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# (54) UNDERWATER CLEANING DEVICE FOR MARINE LIFE ON SEALING SURFACE OF GATE, AND DEVICE COMBINATION AND CLEANING METHOD

UNTERWASSERREINIGUNGSEINRICHTUNG FÜR MEERESLEBEN AUF DER VERSIEGELUNGSFLÄCHE EINES TORES SOWIE GERÄTEKOMBINATION UND REINIGUNGSVERFAHREN

DISPOSITIF DE NETTOYAGE SOUS-MARIN POUR LA VIE MARINE SUR UNE SURFACE D'ÉTANCHÉITÉ D'UNE PORTE, ET COMBINAISON DE DISPOSITIF ET PROCÉDÉ DE NETTOYAGE

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## Description

### FIELD OF THE INVENTION

**[0001]** The invention relates to the technical field of marine life cleaning, in particular to an underwater cleaning device for marine life on a sealing surface of a gate, a device combination and a cleaning method thereof.

### BACKGROUND OF THE INVENTION

**[0002]** With the passage of time, the sealing surfaces of a gate of a building structure located at water intake of a large seawater culvert will be bred with a large number of marine life, which will affect the sealing effect between the gate and the building structure when the gate is closed, to bring a potential safety hazard. Therefore, the marine life on the sealing surfaces of the gate must be cleaned regularly. The traditional cleaning method is usually manually performed by divers diving into the water with hand-held cleaning tools. Such a method brings problems such as heavy workload and difficulty in ensuring the personal safety of divers, and this method is greatly affected by weather and ocean conditions.

**[0003]** Chinese patent ZL201611189296.1, published as CN106475364A, discloses a cleaning robot for cleaning marine life on the outer surface of pipeline, which adopts a magnetic adsorption wheel to position the robot on the outer surface of the pipeline and movable axially to clean the marine life on the outer surface. This method has the following defects however. First, the magnetic adsorption is unsuitable for stainless steel material and the concrete surface. Second, as for the magnetic adsorption wheel driving, the cleaning robot will be difficult to stably move along the pipeline when the surface of the pipeline is uneven due to the large number of marine life attached on the surface. Meanwhile, the underwater carrier with adsorption wheel is unable to adapt to sharp edges and corners, and multi-plane operations. Furthermore, such a cleaning robot is unsuitable for large-scale configuration and has a small cleaning range and limited movement, which leads to an extremely low cleaning efficiency of large vertical gantry steel structure. Chinese application CN106269623 A discloses an automatic cleaning machine including a frame, a longitudinal cleaning system, a transverse cleaning system, and a control system, to clean the sluice gate. However, the operation stability of the machine is to be improved.

### SUMMARY OF THE INVENTION

**[0004]** An aspect of the invention is to provide an underwater cleaning device for marine life on sealing surfaces of a gate, which has neither the inefficiency of the traditional cleaning method by divers nor the problems of poor movement stability of the cleaning device.

**[0005]** Another aspect of the invention is to provide an underwater cleaning device combination for marine life on sealing surfaces of a gate, which has neither the inefficiency of the traditional cleaning method by divers nor the problems of poor movement stability of the cleaning device.

**[0006]** Still an aspect of the invention is to provide an underwater cleaning method for marine life on sealing surfaces of a gate, which has neither the inefficiency of the traditional cleaning method by divers nor the problems of poor movement stability of the cleaning device.

**[0007]** To achieve the above-mentioned objectives, the present invention provides an underwater cleaning device for marine life on sealing surfaces of a gate, adapted for cleaning marine life attached to sealing surfaces of a gate of a building structure, the underwater cleaning device including a main structure, a cleaning structure installed on the main structure, and a rigging structure fixed to the main structure. The rigging structure is connected with a lifting device to drive the cleaning structure to move to a corresponding position on the sealing surfaces of the gate, and the cleaning structure is configured to clean the marine life on the sealing surfaces of the gate when the cleaning structure moves to the corresponding position on the sealing surfaces of the gate. The main structure comprises a truss arranged laterally and a moving carrier slidably provided on the truss, the cleaning structure comprises a nozzle structure, a delivery pipe and a reel device, the delivery pipe is configured to provide jetting fluid to the nozzle structure, the nozzle structure comprises a first nozzle for cleaning an upper sealing surface of the sealing surfaces and a second nozzle for cleaning a lower sealing surface of the sealing surfaces, and the first nozzle and the second nozzle are mounted on the moving carrier. The reel device is mounted on the truss and configured to release or rewind the delivery pipe with a movement of the moving carrier, and the reel device comprises a reel body, a left guide wheel and a right guide wheel, the delivery pipe is wound on the reel body and is located between the left guide wheel and the right guide wheel.

**[0008]** Preferably, opposite sides of the main structure are respectively provided with a guide member for slidably matching with a guide rail that is extended in a vertical direction and provided on both sides of the sealing surfaces of the gate.

**[0009]** Preferably, the nozzle structure is configured to jet fluid in a direction angled at 30-40 degrees relative to the sealing surfaces of the gate.

**[0010]** Preferably, the nozzle structure is a cavitation nozzle structure.

**[0011]** Preferably, the nozzle structure further includes a third nozzle and a fourth nozzle respectively for cleaning a left sealing surface and a right sealing surface of the sealing surfaces, and the third nozzle and the fourth nozzle are mounted on left and right sides of the moving carrier respectively.

**[0012]** Preferably, the cleaning structure further includes a first valve for controlling fluid discharge of the first nozzle, a second valve for controlling fluid discharge

of the second nozzle, and a third valve for control fluid discharge of the third nozzle and the fourth nozzle.

**[0013]** Preferably, the device further includes a vision system, the vision system includes a camera device for collecting underwater image information and at least two fill light devices for providing light sources to the camera device, the fill light devices are respectively installed on left and right sides of the truss; the camera device includes a panoramic camera installed in a middle of the truss, a left camera and a right camera installed on the left and right sides of the truss, and a moving camera installed on the moving carrier.

**[0014]** Preferably, the rigging structure includes a lifting ring for connecting with the lifting device, a plurality of lifting ropes connected with the lifting ring, and a draw rod connected to a lower end of the lifting rope, the draw rod is connected with the main structure and has an adjustable length.

**[0015]** The present invention further provides an underwater cleaning device combination for marine life on sealing surfaces of a gate, adapted for cleaning marine life attached to sealing surfaces of a gate of a building structure, the underwater cleaning device combination including an underwater cleaning device for marine life on sealing surfaces of a gate according to the invention and two guide rails, the guide rails being installed side by side on both sides of the sealing surfaces of the gate. The opposite sides of the main structure are respectively provided with a guide member for matching with the guide rails.

**[0016]** In comparison with the prior art, a new marine life cleaning device is provided in the present invention, the main structure is fixed with the rigging structure, the cleaning structure is installed on the main structure, and the rigging structure is connected to the lifting device. In such an arrangement, the underwater cleaning device can be driven by the lifting device to move along the building structure to the position corresponding to the sealing surfaces of the gate, and then clean the marine life on the sealing surfaces by means of the cleaning structure, which has neither the inefficiency of the traditional cleaning method by divers nor the problems of poor movement stability of the cleaning device, and is applicable to the cleaning of marine life on the sealing surfaces of large gates. In addition, the cleaning device of the present invention is applicable to sealing surfaces of different gates with various sizes and various materials, without any material restriction of the building structure, to obtain good applicability. Furthermore, there is no need to move the main structure on the cleaning structure, which is applicable to perform cleanup on sharp edges and corners, and multiple planes.

**[0017]** The present invention further provides an underwater cleaning method for marine life on sealing surfaces of a gate, adapted for cleaning marine life attached to sealing surfaces of a gate of a building structure. The method includes the following steps:

S1, providing an underwater cleaning device for marine life on sealing surfaces of a gate, the underwater cleaning device including a main structure, a cleaning structure installed on the main structure, and a rigging structure fixed to the main structure;

S2, connecting the rigging structure with a lifting device;

S3, driving the underwater cleaning device by the lifting device to move along the building structure to a position corresponding to the sealing surfaces of the gate; and

S4, cleaning the marine life on the sealing surfaces of the gate through the cleaning structure.

**[0018]** The main structure comprises a truss arranged laterally and a moving carrier slidably provided on the truss, the cleaning structure comprises a nozzle structure, a delivery pipe and a reel device, the delivery pipe is configured to provide jetting fluid to the nozzle structure, the nozzle structure comprises a first nozzle for cleaning an upper sealing surface of the sealing surfaces and a second nozzle for cleaning a lower sealing surface of the sealing surfaces, and the first nozzle and the second nozzle are mounted on the moving carrier. The reel device is mounted on the truss and configured to release or rewind the delivery pipe with a movement of the moving carrier, and the reel device comprises a reel body, a left guide wheel and a right guide wheel, the delivery pipe is wound on the reel body and is located between the left guide wheel and the right guide wheel.

**[0019]** Preferably, the method further includes installing two guide rails extended vertically on the building structure, the guide rails being located at two sides of the sealing surfaces of the gate; arranging two guide members at opposite sides of the main structure; and moving the guide members along the guide rails while the underwater cleaning device moves downward along the building structure in step S3.

**[0020]** In comparison with the prior art, a new marine life cleaning method is provided in the present invention, the rigging structure of the underwater cleaning device is connected to a lifting device, and the underwater cleaning device is driven by the lifting device to move along the building structure to a position corresponding to the sealing surfaces of the gate, to clean the marine life on the sealing surfaces of the gate through the cleaning structure. In such a way, it has neither the inefficiency of the traditional cleaning method by divers nor the problems of poor movement stability of the cleaning device, and is applicable to the cleaning of marine life on the sealing surfaces of large gates. In addition, the cleaning device of the present invention is applicable to sealing surfaces of different gates with various sizes and various materials, without any material restriction of the building structure, to obtain good applicability. Furthermore, there is no need to move the main structure on the cleaning structure, which is applicable to perform cleanup on sharp edges and corners, and multiple planes.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0021]**

FIG. 1 is a perspective schematic view of an underwater cleaning device for marine life on sealing surfaces of a gate according to the embodiment of the present invention.

FIG. 2 is a partial structural schematic view of the moving carrier shown in FIG. 1.

FIG. 3 is a schematic view of the underwater cleaning device for marine life on the sealing surfaces of the gate shown in FIG. 1 during cleaning.

FIG. 4 is a flow chart of a method for an underwater cleaning device for marine life on sealing surfaces of a gate according to an embodiment of the present invention.

## DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENTS

**[0022]** In order to describe the technical content, structural features, achieved objects and effects of the present invention in detail, the following detailed description is given in conjunction with the embodiments and the accompanying drawings. Obviously, the embodiments described are only a part of the embodiments of the present invention, but not all of the embodiments. Based on the embodiments in the present invention, all other embodiments obtained by those of ordinary skill in the art without creative work fall within the protection scope of the present invention as defined by the appended claims.

**[0023]** In the description of the present invention, it should be understood that the orientation or positional relationship indicated by the terms "upper", "lower", "left", "right", "vertical", "horizontal", "lateral", etc. is based on that shown in the drawings and is only for the convenience of describing the present invention and simplifying the description, and therefore should not be construed as a limitation on the protection content of the present invention.

**[0024]** Referring to FIGS. 1-3, the present disclosure provides an underwater cleaning device 100 for marine life on a sealing surface of a gate, which is adapted for connecting with a lifting device (not shown) and is movable in a vertical direction along a building structure 200 under the action of the lifting device, to clean up the marine life adhering to the sealing surface of the gate of the building structure 200. Specifically, the device 100 includes a main structure 1, a cleaning structure installed on the main structure 1, and a rigging structure 3 fixed to the main structure 1. The rigging structure 3 is configured to connect with the lifting device to drive the main structure 1 with the cleaning structure supported to move along the building structure 200 to a corresponding position on the sealing surface of the gate, and the cleaning structure is configured to clean the marine life on the sealing surface of the gate when the cleaning structure moves to the corresponding position on the sealing surface of the gate.

**[0025]** In an embodiment, the opposite sides of the main structure 1 are respectively provided with a guide member 13 for slidably matching with a guide rail (not shown) that is extended in a vertical direction and provided on both sides of the sealing surface of the gate. When the underwater cleaning device 100 is subjected to the force of the lifting device, the guide member 13 can move in the vertical direction along the guide rail, so that the underwater cleaning device 100 can stably move in the vertical direction along the building structure 200, without jamming due to the marine life bred on the guide rails. Preferably, the guide member 13 is a guide wheel, which is not limited however.

**[0026]** It should be noted that, the lateral dimension of the main structure 1 is adapted to those of the building structure 200 and the guide rail, so as to ensure that the underwater cleaning device 100 can operate in a limited space, and transfer a reaction force generated during the cleaning to the guide rails and the building structure 200. The guides 13 are sized to match the guide rails, which is beneficial to transfer the reaction force generated during the cleaning to the guide rails. In specific implementation, the lateral dimension of the main structure 1 can be adjusted adaptively according to the lateral dimension of the sealing surface of the gate to be cleaned, so that the underwater cleaning device 100 can be suitable for cleaning different sealing surfaces of various lateral dimensions, especially for the sealing surfaces of large vertical gantry gates.

**[0027]** Referring to FIG. 1, the rigging structure 3 includes a lifting ring 31 for connecting with the lifting device, a plurality of lifting ropes 32 connected with the lifting ring 31, and a draw rod 33 connected to a lower end of the lifting rope 32, the draw rod 33 is connected with the main structure 1, and has an adjustable length. By adjusting the length of the draw rod 33, the force balance of the rigging structure 3 is ensured, so that the underwater cleaning device 100 can move stably along the guide rails under the action of the lifting device. More specifically, the lifting rope 32 is a stainless steel wire rope, and the draw rod 33 is a basket draw rod.

**[0028]** Referring to FIGS. 2-3, the cleaning structure includes a nozzle structure (not shown) and a delivery pipe (not shown) configured to provide jetting fluid to the nozzle structure. Preferably, the nozzle structure is a cavitation nozzle structure, which uses strong force of micro-jet and shock waves generated by cavitation jet technology to remove the marine life. Such a structure is simple, which is suitable to effectively remove large-area marine life on the sealing surfaces of the gate.

**[0029]** Specifically, the sealing surfaces of the gate includes an upper sealing surface 210 matching with the lintel of the gate, a lower sealing surface 220 matching with the bottom of the gate, and a left sealing surface and a right sealing surface located on opposite sides of the upper sealing surface 210 and the lower sealing

surface 220 (the four surfaces are formed like a door frame structure). Since the upper sealing surface 210 (vertical surface), the lower sealing surface 220 (horizontal surface), the left sealing surface (vertical surface) and the right sealing surface (vertical surface) are located in different planes, in this embodiment, different nozzles with different spray directions are applied to clean the four sealing surfaces, so that everywhere of the sealing surfaces of the gate may be cleaned without dead corners, thereby ensuring the cleaning effect of the sealing surfaces of the gate. Specifically, the nozzle structure includes a first nozzle 21, a second nozzle 22, a third nozzle 23 and a fourth nozzle 24. The first nozzle 21 is configured to clean the marine life on the upper sealing surface 210, and the second nozzle 22 is configured to clean the marine life on the lower sealing surface 220, the third nozzle 23 is configured to clean the marine life on the left sealing surface, and the fourth nozzle 24 is configured to clean the marine life on the right sealing surface. Specifically, the first nozzle 21 is configured to jet fluid in a direction angled at 30-40 degrees relative to the upper sealing surface 210, the second nozzle 22 is configured to jet fluid in a direction angled at 30-40 degrees relative to the lower sealing surface 220, the third nozzle 23 is configured to jet fluid in a direction angled at 30-40 degrees relative to the left sealing surface, and the fourth nozzle 24 is configured to jet fluid in a direction angled at 30-40 degrees relative to the right sealing surface, so as to optimized the cleaning effect.

**[0030]** Please refer to FIG. 1 and FIG. 2, the main structure 1 includes a truss 11 arranged laterally and a moving carrier 12 slidably arranged on the truss 11. The first nozzle 21 and the second nozzle 22 are installed on the moving carrier 12. When the main body structure 1 is driven by an external lifting device to reach the upper sealing surface 210 or the lower sealing surface 220, the first nozzle 21 and the second nozzle 22 carried by the moving carrier 12 to move laterally along the truss 11, so that the upper sealing surface 210 and the lower sealing surface 220 can be cleaned fully, to ensure the cleaning effect. The truss 11 includes a truss beam 111, a left end beam 112 installed on the left side of the truss beam 111, and a right end beam 113 installed on the right side of the truss beam 111. The third nozzle 23 is installed on the left end beam 112, and the fourth nozzle 24 is installed on the right end beam 113, when the underwater cleaning device 100 moves in the vertical direction along the guide rail under the action of the lifting device, the third nozzle 23 and the fourth nozzle 24 clean marine life on the left sealing surface and the left sealing surface respectively.

**[0031]** It is worth noting that, in this embodiment, the moving carrier 12 will simultaneously drive the first nozzle 21 and the second nozzle 22 to move laterally along the truss 11 when moving laterally along the truss 11. In other embodiments, the moving carrier 12 may also include a plurality of independent moving parts that can move laterally along the truss 11, and the first nozzle 21 and the second nozzle 22 are independently installed on different moving parts, in such an arrangement, the first nozzle 21 and the second nozzle 22 can be driven by the moving parts respectively, so as to move laterally along the truss 11.

**[0032]** More specifically, the moving carrier 12 includes a main body 121, a wheel 122 mounted on the main body 121, a driving assembly 123, a lateral limiting wheel 124 and a vertical limiting wheel 125. The main body 121 is a welded structure, which is connected to the first nozzle 21 and the second nozzle 22 by bolts. The wheel 122 is connected to the output end of the drive assembly 123 and driven to move laterally along the truss beam 111. In this embodiment, in the drive assembly 123, dynamic and static technology is adopted, a motor is wrapped in the sealed cavity, and at the same time, compressed air is input into the sealed cavity, so that the sealed cavity maintains a slight positive pressure relative to the external environment. In such a way, the motor in the driving assembly 123 is ensured to be worked normally in an environment with a water depth of 15 meters, to drive the wheels 122 normally. The lateral limiting wheel 124 is configured to realize the lateral limit of the wheel 122, and the vertical limit wheel 125 is configured to realize the vertical limit of the wheel 122. In this embodiment, moving carrier, 12 is engaged with the truss beam 111 by gear rack, which is not limited thereto.

**[0033]** Specifically, the cleaning structure further includes a first valve 25 and a second valve 26 installed on the moving carrier 12, and a third valve 27 installed on the truss 11. More specifically, the first valve 25 is configured to control the liquid outlet of the first nozzle 21, the second valve 26 is configured to control the fluid discharge of the second nozzle 22, and the third valve 27 is configured to control the fluid discharge of the third nozzle 23 and the fourth nozzle 24. That is to say, the first nozzle 21 and the second nozzle 22 are separately controlled by the first valve 25 and the second valve 26, and the third nozzle 23 and the fourth nozzle 24 are simultaneously controlled by the third valve 27, which is convenient for cleaning the left and the right sealing surfaces. Preferably, the first valve 25, the second valve 26 and the third valve 27 are all electromagnetic valves, which is not limited thereto however.

**[0034]** Referring to FIG.1, the cleaning structure further includes a reel device 28 mounted on the truss beam 111, and the reel device 28 is configured to release or rewind the delivery pipe with the movement of the moving carrier 12. Specifically, the reel device 28 uses a spring drive mechanism to realize the retraction of the delivery pipe. According to the invention, the reel device 28 includes a reel body 281, a left guide wheel 282 and a right guide wheel 283. The delivery pipe is wound on the reel body 281 and is located between the left guide wheel 282 and the right guide wheel 283. In such a way, a desired delivery pipe can be ensured due to the reel body 281, and the delivery pipe can be bent to the left or right with a proper bending radius by means of the left guide wheel 282 and the right guide wheel 283, and further the

delivery pipe will not interfere with the main structure 1.

**[0035]** Please continue to refer to FIG. 1, specifically, the underwater cleaning device 100 further includes a vision system having a camera device and a fill light device 45 for providing a light source to the camera device. More specifically, the camera device includes a panoramic camera 41 mounted on the middle position of the truss beam 111, a left camera 42 mounted on the left end beam 112, a right camera 43 mounted on the right end beam 113, and a moving camera 44 mounted on the moving carrier 12. The moving camera 44 is configured to move laterally on the truss beam 111 with the moving carrier 12, collect underwater image information by each camera 41, 42, 43, 44, and transmit such information to an onshore monitor (not shown) through network cables, so that the operator can judge the underwater position of the underwater cleaning device 100, observe the marine life on the sealing surfaces of the gate, and check the jet state of the underwater cleaning device 100. Two fill light devices 45 is provided on the left end beam 112 and the right end beam 113 respectively, so as to establish a full coverage light field, thereby realizing all-round high-definition monitoring of each sealing surface of the gate. Of course, in other embodiments, the two fill light devices 45 may also be installed at other positions of the truss 11, and the left camera 42 and the right camera 43 are not limited to be installed on the left end beam 112 and the right end beam 113.

**[0036]** The present invention also provides an underwater cleaning device combination for marine life on the sealing surfaces of the gate, which is adapted for cleaning the marine life attached to the sealing surfaces of the gate of the building structure 200. The device combination includes the underwater cleaning device 100 according to the invention and two guide rails installed side by side on both sides of the sealing surfaces of the gate. The underwater cleaning device 100 includes a main structure 1, a cleaning structure installed on the main structure 1 for cleaning marine life, and a rigging structure fixed to the main structure 1. Two guide members 13 are arranged at opposite sides of the main structure 1 for matching with the guide rails. The rigging structure 3 is configured to connect with a lifting device to drive the cleaning structure to move to a corresponding position on the sealing surfaces of the gate, and the cleaning structure 1 is configured to clean the marine life on the sealing surfaces when the cleaning structure moves to the corresponding position on the sealing surfaces of the gate. The structures of the underwater cleaning device 100 are as described above, and are not repeated here.

**[0037]** Hereinafter, the operation process of the underwater cleaning device 100 for marine life on the sealing surfaces of the gate according to the present invention will be described with reference to the specific embodiments shown in FIGS. 1-3.

**[0038]** Firstly, the lifting ring 31 of the underwater cleaning device 100 is hung on the hook of the lifting device, so that the underwater cleaning device 100 is lifted and transferred above (on the water) the gate of the building structure 200 to be cleaned. Next, the structural integrity of the underwater cleaning device 100 is checked, after that, the underwater cleaning device 100 is lowered into the water at a low speed, and the vision system is turned on to monitor the underwater image information; sequentially, the underwater cleaning device 100 is continued to be lowered at a low speed to reach the bottom of the gate, during such a process, the growth of marine life on the sealing surfaces of the gate may be observed by the visual system. Then, the underwater cleaning device 100 is lifted to the upper sealing surface 210 and stopped, the first valve 25 is turned on to control the moving carrier 12 to move laterally on the truss 11, and the first nozzle 21 sprays to clean the marine life on the upper sealing surface 210. Then, the moving carrier 12 is controlled to rest in the middle of the truss 11, and the first valve 25 is turned off. Then, the third valve 27 is turned on, and the underwater cleaning device 100 is lowered down at a low speed, and the third nozzle 23 and the fourth nozzle 24 spray to clean the marine life on the left sealing surface and the right sealing surface until the underwater cleaning device 100 is moved down to the lower sealing surface 220. Then, the third valve 27 is turned off, and the second valve 26 is turned on to control the moving carrier 12 to move laterally on the truss 11, so that the second nozzle 22 spray to clean the marine life on the lower sealing surface 220. After the cleaning is completed, the second valve 26 is turned off and the moving carrier 12 is controlled to rest in the middle of the truss 11. Finally, the underwater cleaning device 100 is lifted to move up the water surface along the track. Once the marine life are formed for a period of time, the underwater cleaning device 100 will be lowered down into the water again to clean and the visual system will check the cleaning effect.

**[0039]** Referring to FIG. 4, the present invention also discloses an underwater cleaning method for marine life on the sealing surfaces of the gate, for cleaning the marine life attached to the sealing surfaces of the gate of the building structure, including the following steps:

S1, providing an underwater cleaning device 100 for marine life on sealing surfaces of a gate, wherein the underwater cleaning device 100 is as described above and includes a main structure 1, a cleaning structure installed on the main structure 1, and a rigging structure 3 fixed to the main structure 1;

S2, connecting the rigging structure 3 with a lifting device;

S3, driving the underwater cleaning device 100 by the lifting device to move along the building structure 200 to a position corresponding to the sealing surfaces of the gate; and

S4, cleaning the marine life on the sealing surfaces of the gate through the cleaning structure.

**[0040]** Specifically, the underwater cleaning method

further includes: installing two guide rails extended vertically on the building structure, the guide rails being located at two sides of the sealing surfaces of the gate; arranging two guide members 13 at opposite sides of the main structure 1; and moving the guide members 13 along the guide rails while the underwater cleaning device 100 moves downward along the building structure 200 in step S3. With the cooperation of the guide rail and the guiding member, the underwater cleaning device 100 can stably move in the vertical direction along the building structure 200, without jamming due to the marine life bred on the guide rails. Preferably, the guide member 13 is a guide wheel, which is not limited thereto however.

**[0041]** Compared with the prior art, a new marine life cleaning device 100 is provided, the main structure 1 is fixed with the rigging structure 3, the cleaning structure is installed on the main structure 1, and the rigging structure 3 is connected to the lifting device. In such an arrangement, the underwater cleaning device 100 can be driven by the lifting device to move along the building structure 200 to the position corresponding to the sealing surfaces of the gate, and then clean the marine life on the sealing surfaces by means of the cleaning structure, which has neither the inefficiency of the traditional cleaning method by divers nor the problems of poor movement stability of the cleaning device, and is applicable to the cleaning of marine life on the sealing surfaces of large gates. In addition, the underwater cleaning device 100 of the present invention is applicable to sealing surfaces of different gates with various sizes and various materials, without any material restriction of the building structure 200, to obtain good applicability. Furthermore, there is no need to move the main structure 1 on the cleaning structure, which is applicable to perform cleanup on sharp edges and corners, and multiple planes.

## Claims

1. An underwater cleaning device (100) for marine life on sealing surfaces of a gate, adapted for cleaning marine life attached to sealing surfaces of a gate of a building structure (200), the underwater cleaning device (100) comprising a main structure (1), a cleaning structure installed on the main structure (1), and a rigging structure (3) fixed to the main structure (1), wherein the rigging structure (3) is connected with a lifting device to drive the cleaning structure to move to a corresponding position on the sealing surfaces of the gate, and the cleaning structure is configured to clean the marine life on the sealing surfaces of the gate when the cleaning structure moves to the corresponding position on the sealing surfaces of the gate;

   wherein the main structure (1) comprises a truss (11) arranged laterally and a moving carrier (12) slidably provided on the truss (11), the cleaning structure comprises a nozzle structure, a delivery pipe and a reel device (28), the delivery pipe is configured to provide jetting fluid to the nozzle structure, the nozzle structure comprises a first nozzle (21) for cleaning an upper sealing surface (210) of the sealing surfaces and a second nozzle (22) for cleaning a lower sealing surface (220) of the sealing surfaces, and the first nozzle (21) and the second nozzle (22) are mounted on the moving carrier (12);
   the reel device (28) is mounted on the truss (111) **characterized in that** the reel device (28) is configured to release or rewind the delivery pipe with a movement of the moving carrier (12), and the reel device (28) comprises a reel body (281), a left guide wheel (282) and a right guide wheel (283), the delivery pipe is wound on the reel body (281) and is located between the left guide wheel (282) and the right guide wheel (283) .

2. The underwater cleaning device according to claim 1, wherein opposite sides of the main structure (1) are respectively provided with a guide member (13) for slidably matching with a guide rail that is extended in a vertical direction and provided on both sides of the sealing surfaces of the gate.

3. The underwater cleaning device according to claim 1 or claim 2, wherein the nozzle structure is configured to jet fluid in a direction angled at 30-40 degrees relative to the sealing surfaces of the gate.

4. The underwater cleaning device according to claim 1 or claim 2, wherein the nozzle structure is a cavitation nozzle structure.

5. The underwater cleaning device according to claim 1 or claim 2, wherein the nozzle structure further comprises a third nozzle (23) and a fourth nozzle (24) respectively for cleaning a left sealing surface and a right sealing surface of the sealing surfaces, and the third nozzle (23) and the fourth nozzle (24) are mounted on left and right sides of the moving carrier (12) respectively.

6. The underwater cleaning device according to claim 5, wherein the cleaning structure further comprises a first valve (25) for controlling fluid discharge of the first nozzle (21), a second valve (26) for controlling fluid discharge of the second nozzle (22), and a third valve (27) for control fluid discharge of the third nozzle (23) and the fourth nozzle (24).

7. The underwater cleaning device according to claim 1 or claim 2, further comprising a vision system, wherein the vision system comprises a camera device for collecting underwater image information and at least two fill light devices (45) for providing light sources to

the camera device, the fill light devices (45) are respectively installed on left and right sides of the truss (11); the camera device comprises a panoramic camera (41) installed in a middle of the truss (11), a left camera (42) and a right camera (43) installed on the left and right sides of the truss (11), and a moving camera (44) installed on the moving carrier (12).

**8.** The underwater cleaning device according to claim 1, wherein the rigging structure (3) comprises a lifting ring (31) for connecting with the lifting device, a plurality of lifting ropes (32) connected with the lifting ring (31), and a draw rod (33) connected to a lower end of the lifting rope (32), the draw rod (33) is connected with the main structure (1) and has an adjustable length.

**9.** An underwater cleaning device combination for marine life on sealing surfaces of a gate, adapted for cleaning marine life attached to sealing surfaces of a gate of a building structure (200), the underwater cleaning device combination comprising an underwater cleaning device (100) for marine life on sealing surfaces of a gate according to any of the claims 1 to 8 and two guide rails, the guide rails being installed side by side on both sides of the sealing surfaces of the gate, wherein opposite sides of the main structure (1) are respectively provided with a guide member (13) for slidably matching with the guide rails.

**10.** An underwater cleaning method for marine life on sealing surfaces of a gate, adapted for cleaning marine life attached to sealing surfaces of a gate of a building structure, the under cleaning method comprising steps of:

S1, providing an underwater cleaning device (100) for marine life on sealing surfaces of a gate, the underwater cleaning device (100) comprising a main structure (1), a cleaning structure installed on the main structure (1), and a rigging structure (3) fixed to the main structure (1);
S2, connecting the rigging structure (3) with a lifting device;
S3, driving the underwater cleaning device (100) by the lifting device to move along the building structure (200) to a position corresponding to the sealing surfaces of the gate; and
S4, cleaning the marine life on the sealing surfaces of the gate through the cleaning structure;
wherein the main structure (1) comprises a truss (11) arranged laterally and a moving carrier (12) slidably provided on the truss (11), the cleaning structure comprises a nozzle structure, a delivery pipe and a reel device (28), the delivery pipe is configured to provide jetting fluid to the nozzle structure, the nozzle structure comprises a first nozzle (21) for cleaning an upper sealing surface (210) of the sealing surfaces and a second nozzle (22) for cleaning a lower sealing surface (220) of the sealing surfaces, and the first nozzle (21) and the second nozzle (22) are mounted on the moving carrier (12); **characterized in that**, the reel device (28) is mounted on the truss (111) and configured to release or rewind the delivery pipe with a movement of the moving carrier (12), and the reel device (28) comprises a reel body (281), a left guide wheel (282) and a right guide wheel (283), the delivery pipe is wound on the reel body (281) and is located between the left guide wheel (282) and the right guide wheel (283).

**11.** The underwater cleaning method according to claim 10, further comprising:

installing two guide rails extended vertically on the building structure (200), the guide rails being located at two sides of the sealing surfaces of the gate;
arranging two guide members (13) at opposite sides of the main structure (1); and
moving the guide members (13) along the guide rails while the underwater cleaning device (100) moves downward along the building structure (200) in step S3.

**Patentansprüche**

**1.** Unterwasserreinigungsvorrichtung (100) für Meereslebewesen auf Dichtungsflächen eines Tors, ausgelegt für das Reinigen von Meereslebewesen, die auf Dichtungsflächen eines Tors einer Gebäudestruktur (200) angeheftet sind, wobei die Unterwasserreinigungsvorrichtung (100) eine Hauptstruktur (1), eine auf der Hauptstruktur (1) installierte Reinigungsstruktur und eine auf der Hauptstruktur (1) befestigte Takelungsstruktur (3) umfasst, wobei die Takelungsstruktur (3) mit einer Hebevorrichtung verbunden ist, um die Reinigungsstruktur anzutreiben, damit sie sich zu einer entsprechenden Stelle auf den Dichtungsflächen des Tors bewegt, und die Reinigungsstruktur dazu ausgelegt ist, die Meereslebewesen auf den Dichtungsflächen des Tors zu reinigen, wenn sich die Reinigungsstruktur zur entsprechenden Stelle auf den Dichtungsflächen des Tors bewegt;

wobei die Hauptstruktur (1) eine Traverse (11), die seitlich angeordnet ist, und einen auf der Traverse (11) verschiebbar bereitgestellten, sich bewegenden Träger (12) umfasst, wobei die Reinigungsstruktur eine Düsenstruktur, einen Zufuhrschlauch und eine Haspelvorrich-

tung (28) umfasst, wobei der Zufuhrschlauch dazu ausgelegt ist, das Ausstoßen von Fluid für die Düsenstruktur bereitzustellen, wobei die Düsenstruktur eine erste Düse (21) zum Reinigen einer obere Dichtungsfläche (210) der Dichtungsflächen und eine zweite Düse (22) zum Reinigen einer unteren Dichtungsfläche (220) der Dichtungsflächen umfasst und die erste Düse (21) und die zweite Düse (22) auf dem sich bewegenden Träger (12) montiert sind; wobei die Haspelvorrichtung (28) auf der Traverse (111) montiert ist,

**dadurch gekennzeichnet, dass** die Haspelvorrichtung (28) dazu ausgelegt ist, den Zufuhrschlauch mit einer Bewegung des Bewegungsträgers (12) freizugeben oder wiederaufzuwickeln, und die Haspelvorrichtung (28) einen Haspelkörper (281), ein linkes Führungsrad (282) und ein rechtes Führungsrad (283) umfasst, wobei der Zufuhrschlauch auf dem Haspelkörper (281) aufgewickelt und zwischen dem linken Führungsrad (282) und dem rechten Führungsrad (283) angeordnet ist.

**2.** Unterwasserreinigungsvorrichtung nach Anspruch 1, wobei entgegengesetzte Seiten der Hauptstruktur (1) jeweils mit einem Führungselement (13) bereitgestellt sind, um verschiebbar mit einer Führungsschiene übereinzustimmen, die sich in einer vertikalen Richtung erstreckt und auf beiden Seiten der Dichtungsflächen des Tors bereitgestellt ist.

**3.** Unterwasserreinigungsvorrichtung nach Anspruch 1 oder Anspruch 2, wobei die Düsenstruktur dazu ausgelegt ist, Fluid in eine Richtung in einem Winkel von 30-40° relativ zu den Dichtungsflächen des Tors auszustoßen.

**4.** Unterwasserreinigungsvorrichtung nach Anspruch 1 oder Anspruch 2, wobei die Düsenstruktur eine Kavitationsdüsenstruktur ist.

**5.** Unterwasserreinigungsvorrichtung nach Anspruch 1 oder Anspruch 2, wobei die Düsenstruktur ferner eine dritte Düse (23) und eine vierte Düse (24) jeweils zum Reinigen einer linken Dichtungsfläche und einer rechten Dichtungsfläche der Dichtungsflächen umfasst und die dritte Düse (23) und die vierte Düse (24) jeweils auf einer linken und rechten Seite des sich bewegenden Trägers (12) montiert sind.

**6.** Unterwasserreinigungsvorrichtung nach Anspruch 5, wobei die Reinigungsstruktur ferner ein erstes Ventil (25) zum Steuern des Fluidaustritts aus der ersten Düse (21), ein zweites Ventil (26) zum Steuern des Fluidaustritts aus der zweiten Düse (22) und ein drittes Ventil (27) zum Steuern des Fluidaustritts aus der dritten Düse (23) und der vierten Düse (24) umfasst.

**7.** Unterwasserreinigungsvorrichtung nach Anspruch 1 oder Anspruch 2, ferner umfassend ein Bildverarbeitungssystem, wobei das Bildverarbeitungssystem eine Kameravorrichtung zum Sammeln von Unterwasserbildinformationen und zumindest zwei Fülllichtvorrichtungen (45) zum Bereitstellen von Lichtquellen für die Kameravorrichtung umfasst, wobei die Fülllichtvorrichtungen (45) jeweils auf einer linken und rechten Seite des Auslegers (11) installiert sind; wobei die Kameravorrichtung eine in der Mitte der Traverse (11) installierte Panoramakamera (41), eine linke Kamera (42) und eine rechte Kamera (43), die auf der linken und rechten Seite des Auslegers (11) installiert sind, und eine sich bewegende Kamera (44), die auf dem sich bewegenden Träger (12) installiert ist, umfasst.

**8.** Unterwasserreinigungsvorrichtung nach Anspruch 1, wobei die Takelungsstruktur (3) einen Hebering (31) zum Verbinden mit der Hebevorrichtung, eine Vielzahl von Hebeseilen (32), die mit dem Hebering (31) verbunden sind, und eine Zugstange (33), die mit einem unteren Ende des Hebeseils (32) verbunden ist, umfasst, wobei die Zugstange (33) mit der Hauptstruktur (1) verbunden ist und eine einstellbare Länge aufweist.

**9.** Unterwasserreinigungsvorrichtungskombination für Meereslebewesen auf Dichtungsflächen eines Tors, ausgelegt für das Reinigen von Meereslebewesen, die auf Dichtungsflächen eines Tors einer Gebäudestruktur (200) angeheftet sind, wobei die Unterwasserreinigungsvorrichtungskombination eine Unterwasserreinigungsvorrichtung (100) für Meereslebewesen auf Dichtungsflächen eines Tors nach einem der Ansprüche 1 bis 8 und zwei Führungsschienen umfasst, wobei die Führungsschienen Seite an Seite auf beiden Seiten der Dichtungsflächen des Tors installiert sind, wobei entgegengesetzte Seiten der Hauptstruktur (1) jeweils mit einem Führungselement (13) bereitgestellt sind, um verschiebbar mit den Führungsschienen übereinzustimmen.

**10.** Unterwasserreinigungsverfahren für Meereslebewesen auf Dichtungsflächen eines Tors, ausgelegt für das Reinigen von Meereslebewesen, die auf Dichtungsflächen eines Tors einer Gebäudestruktur befestigt sind, wobei das Unterwasserreinigungsverfahren folgende Schritte umfasst:

S1, Bereitstellen einer Unterwasserreinigungsvorrichtung (100) für Meereslebewesen auf Dichtungsflächen eines Tors, wobei die Unterwasserreinigungsvorrichtung (100) eine Hauptstruktur (1), eine auf der Hauptstruktur (1) instal-

lierte Reinigungsstruktur und eine auf der Hauptstruktur (1) fixierten Takelungsstruktur (3) umfasst;

S2, Verbinden der Takelungsstruktur (3) mit einer Hebevorrichtung;

S3, Antreiben der Unterwasserreinigungsvorrichtung (100) durch die Hebevorrichtung, damit sie sich entlang der Gebäudestruktur (200) an eine den Dichtungsflächen des Tors entsprechenden Stelle bewegt; und

S4, Reinigen der Meereslebewesen auf den Dichtungsflächen des Tors durch die Reinigungsstruktur;

wobei die Hauptstruktur (1) eine Traverse, die seitlich angeordnet ist, und eine auf der Traverse (11) verschiebbar bereitgestellten, sich bewegenden Träger (12) umfasst, wobei die Reinigungsstruktur eine Düsenstruktur, einen Zufuhrschlauch und eine Haspelvorrichtung (28) umfasst, wobei der Zufuhrschlauch dazu ausgelegt ist, das Ausstoßen von Fluid für die Düsenstruktur bereitzustellen, wobei die Düsenstruktur eine erste Düse (21) zum Reinigen einer obere Dichtungsfläche (210) der Dichtungsflächen und eine zweite Düse (22) zum Reinigen einer unteren Dichtungsfläche (220) der Dichtungsflächen umfasst und die erste Düse (21) und die zweite Düse (22) auf dem sich bewegenden Träger (12) montiert sind; **dadurch gekennzeichnet, dass** die Haspelvorrichtung (28) auf der Traverse (111) montiert ist und dazu ausgelegt ist, den Zufuhrschlauch mit einer Bewegung des Bewegungsträgers (12) freizugeben oder wiederaufzuwickeln, und die Haspelvorrichtung (28) einen Haspelkörper (281), ein linkes Führungsrad (282) und ein rechtes Führungsrad (283) umfasst, wobei der Zufuhrschlauch auf dem Haspelkörper (281) aufgewickelt und zwischen dem linken Führungsrad (282) und dem rechten Führungsrad (283) angeordnet ist.

**11.** Unterwasserreinigungsverfahren nach Anspruch 10, ferner umfassend:

Installieren von zwei Führungsschienen, die sich vertikal auf der Gebäudestruktur (200) erstrecken, wobei die Führungsschienen an zwei Seiten der Dichtungsflächen des Tors angeordnet sind,

Anordnen von zwei Führungselementen (13) auf entgegengesetzten Seiten der Hauptstruktur (1); und

Bewegen der zwei Führungselemente (13) entlang der Führungsschienen, während die Unterwasserreinigungsvorrichtung (100) sich entlang der Gebäudestruktur (200) nach unten bewegt, in Schritt S3.

**Revendications**

**1.** Dispositif de nettoyage sous-marin (100) pour la vie marine sur des surfaces d'étanchéité d'une porte, adapté pour nettoyer la vie marine fixée sur les surfaces d'étanchéité d'une porte d'une structure de construction (200), le dispositif de nettoyage sous-marin (100) comprenant une structure principale (1), une structure de nettoyage installée sur la structure principale (1), et une structure de haubanage (3) fixée sur la structure principale (1), dans lequel la structure de haubanage (3) est reliée à un dispositif de levage afin de permettre à la structure de nettoyage de se déplacer jusqu'à un emplacement correspondant sur les surfaces d'étanchéité de la porte, et la structure de nettoyage est configurée pour nettoyer la vie marine sur les surfaces d'étanchéité de la porte lorsque la structure de nettoyage se déplace jusqu'à l'emplacement correspondant sur les surfaces d'étanchéité de la porte ;

dans lequel la structure principale (1) comprend une ferme (11) disposée latéralement et un support mobile (12) prévu de manière coulissante sur la ferme (11), la structure de nettoyage comprend une structure à buses, une conduite de refoulement et un dévidoir (28), la conduite de refoulement est configurée pour fournir un fluide sous forme de jet à la structure à buses, la structure à buses comprend une première buse (21) destinée à nettoyer une surface d'étanchéité supérieure (210) des surfaces d'étanchéité et une deuxième buse (22) destinée à nettoyer une surface d'étanchéité inférieure (220) des surfaces d'étanchéité, et la première buse (21) et la deuxième buse (22) sont montées sur le support mobile (12) ;

le dévidoir (28) est monté sur la ferme (111), **caractérisé en ce que** le dévidoir (28) est configuré pour dérouler ou enrouler la conduite de refoulement avec un déplacement du support mobile (12), et le dévidoir (28) comprend un corps de dévidoir (281), une roue de guidage de gauche (282) et une roue de guidage de droite (283), la conduite de refoulement est enroulée sur le corps de dévidoir (281) et se trouve entre la roue de guidage de gauche (282) et la roue de guidage de droite (283).

**2.** Dispositif de nettoyage sous-marin selon la revendication 1, dans lequel les côtés opposés de la structure principale (1) sont respectivement équipés d'un élément de guidage (13) destiné à correspondre de manière coulissante avec un rail de guidage qui s'étend dans une direction verticale et prévu des deux côtés des surfaces d'étanchéité de la porte.

**3.** Dispositif de nettoyage sous-marin selon la reven-

dication 1 ou la revendication 2, dans lequel la structure à buses est configurée pour projeter un fluide dans une direction à 30 à 40 degrés par rapport aux surfaces d'étanchéité de la porte.

**4.** Dispositif de nettoyage sous-marin selon la revendication 1 ou la revendication 2, dans lequel la structure à buses est une structure à buses à cavitation.

**5.** Dispositif de nettoyage sous-marin selon la revendication 1 ou la revendication 2, dans lequel la structure à buses comprend en outre une troisième buse (23) et une quatrième buse (24) respectivement destinées à nettoyer une surface d'étanchéité de gauche et une surface d'étanchéité de droite des surfaces d'étanchéité, et la troisième buse (23) et la quatrième buse (24) sont montées sur les côtés gauche et droit du support mobile (12) respectivement.

**6.** Dispositif de nettoyage sous-marin selon la revendication 5, dans lequel la structure de nettoyage comprend en outre une première vanne (25) destinée à réguler l'évacuation de fluide de la première buse (21), une deuxième vanne (26) destinée à réguler l'évacuation de fluide de la deuxième buse (22), et une troisième vanne (27) destinée à réguler l'évacuation de fluide de la troisième buse (23) et de la quatrième buse (24).

**7.** Dispositif de nettoyage sous-marin selon la revendication 1 ou la revendication 2, comprenant en outre un système de vision, dans lequel le système de vision comprend une caméra destinée à collecter des informations d'images sous-marines et au moins deux dispositifs d'éclairage d'appoint (45) destinés à fournir des sources de lumière à la caméra, les dispositifs d'éclairage d'appoint (45) sont respectivement installés sur les côtés gauche et droit de la ferme (11) ; la caméra comprend une caméra panoramique (41) installée au milieu de la ferme (11), une caméra de gauche (42) et une caméra de droite (43) installées sur les côtés gauche et droit de la ferme (11), et une caméra mobile (44) installée sur le support mobile (12).

**8.** Dispositif de nettoyage sous-marin selon la revendication 1, dans lequel la structure de haubanage (3) comprend un anneau de levage (31) destiné à être relié au dispositif de levage, une pluralité de câbles de levage (32) reliés à l'anneau de levage (31), et une tige d'étirage (33) reliée à une extrémité inférieure du câble de levage (32), la tige d'étirage (33) étant reliée à la structure principale (1) et ayant une longueur réglable.

**9.** Combinaison de dispositif de nettoyage sous-marin pour la vie marine sur des surfaces d'étanchéité d'une porte, adaptée pour nettoyer la vie marine fixée sur les surfaces d'étanchéité d'une porte d'une structure de construction (200), la combinaison de dispositif de nettoyage sous-marin comprenant un dispositif de nettoyage sous-marin (100) pour la vie marine sur les surfaces d'étanchéité d'une porte selon l'une quelconque des revendications 1 à 8 et deux rails de guidage, les rails de guidage étant installés côte à côte des deux côtés des surfaces d'étanchéité de la porte, dans laquelle les côtés opposés de la structure principale (1) sont respectivement équipés d'un élément de guidage (13) destiné à correspondre de manière coulissante avec les rails de guidage.

**10.** Procédé de nettoyage sous-marin pour la vie marine sur des surfaces d'étanchéité d'une porte, adapté pour nettoyer la vie marine fixée sur les surfaces d'étanchéité d'une porte d'une structure de construction, le procédé de nettoyage sous-marin comprenant les étapes consistant à :

S1, prévoir un dispositif de nettoyage sous-marin (100) pour la vie marine sur les surfaces d'étanchéité d'une porte, le dispositif de nettoyage sous-marin (100) comprenant une structure principale (1), une structure de nettoyage installée sur la structure principale (1), et une structure de haubanage (3) fixée sur la structure principale (1) ;
S2, relier la structure de haubanage (3) à un dispositif de levage ;
S3, entraîner le dispositif de nettoyage sous-marin (100) à l'aide du dispositif de levage afin qu'il se déplace le long de la structure de construction (200) jusqu'à un emplacement qui correspond aux surfaces d'étanchéité de la porte ; et
S4, nettoyer la vue marine sur les surfaces d'étanchéité de la porte par le biais de la structure de nettoyage ;
dans lequel la structure principale (1) comprend une ferme (11) disposée latéralement et un support mobile (12) prévu de manière coulissante sur la ferme (11), la structure de nettoyage comprend une structure à buses, une conduite de refoulement et un dévidoir (28), la conduite de refoulement est configurée pour fournir un fluide sous forme de jet à la structure à buses, la structure à buses comprend une première buse (21) destinée à nettoyer une surface d'étanchéité supérieure (210) des surfaces d'étanchéité et une deuxième buse (22) destinée à nettoyer une surface d'étanchéité inférieure (220) des surfaces d'étanchéité, et la première buse (21) et la deuxième buse (22) sont montées sur le support mobile (12) ; **caractérisé en**

**ce que** le dévidoir (28) est monté sur la ferme (111) et configuré pour dérouler ou enrouler la conduite de refoulement avec un déplacement du support mobile (12), et le dévidoir (28) comprend un corps de dévidoir (281), une roue de guidage de gauche (282) et une roue de guidage de droite (283), la conduite de refoulement est enroulée sur le corps de dévidoir (281) et se trouve entre la roue de guidage de gauche (282) et la roue de guidage de droite (283).

**11.** Procédé de nettoyage sous-marin selon la revendication 10, comprenant en outre :

l'installation de deux rails de guidage qui s'étendent à la verticale sur la structure de construction (200), les rails de guidage situés des deux côtés des surfaces d'étanchéité de la porte ;
le placement de deux éléments de guidage (13) au niveau des côtés opposés de la structure principale (1) ; et
le déplacement des éléments de guidage (13) le long des rails de guidage pendant que le dispositif de nettoyage sous-marin (100) se déplace vers le bas le long de la structure de construction (200) à l'étape S3.

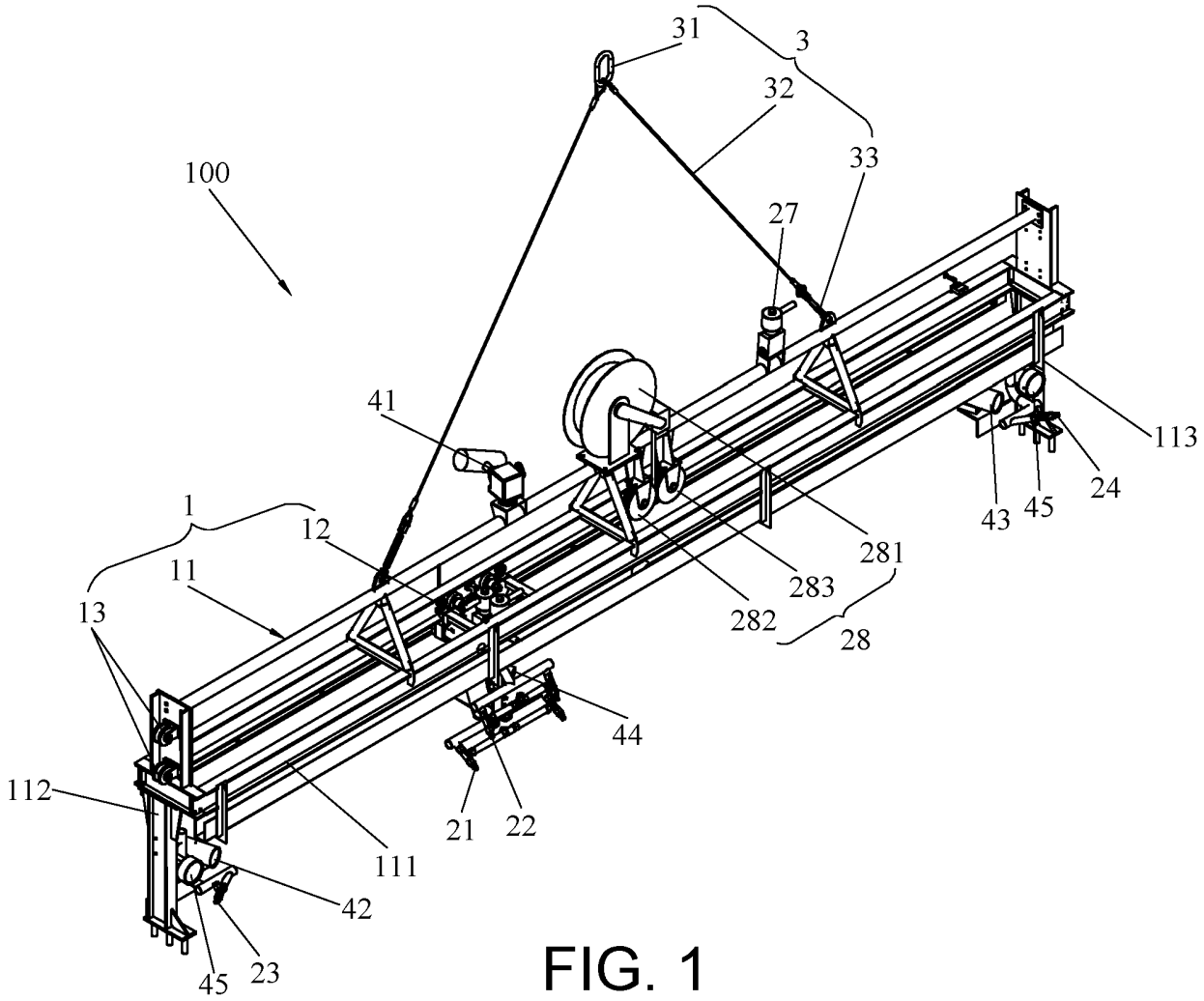

31
3
32
33
100
27
41
113
24
45
43
1
12
11
13
281
283
282
28
44
112
21
22
111
42
45
23

FIG. 1

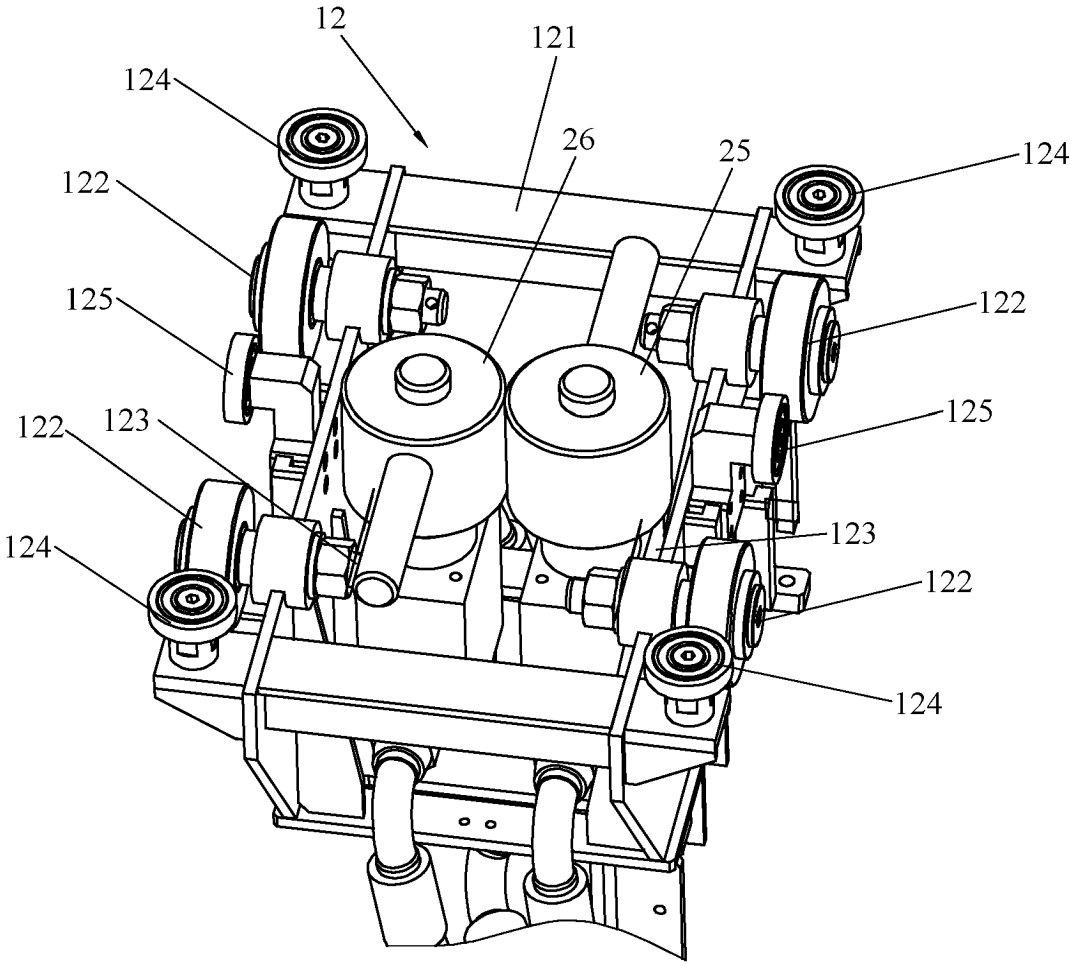



FIG. 2

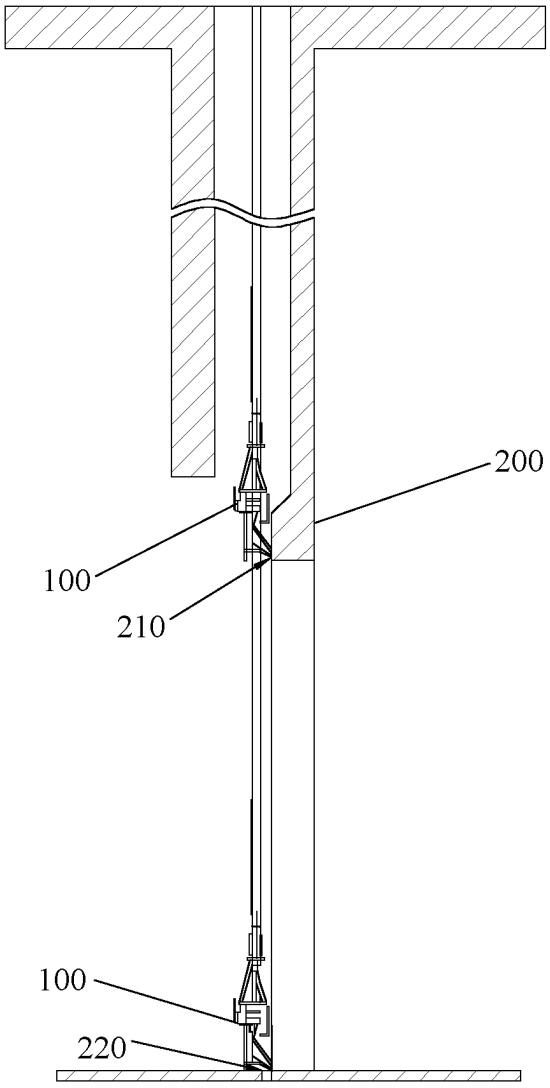



FIG. 3

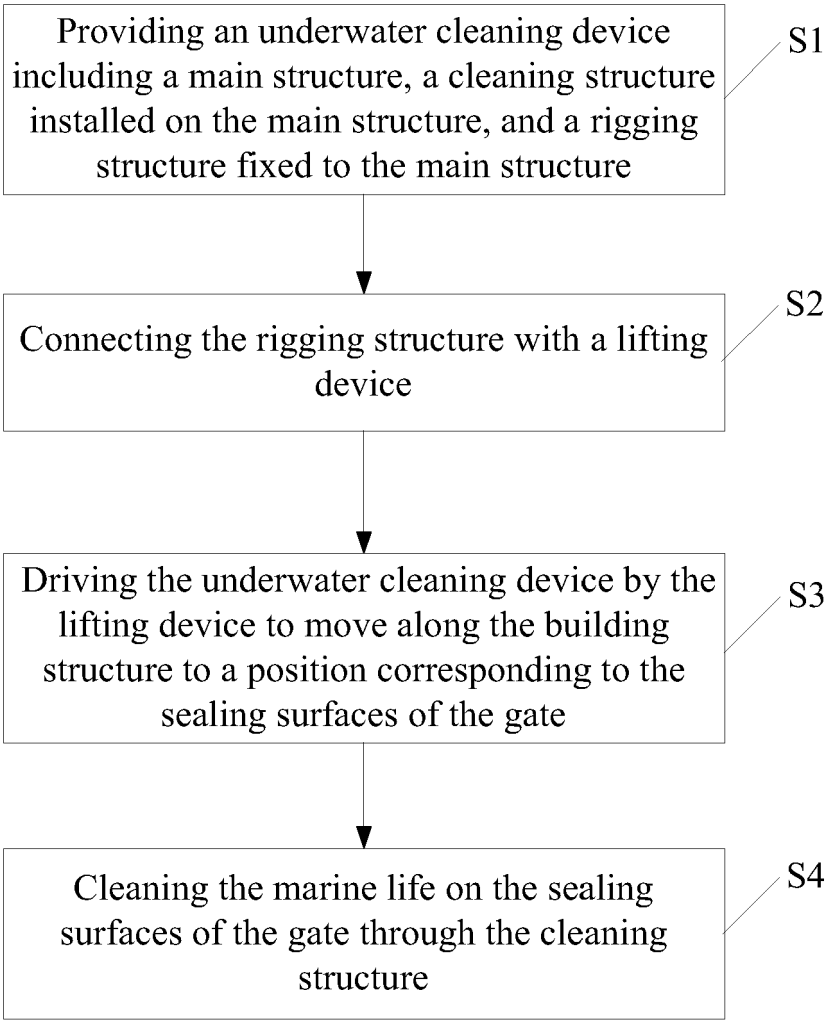

Providing an underwater cleaning device including a main structure, a cleaning structure installed on the main structure, and a rigging structure fixed to the main structure
S1
Connecting the rigging structure with a lifting device
S2
Driving the underwater cleaning device by the lifting device to move along the building structure to a position corresponding to the sealing surfaces of the gate
S3
Cleaning the marine life on the sealing surfaces of the gate through the cleaning structure
S4

FIG. 4

## REFERENCES CITED IN THE DESCRIPTION

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