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(54) **Device for cleaning by way of a fluid jet a submerged surface of a marine construction from mussels and other organisms**

(57) The present invention relates to a cleaning device for removing mussels and other marine organisms from a submerged surface of a construction at sea, the cleaning device comprising:
- a movable arm comprising a proximal end which is constructed to be mounted on a vessel,
- at least one nozzle mounted at a distal end of the moveable arm, the nozzle being constructed to eject a fluid for removing the mussels and other organisms,
- a fluid supply conduit extending along the arm from the proximal end to the distal end and being connected to the nozzle,
wherein the cleaning device is configured for ejecting a fluid jet having a discharge between 10000 - 30000 liter per minute and a pressure of 10 - 40 bar.

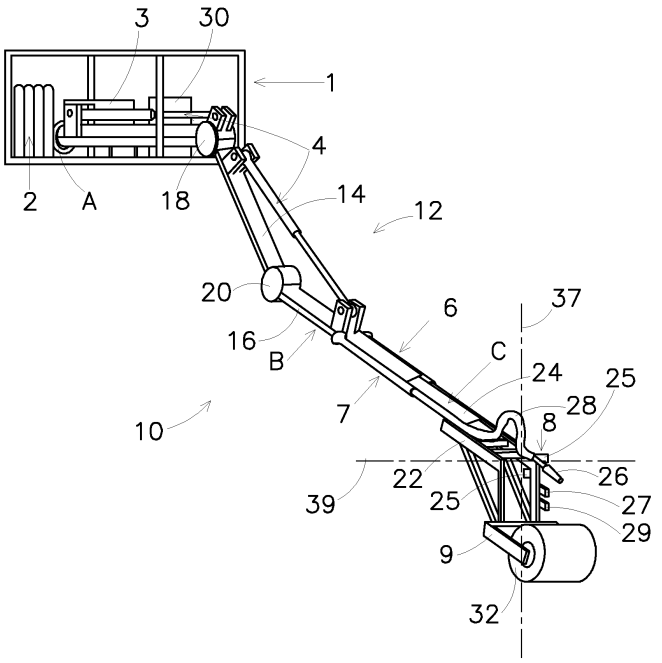

Fig 1

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Description

Field of the art

[0001] The present invention relates to a device for cleaning a marine construction at sea. The present invention relates in particular to removing mussels and other organisms such as barnacles from a submerged surface of said marine construction. Devices for cleaning a submerged structure in general are known in the field of the art.

Discussion of the prior art

[0002] GB1294011 discloses a working vessel 5 on which an arm 14,20 is mounted. Figure 2 shows the arm 14, 20 with a working head 28 mounted to the end thereof. The working head 28 comprises a nozzle 33. The nozzle head 28 comprises wheels 44, 45, 49 which are constructed to roll over the surface of a construction 53 which is to be cleaned, see figure 3. The working head 28 is constructed to position the nozzle 33 close to the surface 53 which is to be cleaned. The arm comprises a spring 26 to control the position of the nozzle head on the surface of the construction. A hydraulic system is provided to move the arm.

[0003] Devices like the device of GB1294011 are typically constructed to operate at a pressure of approximately 380 Bar and a discharge of approximately 36 liter per minute. Other systems exist which operate at 500 bar or 800 bar.

[0004] With such a pressure and discharge, the cleaning of a construction can be performed quite well in many circumstances.

[0005] However, the device of GB1294011 has a serious limitation. The device of GB1294011 needs a relatively calm environment to function properly. The device of GB1294011 does not work at sea. At sea, relative movements of the target and the working vessel due to wind and waves make it too difficult to ensure that the working head follows the contour of the structure which is to be cleaned. In operation, the working head will move relative to the surface which is to be cleaned and will be too far from the target for most of the time in order to function properly.

[0006] More important, the wind and waves cause a substantial risk of collision and damage to both the nozzle and the construction.

[0007] In the present time, more and more constructions are built at sea. Wind turbine parks of tens or hundreds of wind turbines are planned and constructed at sea throughout Europe and in other parts of the world. Other constructions at sea are also planned and constructed.

[0008] Wind turbines typically comprise an under water section, typically a column extending upwards from the seabed. The column intersects the water surface and extends upwards to a considerably height above the water surface. Here, the column supports the nacelle and the rotor. Near the water surface, several auxiliary devices are located such as a boat landing, J-tubes and anodes. These auxiliary devices need to be inspected on a regular basis.

[0009] Typically, mussels and other organisms grow to the underwater surface of the column. The mussels provide additional weight on the wind turbine. Gradually, the wind turbine wil become very heavy due to the mussels. Moreover, the columns will gradually have a larger surface and have a greater drag resistance when a water current flows along the column. Due to the mussels and other organisms, the wind turbine will thus exert a gradually increasing force on its foundation. This can lead to problems, such as stability problems. A need for periodical cleaning thus arises.

[0010] A further effect of the mussels is that inspection of certain parts of the wind turbine becomes more difficult or impossible. Various devices become obstructed by mussels and other organisms, in particular the above mentioned auxiliary devices.

[0011] Inspections are very important and for this reason alone, the mussels should be removed. Thus, wind turbines should be cleaned from mussels on a regular basis.

[0012] However, unlike vessels, wind turbines can not easily be transported to a harbour for cleaning. Cleaning generally should be performed at sea. However, the device of GB1294011 is not suitable to operate at sea. Moreover, no other comparable device exists which is suitable to operate at sea.

[0013] If a wind turbine would be cleaned, only difficult and cumbersome are provided. A possibility would be to use a team of divers or and/or a Remotely Operated Vehicle (ROV). The divers may use brushes to remove the mussels and other organisms. The ROV may comprise a water jet system comparable to the water jet system shown in GB1294011.

[0014] With a team of five divers, the cleaning operation probably would take about one full week per wind turbine. With an ROV, the cleaning operation would take even longer. Divers are very expensive and an ROV is also very expensive in use. Moreover, diving at sea brings along substantial risks for the divers.

[0015] Because these methods are so expensive and cumbersome, wind turbines at sea generally are not cleaned at all. As explained above, this is an undesirable situation.

Object of the invention

[0016] It is an object of the invention to provide an improved cleaning method and device for cleaning a submerged construction at sea.

The invention

[0017] In the present invention, it was discovered that

the problem associated with the device of GB1294011 is related to the pressure at which the water jet is ejected from the nozzle. It was recognized that the discharge also plays a role. The water jet which ejects from the nozzle has a substantial pressure. This is effective when cleaning power is required for removing mussels and other organisms. In use, the water jet squirts from the nozzle and travels through the surrounding water over a certain distance. The water then hits the construction some time after leaving the nozzle.

[0018] It is discovered that during this time and during the distance over which the water jet travels, the pressure drops rather sharply. It was found that the water jet hits the surface with a substantially lower pressure than the pressure with which it ejects from the nozzle. However, this lower pressure is still high enough to clean the surface. But if the distance is increased, the pressure becomes too low to remove any mussels or other organisms. It was found that the limited discharge of the water jet increases this limitation in distance.

[0019] It was found that increasing the pressure does not make it possible to increase the distance, because the resulting drop in pressure will become even more dramatic.

[0020] However, it was found in the present invention that in fact a decrease in pressure can lead to the possibility of positioning the nozzle at a greater distance from the target surface. This result is counterintuitive and surprising. It was further found that a water jet with a lower pressure in combination with a greater discharge may in particular lead to the required result.

[0021] Thus, the invention provides a cleaning device for removing mussels and other marine organisms from a submerged surface of a construction at sea, the cleaning device comprising:

- a movable arm comprising a proximal end which is constructed to be mounted on a vessel,
- at least one nozzle mounted at a distal end of the moveable arm, the nozzle being constructed to eject a fluid for removing the mussels and other organisms,
- a fluid supply conduit extending along the arm from the proximal end to the distal end and being connected to the nozzle,

wherein the cleaning device is configured for ejecting a fluid jet having a discharge between 10000 - 30000 liter per minute and a pressure of 10 - 40 bar.

[0022] The invention allows submerged surfaces to be cleaned at sea from a simple work vessel. The invention allows the nozzle to be positioned at approximately 2-3 meter from the target, thereby allowing the wind and waves to move the work vessel substantially without risk of collision of the nozzle with the construction. Thus, constructions at sea can be cleaned in a much simpler way than is currently possible. The invention provides a substantial advantage in terms of costs over current methods.

[0023] Divers are no longer necessary. Risks involved with divers at sea are taken away. An ROV is also no longer necessary.

[0024] The invention allows cleaning of the construction without any contact between the cleaning device and the construction.

[0025] Furthermore, the present invention allows faster cleaning of submerged surfaces and thus enables a substantial increase in productivity. The invention thus provides a valuable contribution in terms of economic productivity of cleaning operations of submerged constructions at sea. The present invention makes constructions at sea more profitable.

[0026] The water jet ejecting from the nozzle has a certain cross-sectional area and a certain velocity. This combination results in substantial total force being exerted on the target surface. It was found that this substantial force allows removal of mussels, even though the pressure of the water jet is much smaller than the pressure of known systems.

[0027] This is caused by the characteristic of mussels to not only grow on the surface of the construction, but to also become connected with one another. The mussels more or less form a crust. When the crust is hit by the water jet of the invention, the total force applied on the crust by the water jet tends to become concentrated at a certain location, i.e. becomes concentrated in a few connections between a few mussels and the construction. These few mussels then tear loose. The total force subsequently becomes concentrated in a few, next mussels, which also tear loose. One by one or a few by a few, the mussels come loose from the construction, although quite a few mussels remain interconnected and remain as large chunks of crust.

[0028] Thus, even though the average force on the individual mussels is much smaller than in the prior art, a local force on a few individual mussels is more or less the same as in known systems, because the forces are transferred through the crust from one mussel to the next and become concentrated in the connections between a few mussels and the construction. Instead of removing the mussels one at a time, chunks of mussels are removed.

[0029] The present invention may leave some mussels behind on the construction. This is acceptable. The detrimental effects of the mussels are related to the quantity of mussels that are grown on the construction. If a few mussels remain behind on the construction, this does not cause great problems in terms of an increased weight and/or an increased drag. Moreover, inspection is possible when only a few mussels remain on the construction.

[0030] Generally, the fluid will be a liquid, in particular water. The water may be pumped up from the sea directly surrounding the vessel.

[0031] The invention requires a supply of fluid. The fluid supply device may be a pump on board the vessel

which has a dedicated purpose for the mussel cleaning system.

[0032] In use, the jet exerts a considerable force on the target surface. If the force is measured, the measurement is generally not measured on the target structure, but on the cleaning device itself, because this is much easier. The force with which the nozzle is held in position is an indication of the power of the water jet.

[0033] In the present invention, the total reaction force of the water jet on the nozzle may be between 10 kN and 40 kN. The force on the target will be lower and will vary in dependence of the distance to the target. This force is substantially larger than in the prior art. The force is sufficient to tear chunks of mussels from the construction.

[0034] Another advantage of the present invention is that the risk of damage to the coating of the construction is reduced. Damage to coatings is generally caused by excessive peak pressures of the water jet on a small, local area of the target structure. Due to the sharp drop of the pressure in known systems, this pressure may also rise sharply when the distance between the nozzle and the target surface is unexpectedly decreased. This may happen due to a local protrusion on the target structure, or due to a local indentation in the target structure which causes a wheel or other stop organ to move into the indentation, thereby drawing the nozzle closer to the surface of the construction. In particular the antifouling layers are spared from damage.

[0035] Another advantage is that the cleaning of structures with an irregular surface becomes easier. A structure having protrusions, indentations or an otherwise irregular form may be difficult to follow with the working head of GB1294011, even in relatively calm conditions. Conversely, with the invention, an irregular surface may be cleaned by positioning the nozzle at a distance from the target surface and varying the position and angle of the nozzle. This is in particular advantageous for the above mentioned auxiliary devices on wind turbines, such as the boat landing, the J-tubes and the anodes. Other constructions than wind turbines may also have protruding auxiliary devices.

[0036] The arm may comprise one or several hinges in order to be able to reach required surfaces and eject a liquid jet at these surfaces at a required angle.

[0037] The arm will generally be positioned on a vessel, but it is also possible that the arm is mounted on a barge or a semi-submersible vessel.

[0038] It will be clear to a skilled person that the present invention is not limited to cleaning wind turbines. Other constructions may also be cleaned such as jackets, vessels, pipelines, in particular risers, TLP's, other kinds of platforms.

[0039] In an embodiment, the nozzle is constructed to eject a jet having a discharge between 15000 and 25000 liter per minute. It was found that this discharge leads to good results.

[0040] In an embodiment, the nozzle is constructed to eject a fluid at a pressure of between 15 - 30 bar.

[0041] In an embodiment, the nozzle has a diameter of between 3 and 7 cm. In another embodiment, the nozzle has a diameter of between 4 and 6 cm. The nozzle typically is circular or substantially circular.

[0042] In an embodiment, a work vessel is provided to which the arm is mounted.

[0043] In another embodiment, the vessel comprises a fire extinguishing system, and the fire extinguishing system is coupled to the fluid supply conduit in order to serve as the supply of the liquid for the liquid jet.

[0044] In an embodiment, the vessel comprises a dynamic positioning system (DP system) which is configured to accurately position the vessel at a target location in substantially rough weather conditions.

[0045] With a DP system, cleaning can be performed in even rougher conditions.

[0046] In an embodiment, the device comprises a stop organ to prevent damage to the arm or nozzle when the arm contacts the target surface.

[0047] In an embodiment, the device further comprises a deformable part comprising a spring system which is configured to store energy resulting from a contact between the distal end of the arm and the target structure, which contact results in a deformation of the arm.

[0048] In an embodiment, the nozzle is mounted to a working head, and the working head comprises at least one actuator to rotate the working head relative to the arm, for allowing a relatively accurate pointing of the fluid jet at the target structure.

[0049] The nozzle may be pivoted up and/or down and from left to right.

[0050] The present invention further relates to a method for removing mussels and other marine organisms from a submerged surface of a construction at sea, the method comprising providing a vessel comprising a cleaning device comprising:

- a movable arm comprising a proximal end which is mounted on the vessel,
- at least one nozzle mounted at a distal end of the moveable arm, the nozzle being constructed to eject a fluid for removing the mussels and other organisms,
- a fluid conduit extending along the arm from the proximal end to the distal end, the cleaning device being configured for ejecting a fluid jet having a discharge between 10000 and 30000 liter per minute and a pressure of 10 - 40 bar,

wherein the method comprises positioning the vessel at a certain distance from the target surface, positioning the nozzle in a use position and ejecting a fluid jet from the nozzle against the target surface with a discharge between 10000 and 30000 liter per minute and a pressure of 10 - 40 bar.

[0051] The method provides the same advantages as the device of the invention.

[0052] In an embodiment, the method comprises pro-

viding a dynamic positioning system on the vessel and using the dynamic positioning system to maintain the vessel in proximity with the construction.

[0053] The invention is explained in more detail in the text which follows, with reference to the drawings, which show a number of embodiments, which are given purely by way of nonlimiting examples.

List of Figures

[0054]

Figure 1 shows a diagrammatic view of a cleaning device according to the invention.

Figure 2 shows a diagrammatic side view of the cleaning device according to the invention in use.

Figure 3 shows a top view of the cleaning device according to the invention in use.

Figure 4 shows a side view on the working of the prior art.

Figure 5 shows a side view on the working of the present invention.

Detailed description of the Figures

[0055] Turning to Figures 1, 2 and 3, the cleaning device 10 according to the invention is shown. The cleaning device 10 is mounted to the rear end or the forward end of a working vessel 11. The working vessel comprises a DP system 13 for accurate position control.

[0056] The cleaning device 10 can be housed in a container 1, for instance a 20-foot container.

[0057] The cleaning device comprises an arm 12 which comprises multiple segments. In this embodiment, the arm comprises an upper segment 14 and a lower segment 16. The arm is made from aluminium.

[0058] The segments 14, 16 are connected to one another and to the working vessel 11 via a first hinge 18 and a second hinge 20. The hinges 18, 20 may be elbow joints. The first hinge 18 is supported by the container 1.

[0059] A hydraulic system is provided to move the arm in a controllable fashion. The hydraulic system comprises a hydraulic power pack 3, a hydraulic accumulator 2 and hydraulic cylinders 4. The power pack 3 comprises a pump, an electric drive and a storage tank for hydraulic fluid. drives the hydraulic cylinders 4. The hydraulic accumulator 2 is a device known in the prior art and comprises several reservoirs filled with hydraulic oil and compressed air, the oil and the air being separated by a membrane. The hydraulic accumulator 2 can temporarily store energy from the hydraulic system and release the energy on demand. This will be explained further below.

[0060] One or more hydraulic bumper cylinders 7 are provided which allow an outer telescopic arm B and an inner telescopic A arm to slide relative to one another. The hydraulic bumper cylinders 7 are connected to the hydraulic accumulator pack 2.

[0061] A working head 22 is provided at a distal end 24 of the arm 12. The working head 22 comprises a frame. The working head 22 supports a nozzle 26. The nozzle is connected to a conduit 28 which extends through the arm 12 to the working vessel 11. The fluid conduit 28 is connected to a fluid pump 30. The fluid pump 30 may be positioned in the container 1. It is also possible that the fluid pump 30 is part of a fire extinguishing system on board the working vessel 11. The pump has a relatively large size and thus it is more suitable to position the pump on board the working vessel 11 than to mount the pump on the arm 12.

[0062] The working head 22 is pivotable about two axes, i.e. a pan axis 37 allowing the working head to pivot to the left and to the right and a tilt axis 39 allowing the working head to pivot up and down. Actuators 25 in the form of hydraulic cylinders are provided to allow a controlled pan and tilt movement. The nozzle may be pivoted over a range of 180 degrees from left to right. The nozzle may be moved over a range of 160 degrees up and down.

[0063] A camera 27 is provided on the working head to monitor the process. A sonar device 29 is mounted on the working head 22 to monitor the position relative to the construction 36. The sonar may be coupled to the DP system for automatic position control.

[0064] A bumper wheel 32 is connected to a bumper frame 9. The bumper frame 9 is connected to the working head 22.

[0065] In use, the working vessel 11 is positioned near a construction 36 which is to be cleaned. The construction is covered with a layer 45 of mussels and other sea organisms. The mussels are grown together and form a crust-like layer. Mussels and other organisms generally need daylight to grow. Therefore, the majority of the mussels and other organisms are located within limited depths 44 from the water surface 46, which depth typically is no larger then approximately 16 meter. This depth 44 allows cleaning from a working vessel 11 with a movable arm.

[0066] Typically, the working vessel 11 is positioned downstream of the construction 36 if there is a current 38 at the location.

[0067] If there is a current 38, the working vessel 11 is positioned in a weathervaned fashion, i.e. in the direction of the current 38.

[0068] The arm 12 extends from the vessel in the direction of the construction 36. The nozzle 26 is positioned at a distance 40 of about 2-3 meter from a target surface 42 on the construction 36.

[0069] The working head 22 will move due to action of wind and waves. Due to the distance 40, there is no contact between the working head 22 and the construction 36. If there is any contact, the bumper 9 will prevent damage by cushioning the impact. The telescopic arms B,C will slide into one another, thereby avoiding damage. The energy due to the sliding of the telescopic arm B,C is stored in the hydraulic accumulator 2 via a conduit. When the vessel 11 and the construction 36 move away from one another, the telescopic arm B, C extends until it

reaches its normal length. The energy which was previously stored in the hydraulic accumulator 2 is used for this purpose. The telescopic arms B, C have a working range of 3 meter.

[0070] The water pump is started, and a jet 50 ejects from the nozzle 26. The nozzle typically has a substantially circular opening with a diameter between 3 and 7 cm, preferably between 4 and 6 cm. The jet 50 typically has a discharge of about 10000 - 30000 liter per minute and is ejected from the nozzle at a pressure of 10 - 30 bar. Due to the relatively low pressure and the relatively high discharge, this results in a flow of water which has a substantial impulse and thus is capable of exerting a substantial force on the mussels at a distance of 2-3 meter.

[0071] The mussels will tear loose in large chunks and drop to the seabed.

[0072] Figure 4 shows the operation of the device of the prior art of GB1294011. The nozzle 33 (see GB1294011) is positioned in close proximity 41 to the target surface 42. A distance 41 of 10 - 15 centimetres is common. The layer of mussels 45 is formed by individual mussels 52. The water jet 50 is directed at one mussel 52 and the resulting force on this particular mussel tears the connection 54 with which these on mussel is attached to the target surface loose.

[0073] Figure 5 shows the working of the invention. The nozzle 26 is positioned at a much greater distance 40 from the target surface than in the prior art. The distance may be 2-3 meter. The nozzle 26 has a larger opening than the nozzle 33 of the prior art. The water jet 50 ejects from the nozzle with a much lower pressure and a higher discharge per unit of time. Thus, the average force per mussel 52 is substantially smaller than in the prior art.

[0074] Because the mussels 52 are connected to one another, they form a crust 45. The water jet 50 exerts a force on a large number of mussels. The forces on a large number of mussels 52 become concentrated in connections 54 which come loose. Subsequently, the next mussel comes loose, until all the mussels are removed.

[0075] It will be obvious to a person skilled in the art that the details and the arrangement of the parts may be varied over considerable range without departing from the spirit of the invention and the scope of the claims.

Claims

1. Cleaning device for removing mussels and other marine organisms from a submerged surface of a construction at sea, the cleaning device comprising:

   - a movable arm comprising a proximal end which is constructed to be mounted on a vessel,
   - at least one nozzle mounted at a distal end of the moveable arm, the nozzle being constructed to eject a fluid for removing the mussels and other organisms,
   - a fluid supply conduit extending along the arm from the proximal end to the distal end and being connected to the nozzle,

   wherein the cleaning device is configured for ejecting a fluid jet having a discharge between 10000 - 30000 liter per minute and a pressure of 10 - 40 bar.

2. Device according to claim 1, wherein the nozzle is constructed to eject a jet having a discharge between 15000 and 25000 liter per minute.

3. Device according to claim 1 or 2, wherein the nozzle is constructed to eject a fluid at a pressure of between 15 - 30 bar.

4. Device according to any of claims 1-3, wherein the nozzle has a diameter of between 3 and 7 cm.

5. Device according to any of claims 1-4, further comprising a work vessel to which the arm is mounted.

6. Device according to any of claims 1-5, wherein the vessel comprises a fire extinguishing system, and wherein the fire extinguishing system is coupled to the fluid supply conduit in order to serve as the supply of the liquid for the liquid jet.

7. Device according to any of claims 1-6, wherein the vessel comprises a dynamic positioning system which is configured to accurately position the vessel at a target location in substantially rough weather conditions.

8. Device according to any of claims 1-7, further comprising a stop organ to prevent damage to the arm or nozzle when the arm contacts a target surface of the construction.

9. Device according to any of claims 1-8, wherein the device is configured to eject a fluid jet which creates a total reaction force of between 10kN and 40kN on the nozzle.

10. Device according to any of claims 1-9, wherein the nozzle is mounted to a working head, and wherein the working head comprises at least one actuator to rotate the working head relative to the arm, for allowing a relatively accurate pointing of the fluid jet at the target structure.

11. Method for removing mussels and other marine organisms from a submerged surface of a construction at sea, the method comprising providing a vessel comprising a cleaning device comprising :

    - a movable arm comprising a proximal end

which is mounted on the vessel,
- at least one nozzle mounted at a distal end of the moveable arm, the nozzle being constructed to eject a fluid for removing the mussels and other organisms,
- a fluid conduit extending along the arm from the proximal end to the distal end, the cleaning device being configured for ejecting a fluid jet having a discharge between 10000 and 30000 liter per minute and a pressure of 10 - 40 bar,

wherein the method comprises positioning the vessel at a certain distance from a target surface on the construction, positioning the nozzle in a use position and ejecting a fluid jet from the nozzle against the target surface with a discharge between 10000 and 30000 liter per minute and a pressure of 10 - 40 bar.

12. Method of claim 11, wherein the cleaning of the construction is performed without contact between the cleaning device and the construction.

13. Method of claim 11 or 12, comprising positioning the nozzle at 2-3 meter from the target surface.

14. Method of any of claims 11-13, comprising providing a dynamic positioning system on the vessel and using the dynamic positioning system to maintain the vessel in proximity with the construction.

15. Method of any of claims 11-14, comprising generating a fluid jet having a reaction force of between 10kN and 40kN on the nozzle.

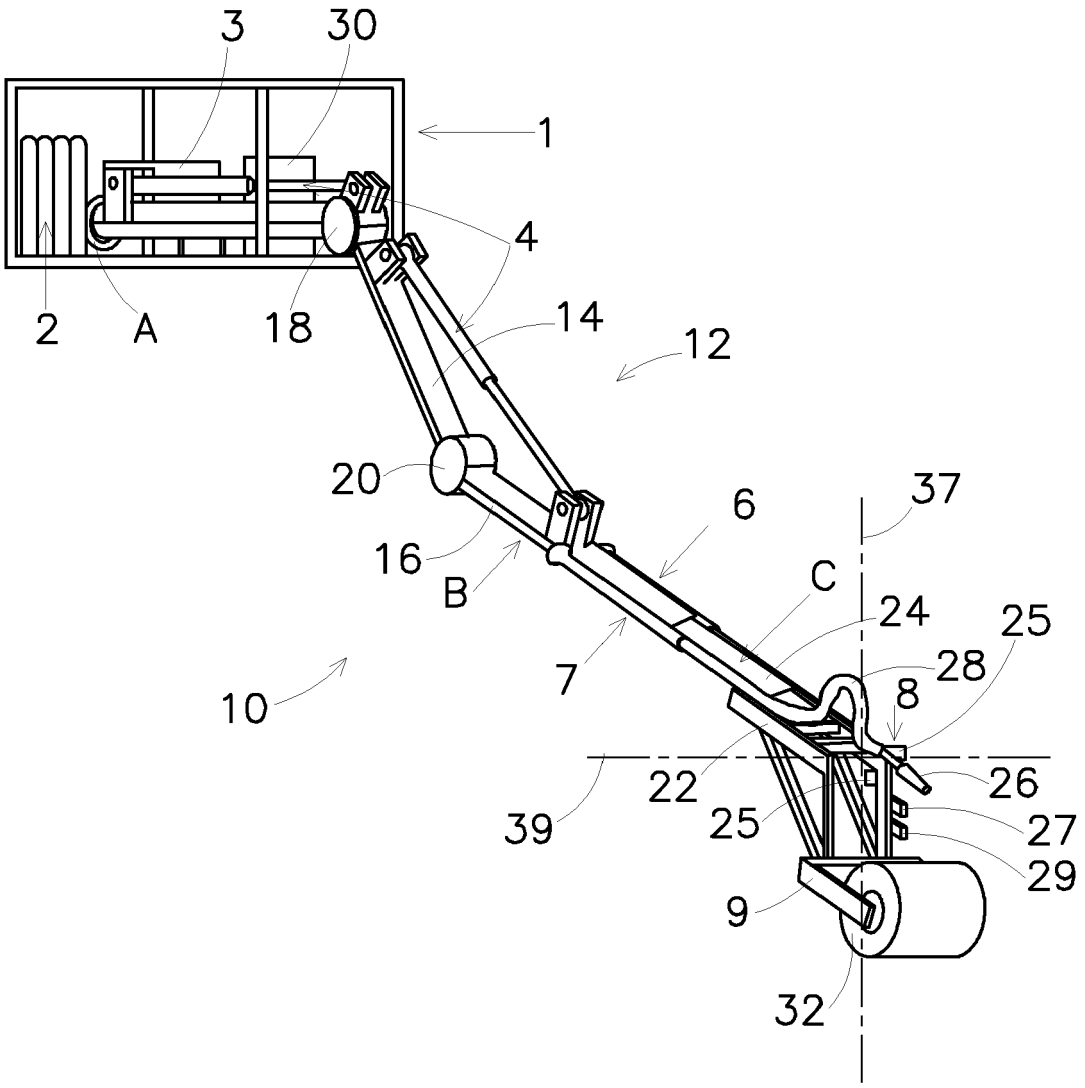

Fig 1

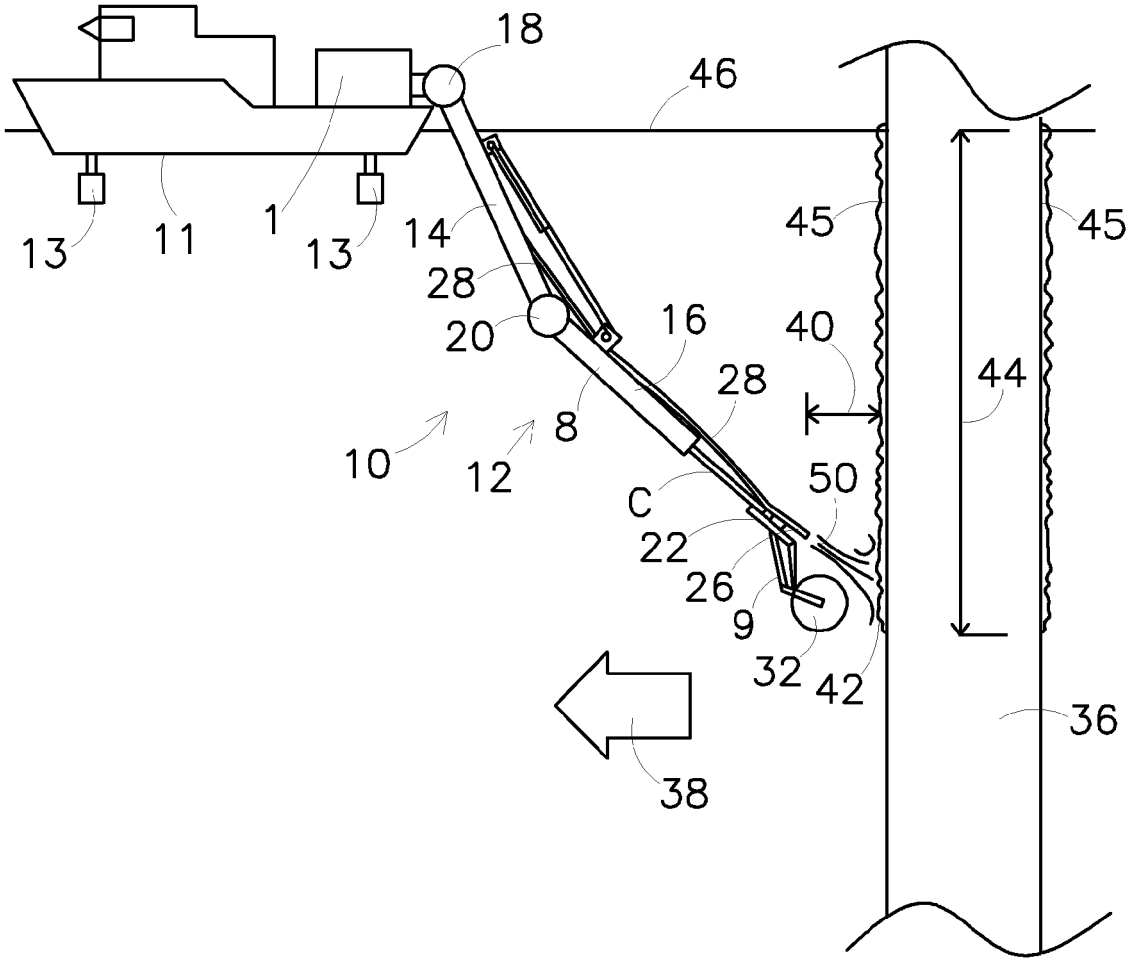
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Fig 2

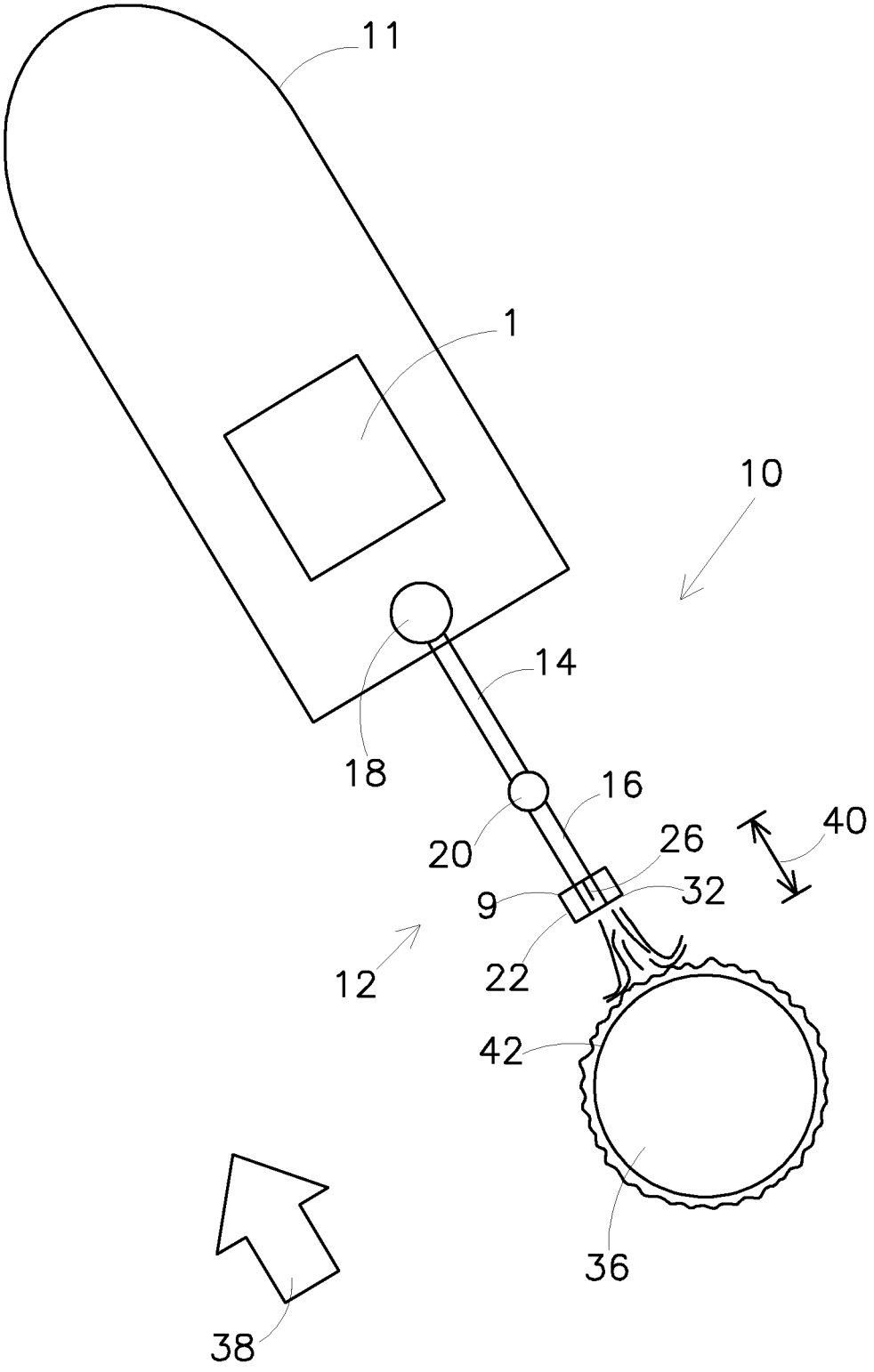
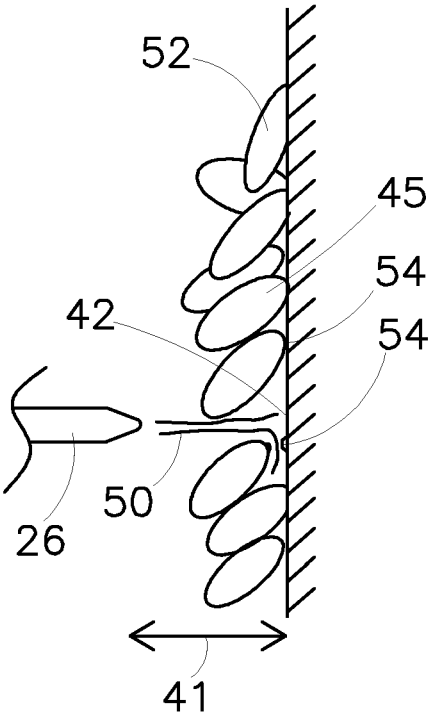


Fig 3



PRIOR ART

Fig 4

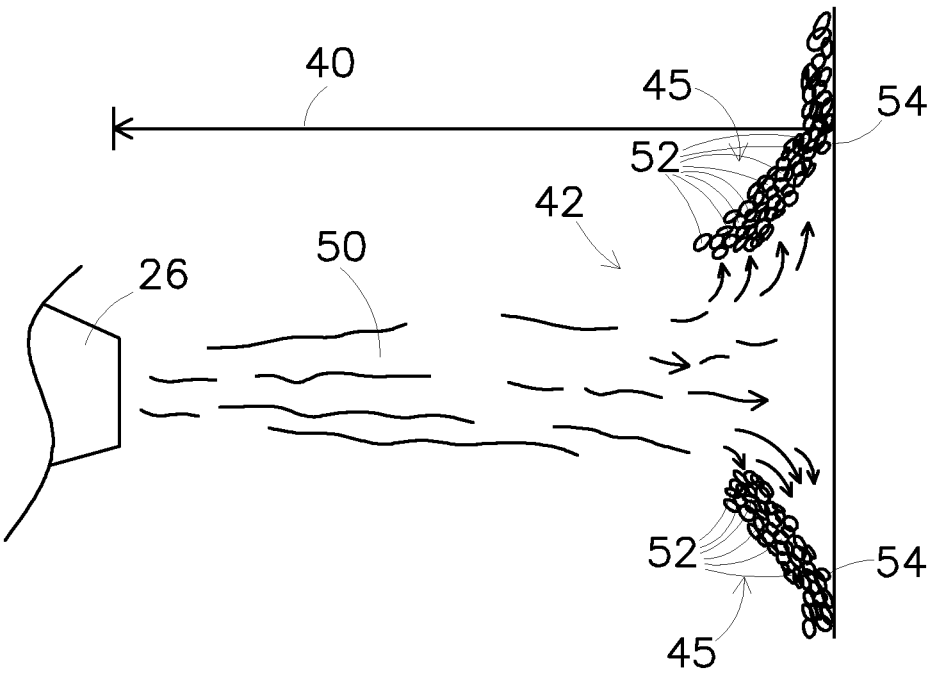


Fig 5

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EUROPEAN SEARCH REPORT

Application Number
EP 09 17 1844

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 1 448 241 A (CRAWFORD, WILLIAM R. III) 5 August 1966 (1966-08-05) * page 2, left-hand column, line 4 - page 3, left-hand column, line 2; figure 2 *	1-5, 7-12, 14-15	INV. B63B59/08
X	FR 2 612 875 A1 (VANEK MICHEL [FR]) 30 September 1988 (1988-09-30) * page 1, line 8 - page 2, line 7; figures 1-3 *	1-5, 8-12,15	
X	US 4 445 451 A (VAN DEN BROEK BERNARDUS C [NL]) 1 May 1984 (1984-05-01) * column 2, line 26 - column 4, line 46; figures 1-3 *	1-4, 8-12,15	
X	WO 02/44020 A1 (TIBLE JEAN PHILIPPE [FR]) 6 June 2002 (2002-06-06) * page 5, line 26 - page 7, line 32; figures 1-4 *	1-4,9-13	
			TECHNICAL FIELDS SEARCHED (IPC) B63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 February 2010	Brumer, Alexandre

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 17 1844

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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25-02-2010

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