

Tool Mounting

The invention relates to a tool mounting having an attachment element and a frame for accommodating tools for the treatment of large surfaces, in particular ship hulls.

A system for cleaning surfaces is described in WO 1996/12570 A2, wherein a tool mounting of the type mentioned at the beginning is provided, which has a frame, on which travel wheels for moving the tool mounting over a surface are arranged, and a water jet system is screwed onto this frame. This tool system is only suitable to a limited extent for the treatment of ship surfaces, because a ship hull is naturally not implemented as a plane, but rather as a curved surface. However, to ensure a correct alignment of the tool in relation to the respective ship surface during use of this system on curved surfaces, in particular the alignment of the tool axis perpendicularly to the surface to be treated, a complex crane system is typically necessary. Furthermore, it has a substantial space requirement because of its construction, which opposes the use in a shipyard, in which typically only little free space is available between ship wall and shipyard wall.

Devices having a similarly high space requirement and restricted adaptation capability to curved surfaces are described in WO 2000/48901 A1 or in EP 0 140 451 A2.

It is therefore the object of the invention to provide a tool mounting, which remedies the disadvantages of the prior art and enables optimum alignment of the tool to the surface to be treated with little space requirement.

This object is achieved by the tool mounting according to the invention of the above-mentioned type in that the attachment element can be arranged at its proximal end via an attachment means on the distal end of a carrier system so it is pivotable about a first pivot axis, the attachment element has a self-supporting connection to the frame at its distal end so it is pivotable about a second pivot axis, and the first pivot axis is aligned essentially orthogonally to the second pivot axis. By way of the attachment element according to the invention, the frame, which is used for accommodating tools, can be arranged in a space-saving manner on a carrier system, wherein the carrier system can be implemented as a crane arm or telescoping arm, for example. The carrier system is not part of the present invention in this case. By way of this arrangement, which is pivotable about a first axis, of the attachment element on the carrier

system and the arrangement of the frame on the proximal end of the attachment element, wherein this connection is also pivotable about a second axis, the tool mounting according to the invention can be optimally aligned to the inclined and/or curved surface. In particular in use on ship hulls, the ability to pivot the tool mounting about two pivot axes which are essentially perpendicular to one another is particularly advantageous. Since the attachment element is only connected on one side to the frame and therefore a self-supporting connection is formed, the space requirement of the tool mounting according to the invention is particularly small.

It is preferably provided that at least one first pivot unit for the deflection about the first pivot axis and at least one second pivot unit for the deflection about the second pivot axis are arranged on the attachment element. By way of this measure, the space requirement of the tool mounting according to the invention is further minimized, because the units provided for the pivoting of the tool mounting are arranged solely on the attachment element. These pivot units are selected in particular from a group which includes electrical and/or hydraulic rotating motors, hydraulic cylinders, and chain drives. Of course, other suitable drive systems which are suitable for pivoting the tool mounting can also be used.

To ensure the guiding of the tool mounting to the surface to be treated or the alignment thereof in a safe and reproducible manner, in a particularly preferred embodiment of the invention, at least one distance sensor and/or one proximity sensor is arranged on the frame and/or the attachment element. Unintentional and incorrect touching of the surface is thus also prevented in particular as the tool mount is moved up to the surface to be treated.

A travel wheel system having at least two travel wheels, which are advantageously equipped with rotary generators, is arranged on the frame for the automatic movement of the tool mounting over a surface to be treated. These travel wheels guide the tool mounting according to the invention over the surface to be treated according to a pre-definable control program.

In a further preferred embodiment of the invention, the travel wheel system has two pivotable pairs of travel wheels, which are arranged on two opposing sides of the frame. When a coating or painting tool is arranged in the tool mounting according to the invention, for example, the second pair of travel wheels arranged trailing the painting tool is thus pivoted in a travel direction, to avoid damage to the coating which was just performed. If the travel direction is changed, the pivoted second pair of travel wheels is folded out again in the direction of the surface to be coated, while the first pair of travel wheels, which is now trailing, is in turn retracted.

To be able to determine the precise position or velocity of the tool located in the tool mounting at any point in time, in a further embodiment of the invention, at least one sensor wheel is arranged on the frame.

In a further variant of the invention, the at least one tool can be arranged by means of a quick-release system in the frame of the tool mounting. Therefore, the required tools may be inserted or removed rapidly into or from, respectively, the tool mounting, which substantially decreases the downtimes of maintenance units in shipyards, for example.

The tool mounting is particularly preferably used for the cleaning and coating of ship hulls, tanks, and other large, in particular curved surfaces and is therefore particularly suitable for accommodating different tools. These tools are selected in particular from a group which includes a combined washing/ablation tool for removing surface layers, in particular a water jet and/or sandblasting tool, a rinsing lance, and a coating tool, in particular for use with lacquers.

The invention will be described in greater detail hereafter on the basis of nonrestrictive exemplary embodiments with associated figures, wherein

- Fig. 1 shows a perspective view of a first embodiment of the invention,
- Fig. 2 shows a perspective view of a second embodiment of the invention,
- Fig. 3 shows the arrangement of the tool mounting from Fig. 2 on a telescopic arm,
- Fig. 4 shows a first perspective view of a third embodiment of the invention,
- Fig. 5 shows a second perspective view of the embodiment from Fig. 4, and
- Fig. 6 shows a typical tool for use with the tool mounting according to the invention.

Fig. 1 shows a tool mounting 100, which has a frame 110 and an attachment element 120. The attachment element 120 is fastened via an attachment means 121, in the form of a flange plate here, on a carrier arm system (see Fig. 3).

The tool mounting 100 is pivotable away from the attachment element 121 via a chain drive 122. For this purpose, the corresponding pivot axis S1 extends

essentially parallel to the surface of attachment means 121. The actuation of the chain drive 122 is performed via a hydraulic cylinder 123.

Furthermore, the tool mounting 100 according to the invention is pivotable via a second pivot axis S2, which also extends essentially parallel to the surface of attachment means 121 and is essentially perpendicular to the first pivot axis 1. A further hydraulic cylinder 123' is provided for this purpose.

Quick-release systems 111 are arranged on the frame 110 on two opposing sides, with the aid of which a tool is fixed in the tool mounting 100 according to the invention. For this purpose, the tool preferably has two guide bolts, which are insertable into the recesses 112 on the frame 110, and which are used for centering and aligning the tool in the tool mounting 100.

A travel wheel system 130, which has two travel wheels 131, is arranged on the side of the frame 110 opposite to the attachment element 120. The travel wheels 131 are preferably driven for this purpose via rotary generators 133 and guide the tool mounting 100 over the surface. Furthermore, two sensor wheels 132a, 132b are provided, which are aligned orthogonally to one another and are used for measuring the velocity and/or determining the positioning of the tool mounting 100.

Finally, a sensor unit 140 is arranged on the frame 110, which is implemented in this embodiment of the tool mounting 100 according to the invention as a distance sensor, which continuously determines the distance of the tool mounting 100 or the tool located therein from the surface to be treated by means of ultrasound technology, for example. Of course, other sensors can also be arranged in the sensor unit 140.

The tool mounting shown in Fig. 1 has proven itself in particular for accommodating those tools, in particular inspection tools and ablation tools, the preferred movement direction of which is in vertical paths in relation to that of the surfaces to be treated.

In practice, the use of a further tool mounting 100 according to the invention as shown in Fig. 2, which was optimized for the horizontal movement along a surface to be treated, has proven itself for coating.

This tool mounting 100 also has an attachment element 120, which enables the adaptation of the tool mounting 100 to curved surfaces because of its ability to pivot via two pivot axes S1, S2, and can be fastened via an attachment means 121 on a carrier arm system 200. In this embodiment, two travel wheel systems 130, 130' are arranged on the frame 110, wherein the respective pairs of travel

wheels 131, 131' are collapsible. Depending on the travel direction, the trailing pair of travel wheels 131, 131' is collapsed, to avoid damage to the coating of the surface which was performed with the aid of the tool (not shown) arranged in the frame 110. Each travel wheel system 130, 131' furthermore has a pair of sensor wheels 132, 132', which determines the position of the tool mounting 100 in relation to the surface to be treated. If the end of a first horizontal path on the surface to be treated has been reached, an offset of the tool mounting 100 is performed with the aid of the carrier arm system 200, which is monitored and controlled by the sensor wheels 132, 132'.

In the case of the automated maintenance of ship hulls and other large surfaces, in particular having curved surfaces, the following procedure has proven itself: Firstly, an inspection and surveying system, which is fixed in the tool mounting 100 according to the invention as shown in Fig. 1, for example, is arranged on an arm system 200, and the entire surface is scanned in vertical paths using this, wherein curvature and contour of the surface are detected and the regions of the surface to be treated are automatically or manually established and stored in a control program.

It is preferably provided for this purpose that the carrier arm system 200 guides the tool mounting 100 to the upper edge of the ship hull and brings the tool mounting 100 into contact with the surface, so that the travel wheels 131 touch the surface. The tool mounting 100 is now guided in vertical paths along the ship hull to record and inspect the surface which is subsequently to be treated, wherein the distance sensor of the sensor unit 140 continuously monitors the distance. The tool mounting 100 is equipped for this purpose with an inspection system, wherein, for example, a camera system or another suitable system for analyzing the surface is arranged on the frame and/or on the attachment element 120. With the aid of the inspection system and the sensor wheels 132a, 132b, the contour of the entire ship hull is recorded, and also the regions to be treated are detected and the position thereof is stored in the control program.

On the basis of this control program, the actual automated maintenance is entirely or partially performed after this inspection step: firstly, in a cleaning step, the cleaning and ablation tool is arranged in the tool mounting according to the invention, and subsequently the surface is in turn cleaned in the previously established regions in vertical paths over the surface to be treated, and the paint layers to be removed are removed using water jet technology, for example. An ablation tool 300 suitable for this purpose can be inferred from Figs. 6 and 7.

For coating the regions which were previously cleaned and stripped of paint, a coating tool is arranged in the tool mounting according to the invention as shown

in Fig. 2 and again guided automatically in horizontal paths over the surface, to prime and subsequently coat the exposed regions.

A further embodiment of the invention can be inferred from Figs. 4 and 5, wherein this tool mounting 100 is capable of accommodating two tools, in the present case ablation tools 300, 300', which simultaneously treat the surface to be cleaned. The treatment time can thus be significantly reduced.

The tool mounting 100 has an attachment element 120, which can be arranged via an attachment flange 121 on the distal end 201 of the carrier arm system 200. A hydraulic cylinder 123, which is housed in the attachment element 120, pivots the tool mounting 100 about a first axis S1 and therefore provides the required contact pressure of the tool 300, 300' on the surface to be treated.

The frame 110 of the tool mounting 100 is pivotable via a pivot unit 124, which is guided like a link, via a second pivot axis S2. In this case, the second pivot axis S2 is aligned essentially orthogonally to the first pivot axis S1. The two tools 300, 300' are housed in two frame elements 113, 113' and are pivotable in these frame elements 113, 113' via two further pivot axes S3, S4, which each extend substantially parallel to the first pivot axis S1 and the second pivot axis S2. Finally, the two frame elements 113, 113' are also pivotable via a fifth axis S5, which extends essentially parallel to the first pivot axis S1. In addition, this further axis S5 preferably lies essentially in a shared plane with the first pivot axis S1 and the second pivot axis S2, so that a particularly space-saving structure of the tool mounting 100 according to the invention is achieved.

This arrangement of five independent pivot axes S1, S2, S3, S4, S5 furthermore enables a particularly flexible adaptation of the tools 300, 300' arranged in the tool mounting 100 according to the invention to the respective surface to be treated. In this case, the tools 300, 300' are preferably moved via link guides within the respective frame element 113, 113'. In this case, in this embodiment of the invention, the pivot movements induced via link guides take place along the pivot axes S2, S3, S4, and S5 without control, whereby a simple adaptation of the tool mounting 100 or the tools 300, 300' to a curved surface, for example, takes place. Only the pivot movement about the pivot axis S1 is controlled via the hydraulic cylinder 123, to achieve the required contact pressure of the tool on the surface to be treated. In an alternative variant (not shown) of the tool mounting 100 according to the invention, one or more of the further pivot axes S2, S3, S4, S5 can also be controlled, which is advantageous in particular in the case of the use of painting tools in the tool mounting 100 according to the invention.

Each frame element 133, 133' is additionally equipped with a travel wheel system 130, wherein the first frame element 113 has three travel wheels 131, while the second frame element 113' is equipped with two travel wheels 131 and one sensor wheel 132 for monitoring the movement of the tool mounting 100 over the surface to be treated. In the illustrated arrangement of the frame elements 113, 113', the tool mounting 100 according to the invention is configured for the vertical treatment of a surface. If the treatment is to be performed in horizontal paths, for example, only the frame parts 113, 113' are thus arranged pivoted by 90° in the frame 110, so that the travel wheels 131 are arranged in the region of the edges of the frame parts 113, 113' which extend vertically in the installation direction.

According to Figs. 6 and 7, an ablation tool 300, which is arranged in the mounting according to the invention, has a tool body 310, which has an essentially elliptical footprint 311, on which two nozzle bodies 400 are arranged. Furthermore, a tool body wall 312, which is essentially orthogonal to the footprint 311, encloses the two nozzle bodies 200.

On the outer side of the tool body wall 312, a seal element 320 is arranged, which consists of a one-piece brush body 321 and a neoprene seal 322, which partially encloses the brush body 321. The seal element 320 is fastened via four spring units 323, in the present case spring mounts, on the tool body 310, wherein this spring mounting enables an adaptation of the seal element 320 to the surface to be treated. In operation, the tool 300 according to the invention has, as a result of this combination seal consisting of brush body 321 and neoprene seal 322 and also the spring mounting via the spring units 323, an optimum leak tightness from the surroundings, so that practically no ablated material reaches the surroundings and simultaneously the suction system can be optimally dimensioned.

Suction openings 313 are provided in the tool body 310 for suctioning away the waste material, wherein the flow conditions inside the tool body are further improved by the arrangement of suction channels 314, which lead to the suction openings 313.

To obtain optimum ablation performance of the tool 310 according to the invention, the nozzle bodies 400 each have three rotor arms 401, on which nozzles 402 are arranged essentially radially.

On at least one rotor arm, as shown in Fig. 7, the longitudinal axes A of the nozzles 402 are arranged essentially perpendicularly to the footprint E of the rotor arm 401, only the nozzle 402' at the proximal end 403 is embodied as

inclined, wherein the angle α is approximately 5° in the present embodiment of the invention. Therefore, a lower ablation rate is obtained in the region of the surface treated by this part of the rotor arm 401, whereby the desired profile between treated and untreated surface is obtained.

The cleaning agent, for example, water, abrasive agents such as sand, or also mixtures of abrasive agents with water or solvents, is conducted via a central feed line 315 by means of high pressure (500 to 3000 bar) to the nozzles 402, 402', and is guided via the nozzles 402, 402' to the surface to be treated. A hydraulic motor causes for this purpose, for example, via a bevel gear, a rotation of the nozzle bodies 400, to obtain uniform treatment of the surface. The waste material made of ablated material resulting in this case, and the water and/or abrasive agents used, are suctioned off via the suction openings 313, to minimize stress of the environment with these materials. Furthermore, the seal element 320 according to the invention assists the suctioning off during the ablation.

Finally, additional sensors can be attached to the tool body 310, which monitor and control the optimum alignment of the tool 300 on a surface. These can be, for example, proximity sensors based on ultrasound technology and the like. Inspection devices such as cameras and the like can also be provided. The tool 300 has proven itself in particular for use in automated maintenance facilities for the treatment of curved surfaces, for example, ship hulls. For this purpose, the tool 300 is arranged in the tool mounting 100 according to the invention, which is attached via the arm system 200 to the surface to be treated.

It is obvious that the present invention is not restricted to the illustrated exemplary embodiments. Rather, different systems can be used for pivoting the tool mounting and the frame elements thereof. A variety of different tools such as ablation tools, coating tools, inspection systems, and the like can also be arranged in the tool mounting according to the invention.

CLAIMS

1. A tool mounting (100) having an attachment element (120) and a frame for accommodating tools (300, 300') for the treatment of large surfaces, in particular ship hulls, **characterized in that** the attachment element (120) can be arranged at its proximal end via an attachment means (121) on the distal end (201) of a carrier system (200) so it is pivotable about a first pivot axis (S1), the attachment element (120) has a self-supporting connection at its distal end to the frame (110) so it is pivotable about a second pivot axis (S2), and the first pivot axis (S1) is aligned essentially orthogonally to the second pivot axis (S2).
2. The tool mounting (100) according to claim 1, **characterized in that** at least one first pivot unit (122, 123) for the deflection about the first pivot axis (S1) and at least one second pivot unit (123') for the deflection about the second pivot axis (S2) are arranged on the attachment element (120).
3. The tool mounting (100) according to claim 2, **characterized in that** the pivot units (122, 122') are selected from a group which contains electrical, pneumatic, and/or hydraulic rotating motors, hydraulic cylinders (123, 123'), and chain drives (122).
4. The tool mounting (100) according to one of claims 1 to 3, **characterized in that** the frame (110) has at least two frame elements (113, 113') which are each used to accommodate one tool (300, 300').
5. The tool mounting (100) according to claim 4, **characterized in that** the tools (300, 300') which can be arranged in the frame elements (113, 113') are pivotable via two axes (S3, S4) extending essentially orthogonally to one another.
6. The tool mounting (100) according to claim 4 or 5, **characterized in that** the at least two frame elements (113, 113') are pivotable in relation to one another via a further axis (S5).
7. The tool mounting (100) according to one of claims 4 to 6, **characterized in that** the further axis (S5) lies essentially in a plane with the first pivot axis (S1) and the second pivot axis (S2).
8. The tool mounting (100) according to one of claims 1 to 7, **characterized in that** at least one distance sensor (140) and/or proximity sensor is arranged on the frame (110) and/or on the attachment element (120) and/or the frame elements (113, 113').

9. The tool mounting (100) according to one of claims 1 to 8, **characterized in that** a travel wheel system (130, 130') having at least two travel wheels (131, 131') is arranged on the frame (110) and/or frame elements (113, 113').
10. The tool mounting (100) according to claim 9, **characterized in that** at least one of the travel wheels (131, 131') is equipped with rotational generators.
11. The tool mounting (100) according to claim 9 or 10, **characterized in that** the travel wheel system (130, 130') has two pivotable pairs of travel wheels (131, 131'), which are arranged on two opposing sides of the frame (110).
12. The tool mounting (100) according to one of claims 1 to 11, **characterized in that** at least one sensor wheel (132, 132a, 132b) for determining the velocity and/or position is arranged on the frame (110) and/or on the at least one frame element (113, 113').
13. The tool mounting (100) according to one of claims 1 to 12, **characterized in that** at least one tool (300, 300') can be arranged by means of at least one quick-release system (111) in the frame (110).
14. The tool mounting (100) according to one of claims 1 to 12, **characterized in that** at least one tool (300, 300') can be arranged via a link guide in the frame (110) and/or frame element (113, 113').
15. The tool mounting (100) according to one of claims 1 to 13, **characterized in that** the at least one tool (300, 300') is selected from a group which contains a combined washing/ablation tool for removing surface layers, in particular a water jet and/or sandblasting tool, a flushing lance, and a painting tool.

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