

## **Maintenance device**

The invention relates to a maintenance apparatus for large surface areas of steel structures, in particular internal areas of ships or tank installations, comprising at least one carrier system that is movable along a vertical carrier, wherein at least one arm system is arranged on the carrier system.

A device for processing a tank container is described in EP 1 879 793 B1, wherein working platforms are pivoted by extension arms which are held by a mast which can be inserted through an upper opening of the tank chamber. At least the upper part of the mast is arranged as a tube in this case and the extension arms can be moved through the tube together with a carrier part to which they are linked. It is disadvantageous in this system that it has an expensive and complex configuration.

It is therefore the object of the invention to provide a maintenance apparatus which allows reaching all positions in the inner areas of ships or tank installations for example, but which simultaneously has a simple and low-cost configuration which in addition is easy to transport and assemble.

This object is achieved in accordance with the invention such a way that the at least one carrier system is movable along the vertical carrier by means of a lifting cylinder system. Said carrier system is arranged on the vertical carrier and can be moved along said carrier. In this respect, the at least one arm system can preferably be arranged on the carrier system in such a way that it is oriented substantially parallel to the longitudinal axis of the vertical carrier when the system in accordance with the invention is introduced into the interior of a tank for example. The lifting cylinder system in accordance with the invention is especially well-suited as a result of a simple configuration to move the at least one carrier system in a secure and reproducible manner along the vertical carrier.

Projections are preferably provided on the vertical carrier, into which the at least one carrier system engages. In a preferred embodiment of the invention, the projections are arranged in a hook-like way and are arranged in a horizontally offset manner with respect to each other on the vertical carrier. During the movement of the carrier system, it engages in the projections, wherein a stair-like upward climbing of the carrier system occurs by means of the lifting cylinder system along the vertical carrier as a result of the horizontally offset arrangement of said projections.

In an especially preferred embodiment of the invention, the vertical carrier has a substantially polygonal cross-section, preferably a square or rectangular one, on the side walls of which the projections are arranged parallel to the longitudinal axis of the vertical carrier in a horizontally offset manner with respect to each other. It is provided in this embodiment in accordance with the invention that the carrier system is arranged on at least one side wall of the vertical carrier and engages in these projections.

It is provided in an especially preferred way that the lifting cylinder system of the at least one carrier system comprises two lifting cylinders which can be moved independently from each other and whose piston rods cooperate with the projections of the vertical carrier. In this case, the distal ends of the piston rods engage in the hook-like projections, wherein a first piston rod engages at first in a first projection during movement of the carrier system along the vertical carrier, while the piston rod of a second lifting cylinder is extended or retracted depending on the direction of movement in order to engage in a projection above or beneath the first projection. The projections can be arranged on top of each other along a line parallel to the longitudinal axis of the vertical carrier or can be offset diagonally with respect to each other.

In order to move the piston rods of the two lifting cylinders along defined orbits, it is provided according to an especially preferred embodiment of the invention that the piston rods of the two lifting cylinders can respectively be moved along a guide on the at least one carrier system, wherein the guide has at least one change in direction and/or is arranged in the manner of a connecting link in an especially preferred way. As a result of this fold in the guide, the guidance of the distal ends of the piston rods out of the respectively preferred hook-like projections is enabled.

A working platform is arranged in an especially preferred embodiment of the invention on the arm system of the at least one carrier system, which working platform can be used by two persons for example. In this case, one person is responsible for the movement and control of the working platform, while the second person performs the inspection and/or processing of the steel structure surface. It can alternatively be provided that a tool holder for accommodating maintenance tools such as a combined washing/granulating tool for removing surface layers, especially a water-jet and/or sandblasting tool, a spraying lancet or a painting tool, is arranged on the at least one arm system of the at least one carrier system.

In order to ensure a precise and secure guidance of the working platform or the tool to the surface to be processed, the at least one arm system arranged on the

at least one carrier system is arranged as a multiple folding arm system, preferably in form of a knee joint system, in an especially preferred embodiment of the invention.

In order to allow adjusting the maintenance apparatus in accordance with the invention to different requirements especially concerning its range, it is provided in accordance with the invention in a further embodiment that the at least one arm system is arranged in a segmented manner, wherein the distal end segment of the arm system facing away from the carrier system comprises at least two swivel axes. As a result of the segmented configuration of the arm system, the arm system can be adjusted to the respective conditions by adding and/or removing individual segments. As a result of the at least two swivel axes of the end segment, the working platform or tool holder can be moved with high precision towards the surface to be processed, wherein said positioning precision is further increased in such a way that in a preferred embodiment of the invention the working platform and/or tool holder is additionally arranged in a rotatable manner on the distal end segment.

Such an arrangement has proven its worth in practice in particular in which at least one carrier system, preferably two thereof, is arranged on the vertical carrier, wherein each carrier system comprises two arm systems which respectively comprise one working platform on their distal end segment. As a result, four arms with one respective working platform preferably for two persons are thus arranged on the vertical carrier, which persons can act independently from each other so that rapid processing of an inner area of a ship is possible. In the case of two carrier system with two respective arm systems, they can be movable in a dependent or independent manner with respect to each other along the vertical carrier.

The invention will be explained below in closer detail by reference to a non-limiting embodiment shown in the drawings, wherein:

- Fig. 1 shows a perspective view of the maintenance apparatus in accordance with the invention;
- Fig. 2 shows a top view of the base element of the maintenance apparatus of Fig. 1;
- Fig. 3 shows a side view of the vertical carrier;
- Fig. 4 shows a sectional view of the vertical carrier of Fig. 3;

Fig. 5 shows the carrier system of Fig. 3 and Fig. 4 in a view from above, and

Fig. 6 shows a sectional view of the end segment of the arm system.

Fig. 1 shows the maintenance apparatus 100 in accordance with the invention, wherein a carrier system 200 with four arm systems 300 arranged thereon is arranged on a vertical carrier 110. The vertical carrier 110 is fixed in a base element 120, which has a substantially square layout in the present embodiment, at the corner points of which one respective roller 121 and a supporting foot 122 are arranged. The maintenance apparatus 100 can be moved in a simple manner by means of the rollers 121, whereas the adjustable supporting feet 122 are used for stable erection of the maintenance apparatus 100 at the intended position, e.g. in the interior of the tank of a ship.

In Fig. 2, the base element 120 is shown in a view from above, wherein the vertical carrier 110 can be inserted into a receiver 123 of the base element 120.

As is shown in Figs. 3 and 4, the vertical carrier 110 comprises projections 111 which are arranged along a falling line F parallel to the longitudinal axis A of the vertical carrier 110. Said hook-like projections 111 are arranged on the side walls 112 of the vertical carrier 110 in such a way that they respectively extend in a horizontally offset manner with respect to each other.

A carrier system 200 is arranged on the vertical carrier 110, which comprises two hydraulic cylinders 210, 210' with piston rods 211, 211'. The distal end 212, 212' of the piston rod 211, 211' which faces away from the lifting cylinder 210, 210' can be moved with folding along a guide 213, 213' and engages in a recess 111a, 111a' of a projection 111, 111'.

If the carrier system 200 is to be moved downwardly as shown in Fig. 4, the piston rod 211 of the first hydraulic cylinder 210 shown in the left half of the image is retracted at first, so that it is removed from the recess 111a of the projection 111. At the same time, the piston rod 211' of the second hydraulic cylinder 210' is extended along the guide 213' until its distal end 212' engages in the recess 111a' of the projection 111'.

The piston rod 211' is retracted during further downward movement along the vertical carrier 110, while the piston rod 211 of the first hydraulic cylinder 210 is extended in order to enable engagement in the adjacent projection 111 situated beneath the first projection 111. As a result, the carrier system 200 is moved downwardly in a step-by-step manner. The upward movement of the carrier system 200 along the vertical carrier 110 occurs analogously.

Fig. 5 shows the carrier system 200 in a top view again, wherein the illustration shows that the carrier system 200 surrounds the vertical carrier 110, wherein the vertical carrier 110 has a substantially square cross-section.

As is shown in particular in Fig. 1, the arm systems 300 are fixed to the carrier system 200. The arm system 300 is arranged in a segmented manner for this purpose, wherein the individual segments 310 can be fixed to each other via bolt connections for example. Furthermore, each arm segment 310 is connected to the adjacent segment 310 via a hydraulic swivel system 320, which allows folding of the segments 310 with respect to each other in the manner of a knee joint. Furthermore, each arm system 300 is attached to the carrier system 200 in such a way that it can be pivoted in the horizontal plane by an angle of more than 180°.

An end segment 340 is arranged at the distal end 330 of the arm system 300, to which a work basket 350 is attached. The end segment 340 (see Fig. 6) can be swivelled via two axes, wherein the swivelling occurs about a first swivel axis S1 by means of a double-chain drive 341. A second swivel axis S2 extends substantially normally to the first swivel axis S1. Finally, the work basket 350 can additionally rotationally be fixed via a rotational axis to the end segment 340 (not shown).

It is understood that the present invention is not limited to the illustrated embodiment. It can also be provided in actual fact that not a single carrier system 200 is provided which comprises the vertical carrier 110, but that it is arranged in two parts for example, wherein one respective carrier system engages around at least one side with two adjacent edges. Similarly, the projections can be arranged in different ways, and their horizontal and/or vertical arrangement on the vertical carrier can vary.

## **CLAIMS**

1. A maintenance apparatus (100) for large surface areas of steel structures, in particular internal areas of ships or tank installations, comprising at least one carrier system (200) that is movable along a vertical carrier (110), wherein at least one arm system (300) is arranged on the carrier system (200), wherein the at least one carrier system (200) is movable along the vertical carrier (110) by means of a lifting cylinder system, wherein projections (111, 111') are provided on the vertical carrier (110), into which the at least one carrier system (200) engages, and the lifting cylinder system of the at least one carrier system (200) comprises two lifting cylinders (210, 210') which are movable independently from one another and whose piston rods (211, 211') cooperate with the projections (111, 111') of the vertical carrier (110), **characterized in that** the piston rods (211, 211') of the two lifting cylinders (210, 210') are respectively movable along at least one guide (213, 213') on the at least one carrier system (200), wherein the guide (213, 213') preferably comprises at least one change in direction and/or is arranged in the manner of a connecting link.
2. A maintenance apparatus (100) according to claim 1, **characterized in that** the projections (111, 111') are arranged in a hook-like manner and are arranged in a horizontally offset manner with respect to each other on the vertical carrier (110).
3. A maintenance apparatus (100) according to one of the claims 1 or 2, **characterized in that** the vertical carrier (110) has a substantially polygonal cross-section, preferably a square or rectangular one, on the side walls of which the projections (111, 111') are arranged in a horizontally offset manner with respect to each other parallel to the longitudinal axis (A) of the vertical carrier (110).
4. A maintenance apparatus (100) according to one of the claims 1 to 3, **characterized in that** a working platform (350) is arranged on the at least one arm system (300) of the at least one carrier system (200).
5. A maintenance apparatus (100) according to one of the claims 1 to 4, **characterized in that** at least one tool holder for accommodating maintenance tools such as a combined washing/granulating tool for removing surface layers, especially a water-jet and/or sandblasting tool, a spraying lance or a painting tool, is arranged on the at least one arm system (300) of the at least one carrier system (200).

6. A maintenance apparatus (100) according to one of the claims 1 to 5, **characterized in that** the at least one arm system (300) arranged on the at least one carrier system (200) is arranged as a multiple folding arm system, preferably in form of a knee joint system.
7. A maintenance apparatus (100) according to claim 4 or 5, **characterized in that** the arm system (300) is arranged in a segmented manner, wherein the distal end segment (340) of the arm system (300) facing away from the carrier system (200) comprises at least two swivel axes (S1, S2), and preferably the working platform (350) or the tool holder is additionally rotatably arranged on the distal end segment (340).
8. A maintenance apparatus (100) according to claim 7, **characterized in that** at least one carrier system (200), preferably two thereof, is arranged on the vertical carrier (110), wherein each carrier system (200) comprises at least one arm system (300), preferably two thereof, which respectively comprise one working platform (350) on their distal end segment (340).
9. A maintenance apparatus (100) according to claim 8, **characterized in that** each arm system (300) is movable substantially independently from the other arm systems (300).
10. A maintenance apparatus (100) according to one of the claims 8 or 9, **characterized in that** the two carrier systems (200) are movable in a dependent or independent manner with respect to each other along the vertical carrier (110).