

A maintenance apparatus

The invention relates to a maintenance apparatus for large-area steel building surfaces with a mobile support system, the support system comprising at least one vertical support on which at least one horizontal support is disposed which can move vertically along the vertical support and comprises at least one work cabin.

In many areas of technology it is necessary to examine and process the surface of large-area construction surfaces, especially those made of steel. For example, the hull of ships needs to be protected in regular intervals against corrosion. For this purpose, old damaged coatings are removed by special processes in order to provide the cleaned steel surface of the ship's hull with a new coating. This process is known as "recoating". The manual performance of this process is very work-intensive and hazardous to the health of all involved persons. Since relatively large surface areas are concerned, expensive and complex scaffold structures are necessary in order to reach every point of the ship's hull.

An apparatus for the surface treatment of freestanding, substantially perpendicular walls especially of ships has been described for example in EP 0 640 440 A1. In this case, a carriage with two mast elements is provided on which a cabin is arranged which is movable relative to the ship's wall. This apparatus concerns a relatively large inflexible apparatus which is rather unsuitable especially for processing the bow of a ship's hull.

US Pat. No. 4,285,469 also discloses an apparatus for cleaning perpendicular surfaces which comprises a water jet device for cleaning the hulls of ships and is fixedly installed in a quay wall. Such an apparatus is entirely unsuitable for mobile use.

US Pat. No. 3,548,541 describes an apparatus of the kind mentioned above which comprises a vertical support on which a horizontal support with a work cabin is arranged. This apparatus generally shows very low flexibility as a result of the arrangement of the horizontal support and is further only suitable for performing a single work step during the "recoating", which is the performance of sandblasting.

It is therefore the object of the invention to eliminate the aforementioned disadvantages of the state of the art and to provide an apparatus of the kind mentioned above which offers especially high flexibility in use.

This object is achieved in accordance with the invention such a way that at least two arm systems are provided on the at least one horizontal support, with a tool holder being disposed on at least one arm system. This substantially concerns a mobile, tower-crane-like support system which is capable of simultaneously performing two different working steps on the steel building surface as a result of its at least two arm systems. One arm system is equipped for example with a tool for cleaning the surface by means of a water jet, whereas the second arm system comprises a blasting head for sandblasting.

In a preferred embodiment of the invention, at least one of the two arm systems is a five-axis, incrementally controlled articulated arm system for accommodating automated tools. The five-axis system allows that the automated tool can also be moved towards positions that are difficult to access, while an incremental control allows an automated guidance of the tool over a specific surface area of the steel building surface to be processed.

The automated tools are usually chosen from a group which comprises blasting heads for water or different granulates, coating heads and inspection systems. These tools are especially used in the aforementioned "recoating" of ship's hulls. In a first embodiment of the invention the two arm systems can be triggered independent from one another. As an alternative to this it can be provided that the two arm systems can be triggered depending on one another. The dependence of the two arm systems from one another is advantageous for example when the first arm system performs a coating of the surface for example while the second arm system comprises an inspection system that checks the quality of the lacquer layer that has just been applied. Arm systems that work independent from one another will be used especially when both arm systems are equipped with the same tool in order to achieve a more rapid progress in the work.

In an especially preferred embodiment of the invention, a first work cabin with a first arm system is provided at a first end of the at least one horizontal support, and a second arm system with a second work cabin is provided at the second end of the at least one horizontal support. This embodiment is especially suitable for the purpose that the first work cabin which is preferably arranged directly on the horizontal support processes the steel building surface via a first arm system, while the second work cabin can be moved by a second arm system directly to a steel building surface in order to enable manual work on this surface for example. The single-man or two-man work cabin is usually provided with all structures in order to ensure the removal of the waste material during stripping or the sealing of the cabin field towards the outside for minimizing environmental pollution by released waste material or the overspray mist during recoating. A suction system

for the interior space of the cabin is especially also provided as well as the supply of the workplace with fresh air for the workers who perform the stripping and coating work manually.

The special flexibility of the maintenance apparatus in accordance with the invention is especially also achieved in such a way that at least one of the horizontal supports is pivotable at least in part in the horizontal plane, so that especially the work cabin and the respective tools can be moved more easily towards the ship's hull. Furthermore, flexibility is also supported in such a way that in especially preferred embodiments of the invention the horizontal support and/or vertical support can be telescopically extended with respect to its length. As a result, the maintenance apparatus can be used for a large variety of applications because its dimensions can be adjusted accordingly.

Preferably, the support system is incrementally movable in a programmable way substantially parallel to the steel building surface. In this case, the tower or the respective arm system is guided continuously along steel building surface, with especially a horizontal and vertical meandering motion being performed in an automated way. A progressing processing surface is thus generated in this manner. In order to ensure an especially flexible operating mode of the maintenance apparatus in accordance with the invention, the support system is preferably movable on a rail system. It can alternatively be provided that the support system can be arranged on a motor vehicle. This leads to the special advantage that for brief processing no separate rail system is necessary and the maintenance system can easily be moved by means of the motor vehicle, especially a truck, to the respective positions.

The maintenance system as described above is especially suitable for processing and/or inspecting ship's hulls and/or the outside walls of steel tanks.

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

Fig. 1a shows a perspective view of a first embodiment of the maintenance apparatus in accordance with the invention;

Fig. 1b shows a detailed view of the maintenance apparatus of Fig. 1a;

Fig. 2a shows a first side view of a second embodiment of the maintenance apparatus in accordance with the invention;

Fig. 2b shows a view of the maintenance apparatus of Fig. 2a from above;

Fig. 2c shows a second side view of the maintenance apparatus of Fig. 2a;

Fig. 3 shows a side view of a third embodiment of the maintenance apparatus in accordance with the invention, and

Fig. 4 shows a plurality of maintenance apparatuses in accordance with the invention used on a ship's hull in a top view.

Fig. 1a shows a preferred embodiment of the maintenance apparatus 100 in accordance with the invention, with a horizontal support 20 being vertically movable on a vertical support 10 which is arranged on a platform 11.

Platform 11 is movable along a rail system 30 and comprises devices such as a power supply 12, a water supply 13, a compressed air supply 14 and/or a material supply 15 for sand and/or paint, which are in connection with the horizontal support 20 via supply lines (not shown) along the vertical support 10. Furthermore, a leveling system 16 is provided beneath the platform 11 with which the platform 11 and consequently the vertical support 10 can be aligned in the required manner along the steel surface to be processed, while the displacement along the rail system 30 allows a movement substantially parallel to said surface.

In the embodiment of the invention as shown here, a first work cabin 21 is arranged at one end of the horizontal support 20, which work cabin comprises a first arm system 22, at the end of which there is an automated tool 23 such as a sandblasting head for processing the steel surface. The first arm system 22 preferably concerns a five-axis, incrementally controlled articulated arm system, with the help of which the tool 23 is guided towards the steel surface to be processed and is guided along the same in order to strip lacquer and paint from the same for example.

A second work cabin 24 is arranged on the horizontal support 20 at the opposite end, which second work cabin can be changed in its position via a second arm system 25. Said second work cabin 24 is especially configured for manual processing of the surface and comprises in accordance with Fig. 1b an extensible element 26 with sealing devices which is moved by a piston 27 to the surface to be processed and is pressed against the same. A hermetically sealed working space is thus created which is vented via a venting system 28 and is especially provided for coating the surface to be processed with paint. As a result of the hermetic sealing of the area to be processed it remained substantially free from dust and contamination, while no undesirable mist of paint is allowed to escape to the outside.

The embodiment in accordance with the invention as shown in Figs. 1a and 1b further comprises a counterweight system on the bottom side of the horizontal support 20, the weights 29, 29' of which will adjust synchronously according to the motions of the first work cabin 21 or its arm system 22 and the second work cabin 24.

The maintenance apparatus 100 as shown here allows a simultaneous processing of the surface. For example, a first worker cleans the surface by means of sandblasting in the first work cabin 21 in a first step while a second worker performs subsequent coating of the surface in the second work cabin 24.

A further variant of the maintenance apparatus 100 in accordance with the invention is shown in the Figs. 2a to 2c. The embodiment as shown here differs from the preceding ones in such a way that the second work cabin 24 is arranged on a second arm system 25 of the horizontal support 20, which in contrast to the preceding embodiment is telescopically extensible. Fig. 2b shows especially that the first arm system 22 of the first work cabin 21 is equipped with a sandblasting head for example, wherein the first arm system 22 can be swiveled by an angle α of up to 120° , so that a wide area of the surface can be processed without having to displace the vertical support 10 via its platform 11. It is simultaneously provided that the first arm system 22 is also telescopically extensible. The second work cabin 24 is arranged on a telescopic arm 25 which is additionally pivotable by an angle β of up to 45° in relation to the surface to be processed.

Fig. 2c shows the use of the maintenance apparatus 100 in accordance with the invention in the processing of a ship's hull 200. As a result of its compact and flexible configuration it can be arranged between the ship's hull 200 and a dock wall 300 for example.

The maintenance apparatus 100 as shown in Fig. 3 comprises two work cabins 21, 24 which are each set up for manual processing of the surface. These work cabins 21, 24 are respectively arranged on telescopic arms 22, 25, with each of these arm systems 22, 24 being extensible and pivotable independent of the other one.

Fig. 4 shows a view from above of the section of a ship's hull 200 which is simultaneously processed by means of five maintenance apparatuses 100 in accordance with the invention. Each of these maintenance apparatuses 100 removes the paint originally disposed on the ship's hull in its area and coats it with new paint in the next step. It can similarly be provided for example that a cleaning unit for cleaning the ship's surface 200 by means of a high-pressure

water jet is arranged on the first arm system 22, whereas the cleaned surface is checked for defective places in the second work cabin 24.

It is understood that the invention is not limited to the embodiments as described above. In particular, the use of a large variety of tools can be provided on the arm systems of the first work cabin. It can similarly be provided that both work cabins comprise a separate arm system for accommodating tools. These tools comprise all appliances which are configured for washing or cleaning, processing such as roughening and/or coating of surfaces, and devices and apparatuses for inspecting surfaces. The present maintenance system is especially also suitable for the automated processing of substantially perpendicular surfaces, especially those made of steel, with only one person being required for example for monitoring a fully automatic recoating process.

CLAIMS

1. A maintenance apparatus (100) for large-area steel building surfaces (200), comprising a mobile support system, with the support system comprising at least one vertical support (10) on which at least one horizontal support (20) is disposed which can move vertically along the vertical support (10) and comprises at least one work cabin (21, 24), at least two arm systems (22, 25) being provided on the at least one horizontal support (20), **characterized in that** a first work cabin (21) with a first arm system (22) with a tool holder for the reception of automated tools (23) is provided at a first end of the at least one horizontal support (20), and a second arm system (25) with a second work cabin (24) is provided at a second end of the at least one horizontal support (20).
2. A maintenance apparatus (100) according to claim 1, **characterized in that** at least one of the two arm systems (22, 25) is a five-axis, incrementally controlled articulated arm system for accommodating automated tools (23).
3. A maintenance apparatus (100) according to claim 1 or 2, **characterized in that** the automated tools (23) are usually chosen from a group which comprises blasting heads for water or different granulates, coating heads and inspection systems.
4. A maintenance apparatus (100) according to one of the claims 1 to 3, **characterized in that** the two arm systems (22, 25) can be triggered independent from one another.
5. A maintenance apparatus (100) according to one of the claims 1 to 3, **characterized in that** the two arm systems (22, 25) can be triggered dependent on one another.
6. A maintenance apparatus (100) according to one of the claims 1 to 5, **characterized in that** the second work cabin (24) can be moved via the second arm system (25) in its position.
7. A maintenance apparatus (100) according to one of the claims 1 to 6, **characterized in that** the horizontal support (20) is pivotable at least in part in the horizontal plane.

8. A maintenance apparatus (100) according to one of the claims 1 to 7, **characterized in that** the horizontal support (20) and/or the vertical support (10) is telescopically extensible in its length.
9. A maintenance apparatus (100) according to one of the claims 1 to 8, **characterized in that** the support system is movable in an incrementally programmable manner substantially parallel to the steel building surface (200).
10. A maintenance apparatus (100) according to one of the claims 1 to 9, **characterized in that** the support system is movable on a rail system (30).
11. A maintenance apparatus (100) according to one of the claims 1 to 9, **characterized in that** the support system can be arranged on a motor vehicle.
12. The use of a maintenance apparatus (100) according to one of the claims 1 to 11 for processing and/or inspecting ship's hulls and/or the outside walls of steel tanks.