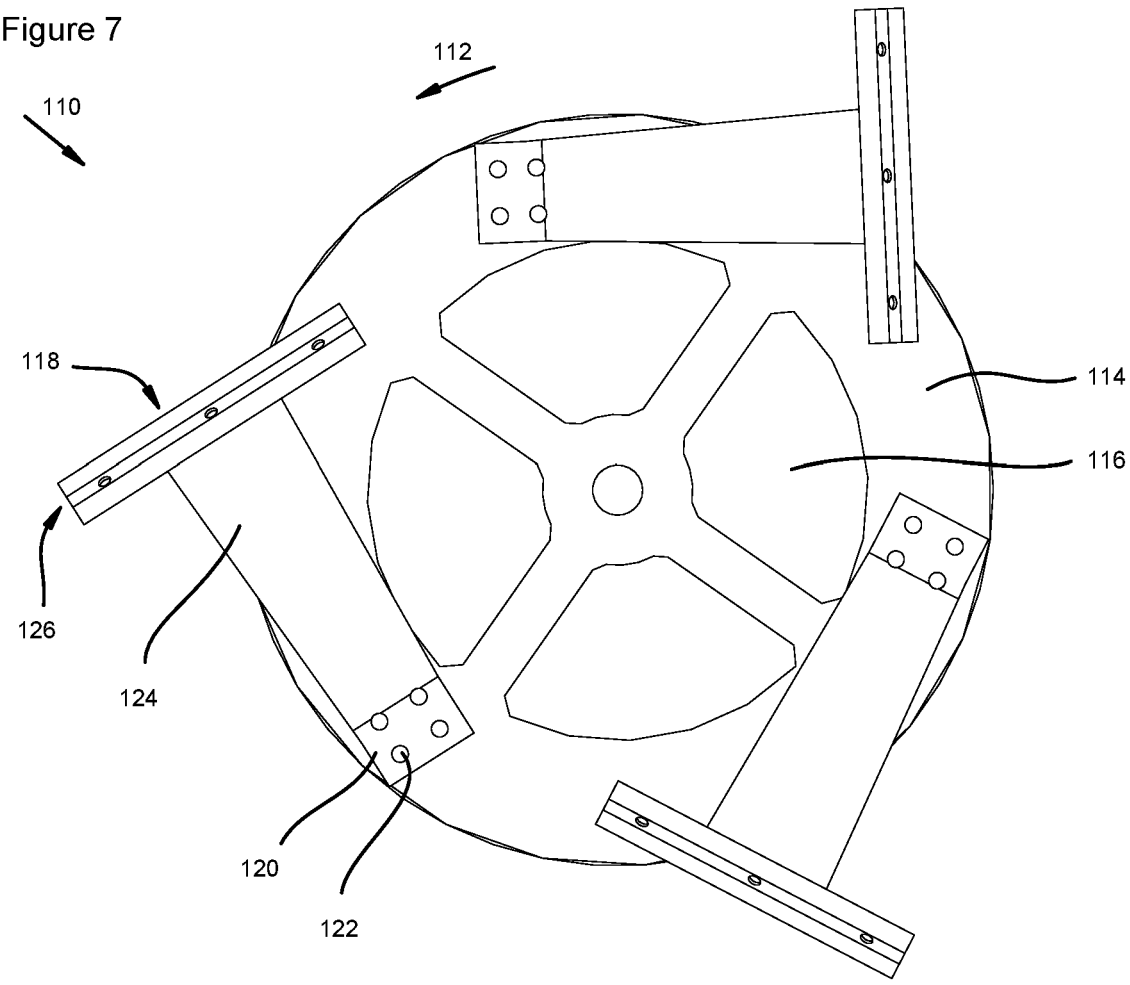


Figure 8

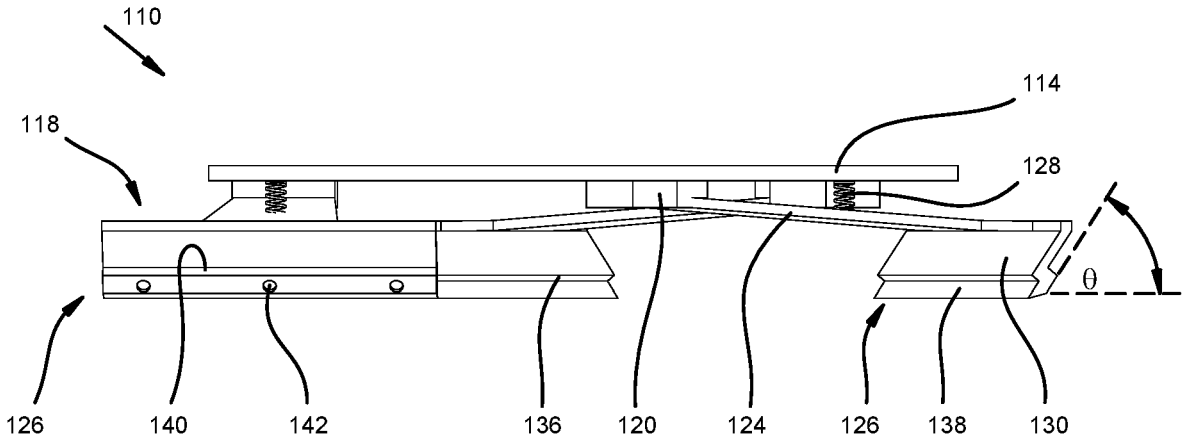


Figure 9

