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DOCKING APPARATUS FOR SHIPS

TECHNICAL FIELD

The present invention relates to an apparatus for hauling ships into and out of docks.

BACKGROUND ART

When ships are hauled into docks for repairing, the surface of the hull is cleaned with pressurized water first to remove salt and deposits, then blasted at corroded portions and finally coated with paint. After these hull surface treating procedures have been completed in series, the ship is hauled out of the dock. The operation of hauling the ship into and out of the dock and the surface treating operation are the chief work at the dock, which must therefore be equipped with apparatus for performing these operations. Self-running surface treating trucks provided on opposite side walls of the dock are usually used for the surface treating operation, while ships are hauled into and out of the dock usually by a rope. With such a tow apparatus, however, the rope must be tied to and removed from the ship for docking manually by many workers, so that the work temporarily reaches a peak and involves problems in respect of safety. Furthermore, docks of larger scale receive larger ships which require a rope of increased diameter to result

in a higher peak in the amount of work. To meet the situation, it appears useful to provide on opposite side walls of the dock self-running docking trucks for hauling the ship into and out of the dock. However, since the surface treating operation and the hauling operation are conducted not concurrently but, so to speak, alternatively, it is uneconomical to provide two types of self-running trucks separately, while there is the likelihood that one truck will become an obstacle when the other truck is used. Although it may be possible to use a single truck for both surface treatment and docking, the truck, which needs to have a great weight for hauling the ship into and out of the dock, must be driven in its entirety also for surface treatment. Generally the truck is run more frequently for surface treatment than for hauling, so that the travel of the heavy truck in its entirety for surface treatment entails an increased operating cost and is not economical.

An object of the present invention is to obviate or mitigate the foregoing problems and to provide an economical docking apparatus for ships which assures savings in labor and improved safety when hauling the ship into and out of a dock.

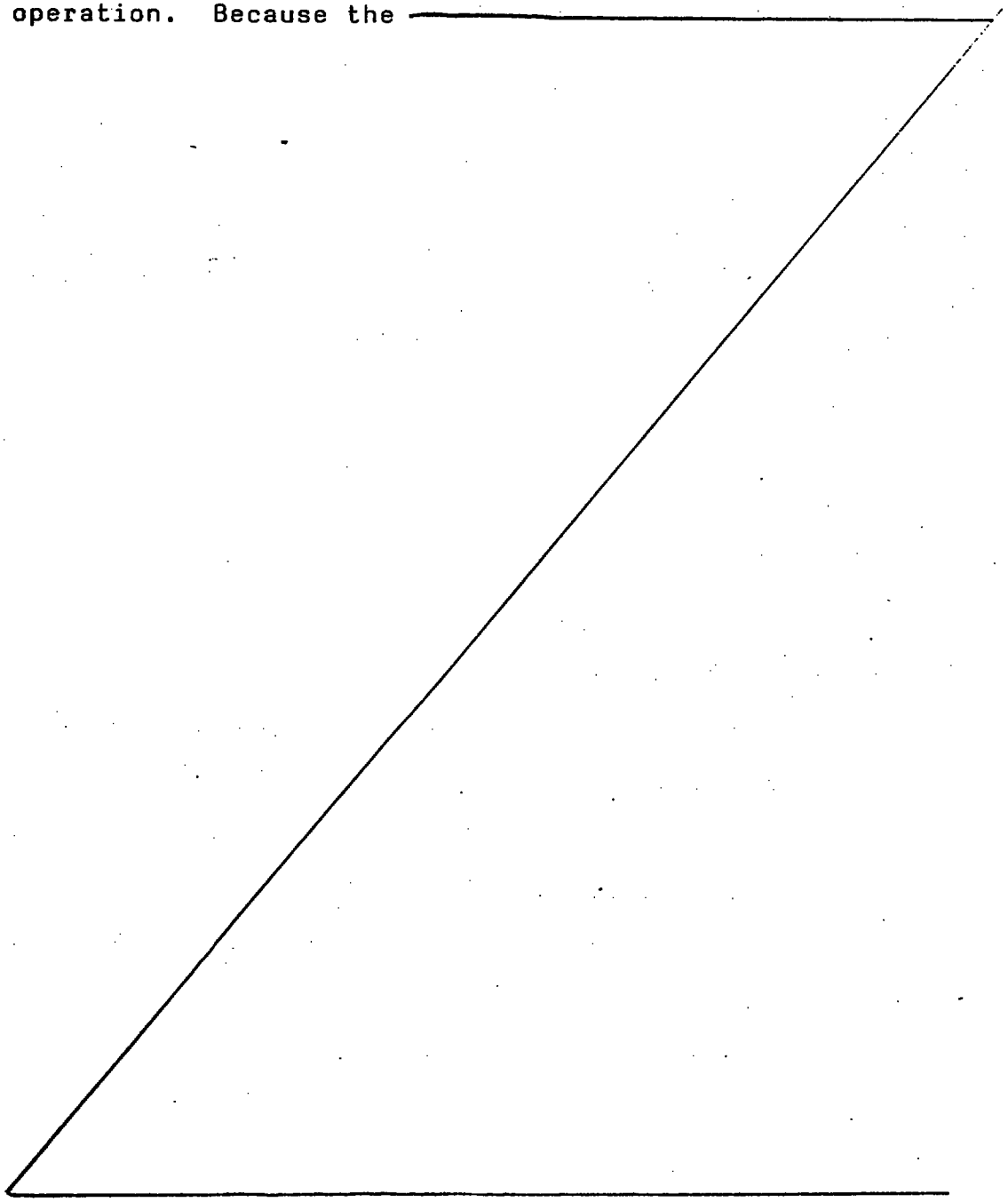
The present invention provides an apparatus for hauling a ship into and out of a dock, the apparatus comprising a surface treating truck having a hull surface treating device, and a docking truck having a retra-

ctable hull suction disk, the trucks being arranged to be provided on a side wall of the dock, adapted to run therealong substantially horizontally, and being connectible to and separable from each other, and the surface treating truck alone being provided with a running drive unit, the docking truck comprising a pair of mounting portions arranged to extend substantially vertically along the dock side wall, a lift assembly provided between the mounting portions and movable upward and downward therealong, and an arm mounted at one end on the lift assembly and pivotable in a substantially horizontal plane, the hull suction disk being attached to the other end of the arm.

When a ship is to be hauled into or out of the dock by the present apparatus, the surface treating truck is connected to the docking truck, the suction disk of the docking truck is brought into sucking engagement with the hull, and both the trucks are caused to run by the running drive unit on the surface treating truck to pull the ship along. Thus there is no need to use a tow wire rope conventionally used. For surface treatment, the docking truck is separated from the surface treating truck and held at rest at a suitable location, e.g. at the inlet or innermost portion of the dock, allowing the surface treating truck alone to run.

The ship can be hauled into or out of the dock by the present apparatus, with the docking truck connected

to the surface treating truck, without using any tow wire rope as described above. This operation can be carried out also automatically. Accordingly the present apparatus does not require many workers, assuring savings in labor and improved safety in the hauling operation. Because the



surface treating truck only can be run as separated from the docking truck for surface treatment, the former truck, which is used more frequently than the latter, can be operated at a reduced cost, hence economical. The apparatus is further economical in that the running drive unit is provided not on the docking truck but on the surface treating truck only.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 (a) and (b) are plan views of a dock and docking apparatus of the invention to schematically show the apparatus in two modes, i.e. in hauling or docking operation and hull surface treating operation;

Fig. 2 is a front view showing a surface treating truck;

Fig. 3 is a plan view of the same;

Fig. 4 is a side elevation of the same;

Fig. 5 is an enlarged view in section taken along the line V-V in Fig. 4;

Fig. 6 is a view in section taken along the line VI-VI in Fig. 5;

Fig. 7 is a front view showing a docking truck;

Fig. 8 is a plan view of the same;

Fig. 9 is a side elevation partly broken away and showing the same;

Fig. 10 is a plan view on an enlarged scale showing

a hull suction disk of the docking truck;

Fig. 11 is a view showing the same as it is seen along the line XI-XI in Fig. 10;

Fig. 12 is a front view of the docking apparatus to show the surface treating truck and the docking truck as connected together;

Fig. 13 is a plan view of the same;

Fig. 14 is an enlarged view in section taken along the line XIV-XIV in Fig. 13; and

Fig. 15 is an enlarged view in section taken along the line XV-XV in Fig. 13.

DETAILED DESCRIPTION OF EMBODIMENT

With reference to Fig. 1, two docking apparatus 3 are provided on each of opposite side walls 2 of a dock 1. Each docking apparatus 3 comprises a surface treating truck 4 and a docking truck 5. Figs. 2 to 15 show the docking apparatus 3 on one side wall 2 toward the inlet of the dock.

With reference to Figs. 2 to 4, an upper rail 7 extending horizontally along the side wall 2 and an H-shaped lower rail 8 similarly extending are provided on an upper horizontal stepped portion 6 of the wall 2 and on a lower portion of the side wall 2, respectively. The surface treating truck 4 is mounted on these rails 7 and 8 freely movably. The truck 4 comprises an elongated horizontal portion 11 supported by two impact eliminating assemblies 55 on the

upper rail 7, and a vertical portion 12 extending vertically and having an upper portion fixed to the inner side of one end of the horizontal portion 11 which end is closer to the innermost portion of the dock. The lower end of the vertical portion 12 is supported by horizontal rollers 13 on the lower rail 8.

Figs. 5 and 6 show the impact eliminating assembly 55 in detail. The horizontal portion 11 of the truck 4 is provided at its bottom with vertical rollers 9 rollable in contact with the upper surface of the upper rail 7, and horizontal rollers 10, 58 rollable in contact with opposite sides 57 of the upper rail 7. The two horizontal rollers 10 arranged on one side of the rail 7 which side is outward of the dock are mounted directly on a frame 59 fixed to the bottom of the horizontal portion 11. The single horizontal roller 58 disposed on the other side of the rail 7 inwardly of the dock is mounted on an intermediate portion of an arm 60, one end of which is rotatably supported by a vertical pivot 62 on a frame 61 fixed to the bottom of the horizontal portion 11. Provided between the movable other end of the arm 60 and the frame 61 is a hydraulic cylinder 63 for biasing the horizontal roller 58 into pressing contact with the side surface 57. The horizontal portion 11 has a hydraulic circuit 64 for supplying oil to the cylinder 63. The circuit 64 comprises an oil channel 66 connecting an oil

tank 65 to the cylinder 63, a hydraulic pump 68 driven by an electric motor 67 for supplying oil to the cylinder 63 via the channel 66, a check valve 69 disposed at an intermediate portion of the channel 66 between the pump 68 and the cylinder 63, a first relief valve 70 disposed at a portion of the channel 66 closer to the pump 68 than the check valve 69, and a second relief valve 71 interposed between another oil tank 65 and a portion of the channel 66 closer to the cylinder 63 than the check valve 69. The second relief valve 71 is set to a pressure slightly greater than the value corresponding to the greatest horizontal load that will act on the truck horizontal portion 11 outward of the dock, while the first relief valve 70 is set to a lower pressure.

The horizontal portion 11 of the surface treating truck 4 has a power supply reel 14, a running drive unit 15 and a control chamber 16. Thus the truck 4 is adapted to run by itself along the upper and lower rails 7 and 8. The truck horizontal protion 11 is fixedly provided on its inner side with two horizontal connecting plates 17 slightly projecting inwardly of the dock 1 and positioned toward the inlet of the dock and toward the innermost portion thereof, respectively. Each connecting plate 17 has a vertical hole 18.

The truck 4 has a hull surface treating device 19.

The device 19, which treats the surface of the hull by a sequence of steps, has the following construction as already known. The vertical portion 12 has at an upper portion a post 20 rotatable about a vertical axis and tiltably provided with a jib 21. A surface treating head 22 tiltable as desired to position along the hull is attached to the free end of the jib 21. The truck horizontal portion 22 is further provided with a reel 23 for supplying water for surface treatment, a hydraulic unit 54, a fan 24 having a bag filter, and a coating unit 25.

With reference to Figs. 7 to 9, the docking truck 5 comprises a pair of vertical portions 26 extending vertically along the dock side wall 2, and horizontal portions 27 interconnecting the upper and lower ends of the portions 26. The lower end of each vertical portion 26 is supported by horizontal rollers 28 on the lower rail 8. Standby intermediate rails 29 for holding the docking truck 5 at rest extend horizontally along the side wall 2 at an upper portion thereof and are positioned toward the dock inlet and toward the innermost portion thereof. The rail 29 is slightly longer than the docking truck 5. An upward projection 30 is formed on the upper side of the rail 29 at its inner edge over the entire length thereof. Each vertical portion 26 of the truck 5 is fixedly provided with a locking block 31 on the outer side, the block slightly projecting

outwardly of the dock 1. A groove 32 for the projection 30 to fit in is formed in the lower side of the locking block 31.

The outer side of the docking truck 5 is positioned slightly inward from the inner side of the surface treating truck horizontal portion 11. A horizontal connecting block 33 and a horizontal connecting plate 34 fixed to an upper portion of each vertical protion 26 of the truck 5 on the outer side thereof project outwardly of the dock 1 above and below the connecting plate 17 on the truck 4. As seen in detail in Figs. 14 and 15, a connecting hydraulic cylinder 36 fixed to the center of upper side of the block 33 by a mount 35 and directed downward has a rod 37, to the lower end of which is fixed a connecting pin 38 vertically movable and extending vertically through the block 33. Two raising hydraulic cylinders 39 fixed to the upper side of the connecting block 33 on opposite sides of the cylinder 36 and directed downward have rods 40, each of which has at its lower end a vertically movable raising pin 41 extending vertically through the block 33. The connecting plate 34 has a vertical connecting hole 44 corresponding to the pin 38.

The vertical portions 26 of the docking truck 5 are provided with vertical guide rails 42 on the opposed surfaces thereof. A lift assembly 43 is provided between the guide rails 42 with vertical rollers (not shown) inter-

posed therebetween. An electric winch 45 for upwardly or downwardly moving the lift assembly 43 along the guide rails 42 on the vertical portions 26 is mounted on the upper horizontal portion 27 of the truck 5. The lift assembly 43 is suspended from wire ropes 46 paid off from the winch 45.

A horizontal arm 47 is mounted at its one end on the lift assembly 43 so as to be pivotally movable about a vertical axis. A hydraulic cylinder 48 for moving the arm 47 in a horizontal plane is connected at its opposite ends to an intermediate portion of the arm 47 and the lift assembly 43. A vacuum hull suction disk 49 optionally tiltable to position along the hull is attached to the free end of the arm 47 as will be described below. A pivotal member 72 is connected to the free end of the arm 47 by a vertical pivot, and a suction disk connecting member 73 is attached to the pivotal member 72 by a horizontal pivot.The suction disk 49 is secured to the connecting member 73. A hydraulic cylinder 74 for revolving the suction disk 49 in a horizontal plane has opposite ends conntected to the pivotal member 72 and the arm 47. A hydraulic cylinder 75 for turning the suction disk 49 in a vertical plane is connected between the connecting member 73 and the pivotal member 72. Mounted on the top of the lift assembly 43 are a hydraulic unit 50 for driving the cylinders 48, 74, 75 and a vacuum pump unit 51 for operating the suction disk 49.

No running drive unit is provided on the docking truck 5.

The docking apparatus 3 toward the innermost portion of the dock is similarly mounted on the upper and lower rails 7 and 8. This docking apparatus 3 is symmetric with the docking apparatus 3 positioned toward the dock inlet with respect to a vertical plane intersecting the side wall 2 of the dock at right angles therewith. Further each docking apparatus 3 on one side wall 2 is symmetric with the corresponding docking apparatus on the other side wall 2 with respect to a vertical plane positioned at the center of the dock 1 in parallel with the side walls 2.

When the docking apparatus 3 are not used for hauling a ship into or out of the dock 1, the two trucks 4 and 5 of each docking apparatus 3 are separate from each other, with the docking truck 5 held at rest in standby position as located close to the inlet or innermost portion of the side wall 2. More specifically stated, the locking blocks 31 of each docking truck 5 rest on the corresponding standby intermediate rail 29, with the projection 30 of the rail 29 fitting in the grooves 32 in the blocks 31, whereby the docking truck 5 is locked to the intermediate rail 29.

When hauling a ship, the two trucks 4 and 5 of each docking apparatus 3 are connected together as seen in Figs. 12 to 15 in the following manner. First,the surface treating truck 4 is driven toward the corresponding docking

truck 5 to bring the vertical portion 12 of the truck 4 closer to the truck 5. When the vertical portion 12 approaches the docking truck 5, the horizontal portion 11 of the truck 4 moves along the outer side of the docking truck 5 without interfering therewith to bring each connecting plate 17 of the truck 4 into the space between the corresponding connecting block 33 and connecting plate 34 of the docking truck 5. The truck 4 is stopped when the hole 18 in the plate 17 comes into register with the hole 44 in the plate 34. The connecting hydraulic cylinder 36 is then operated to lower the connecting pin 38 into the holes 18, 44, and the raising pins 41 are thereafter lowered by the raising hydraulic cylinders 39 to raise the docking truck 5. Although the two trucks 4, 5 are connected together by each connecting pin 38 inserted in the holes 18, 44 in the connecting plates 17, 34 of the trucks 4, 5, the docking truck 5 is still unable to run because the locking blocks 31 of the truck 5 rest on the intermediate rail 29. Accordingly only when the truck 5 is raised by the raising pins 41, the locking blocks 31 are lifted off the intermediate rail 29, allowing the docking truck 5 to run with the travel of the surface treating truck 4 free of interference with the intermediate rail 29.

A ship 52 is hauled into the dock in the following manner, with the two trucks 4, 5 of each docking apparatus

3 connected together as above.

First, the ship 52 is guided to the inlet of the dock to place the bow into the dock 1 by a tugboat (not shown). At this time, the four docking apparatus 3 on the opposite side walls 2 of the dock are positioned in the vicinity of the inlet. The lift assembly 43 of each docking truck 5 is locked in its raised position to the vertical portions 26 by stoppers (not shown), with the suction disk 49, i.e., the arm 47, turned outwardly of the dock and retracted in the lift assembly 43 as indicated in broken line in Fig. 13. After the bow of the ship 52 has been guided into the dock 1 to some extent, the arms 47 of the two inner docking apparatus 3 are turned inwardly of the dock to move the suction disks 49 toward the ship 52, and the suction disks 49 are brought into sucking engagement with the outer plate of the hull at the bow, with the inclincation of the disks 49 suitably adjusted. The two inner docking apparatus 3, namely, the surface treating trucks 4 and the docking trucks 5, are thereafter moved inwardly of the dock while adjusting the position of the ship 52 by the tugboat, whereby the ship 52 is further hauled into the dock 1. After a major portion of the ship 52 has been guided into the dock 1, the suction disks 49 of the other two docking apparatus 3 toward the inlet of the dock are similarly brought into sucking engagement with

the hull at the stern. The four docking apparatus 3 are then driven further inward of the dock to guide the ship 52 to a predetermined position within the dock 1 (see Fig. 1 (a)), whereupon the four docking apparatus 3 are brought to a halt, and the ship 52 is slowed down and stopped by the tugboat ties to the stern. The ship 52 is positioned in place widthwise thereof by suitably moving the arms 47 of the apparatus 3. The tugboat is then separated from the ship 52, and the gates of the dock are closed.

A plurality of support blocks are arranged as specified on the bottom 53 of the dock 1 before the ship 52 is guided in. After the gates have been closed, water is discharged from the interior of the dock 1 at a full speed. As the level of water within the dock 1 lowers, the ship 52 is also lowered gradually. Before this step, the stoppers for locking each lift assembly to the vertical portions 26 of the docking truck are disengaged, with the brake for the winch 45 set for slipping, so that the lift assemblies 43 are allowed to lower with the ship 52 while maintaining the ship in a constant position with respect to a horizontal plane. When the vertical spacing between the bottom of the ship and the central support block has been reduced to a predetermined value, the speed of discharge of water is reduced to one half the initial speed. Upon the bottom of the ship reaching the central support block, the discharge

is discontinued to check the ship 52 for its position. If not positioned properly, the ship 52 is slightly floated off the central support block with a supply of water into the dock 1 and is adjusted in position, followed by the same procedure as above. When the ship is properly positioned, the level of the support blocks on opposite sides are adjusted to cause all the blocks to support the ship 52. The suction disks 49 of the four docking apparatus 3 are separated from the ship 52 and retracted into the lift assemblies 43. The lift assemblies 43 are raised and locked in position to the vertical portions 26 of the docking trucks 5. The remaining water is then discharged at a full speed again to completely drain the dock 1. With the work thus completed, the ship 52 is supported on the support blocks.

The above operation can be carried out also automatically with use of sensors for detecting the horizontal and vertical positions of the ship 52, etc. and a microcomputer or the like, or semi-automatically under manual control.

After the ship 52 has been completely hauled into the dock, the two trucks 4 and 5 of each docking apparatus 3 are separated from each other in the following manner. The four docking apparatus 3 are brought toward the inlet or the innermost portion of the side walls 2, as specified

for each. Each docking apparatus 3 is halted when the locking blocks 31 of the docking truck 5 are positioned above the opposite ends of the corresponding intermediate rail 29. The raising pins 41 are then lifted by the raising hydraulic cylinders 39 to thereby lower the docking truck 5, allowing the projection 30 of the intermediate rail 29 to fit into the grooves 32 in the locking blocks 31, whereby the docking truck 5 is locked to the rail 29. Subsequently the connecting pins 38 are lifted and upwardly withdrawn from the connecting plates 17 of the surface treating truck 4 by the connecting hydraulic cylinders 36 to separate the truck 4 from the truck 5, whereby the truck 4 is made free to run as disconnected from the truck 5. Accordingly the surface treating trucks 4 only are used for treating the surface of the hull by a process comprising in series the steps of cleaning the surface of the hull with pressurized water to remove salt and deposits, blasting corroded portions and finally coating the hull with paint (see Fig. 1 (b)).

After the surface treatment, the ship 52 is hauled out from the dock 1 by a procedure reverse to the docking procedure described above.

Thus ships can be hauled into and out of the dock by the docking apparatus 3, with the surface treating truck 4 and the docking truck 5 connected together, without using

tow wire ropes. This operation can be carried out also automatically. Accordingly the present apparatus does not require many workers, assuring savings in labor and improved safety in the hauling operation. Because the surface treating truck 4 only can be run as separated from the docking truck 5 for surface treatment, the truck 4, which is used more frequently than the truck 5, can be operated at a reduced cost, hence economical. The apparatus is further economical in that the running drive unit 15 is mounted not on the docking truck 5 but on the surface treating truck 4 only.

The impact eliminating assembly 55 provided on the surface treating truck 4 eliminates the clearances between the upper rail 7 and the horizontal rollers 10, 58 on opposite sides thereof at all times as will be described below. Consequently the truck 4 and the rail 7 will not be subjected to an impactive load unlike those of the prior art and therefore need not be given increased strength, hence economical. More specifically stated, the horizontal portion 11 of the truck 4 is subjected to a horizontal load acting inwardly of the dock due to the gravity acting on the truck 4 or trucks 4, 5 when the truck 4 runs singly or as connected to the truck 5 not in sucking engagement with any ship. Further when the truck 4 runs as connected to the truck 5 in sucking engagement with a ship, the horizontal

portion 11 of the truck 4 will be subjected to a horizontal load resulting from rolling or pitching of the ship or the wind and acting thereon outwardly of the dock. If the outward horizontal load is greater than the inward horizontal load due to the gravity on the trucks 4, 5, a horizontal outward load generally acts on the portion 11 outwardly of the dock, whereas if otherwise, an inward horizontal load acts thereon generally. When the overall inward horizontal load acts on the portion 11, the horizontal rollers 10 positioned outwardly of the dock press against the side face 57 of the rail with an increased pressure, while the horizontal roller 58 positioned inwardly of the dock presses against the other rail side face 57 at a relatively low pressure dependent on the pressure setting of the first relief valve 70 to eliminate the clearances between the rail 7 and the horizontal rollers 10, 58 at all times. Conversely when the overall outward load acts on the horizontal portion 11, the horizontal roller 58 is pressed against the rail side face 57 under a high pressure. However, before the internal pressure of the cylinder 63 reaches the pressure setting of the second relief valve 71, the oil will not be released from the cylinder 63 to the tank 65, with the result that the horizontal rollers 10 and 58 on opposite sides will not come out of contact with the rail 7. As already stated, the pressure to which the valve 71 is set is slightly

greater than the value corresponding to the greatest outward horizontal load on the horizontal portion 11, so that the rollers 10, 58 are held in contact with the rail side faces 57 at all times without any clearance therebetween. Furthermore, even when the width of the upper rail 7 involves variations due to manufacturing or installation errors, the distance between the opposed horizontal rollers 10 and 58 varies with the width of the rail 7 in the following manner, consequently eliminating the clearances between the rail 7 and the rollers 10, 58 at all times. When the truck 4 runs on the rail 7 at a portion of increased width, the oil within the cylinder 63 partly escapes through the second relief valve 71 to the tank 65, permitting the inward roller 58 to move away from the rollers 10 on the other side. At a rail portion of decreased width, oil is supplied from the tank 65 to the cylinder 63 through the check valve 69, moving the inward roller 58 toward the rollers 10 on the other side. To hold the inward horizontal roller 58 in pressing contact with the rail side face 57, the hydraulic cylinder 63 needs only to be driven free of load, so that the torque of the motor 67 can be small.

Although the docking truck 5 is mounted on each side wall 2 of the dock 1 according to the foregoing embodiment, the truck 5 may be provided on only one side wall 2. Further instead of providing two docking trucks 5 on each side wall 2 as in the above embodiment, only one docking truck 5 may be mounted on each side wall 2.

Claims :-

1. An apparatus for hauling a ship into and out of a dock, the apparatus comprising a surface treating truck having a hull surface treating device, and a docking truck having a retractable hull suction disk, the trucks being arranged to be provided on a side wall of the dock, adapted to run therealong substantially horizontally, and being connectible to and separable from each other, and the surface treating truck alone being provided with a running drive unit, the docking truck comprising a pair of mounting portions arranged to extend substantially vertically along the dock side wall, a lift assembly provided between the mounting portions and movable upward and downward therealong, and an arm mounted at one end on the lift assembly and pivotable in a substantially horizontal plane, the hull suction disk being attached to the other end of the arm.

2. An apparatus according to claim 1, wherein an upper rail for supporting an upper portion of the surface treating truck is arranged to be provided in a substantially horizontal plane at an upper portion of the dock side wall, and a lower rail for supporting a lower portion of the surface treating truck and a lower portion of the docking truck is arranged to be provided at a lower portion of the dock side wall, the dock side wall being arranged to be provided at an upper portion there-

of between the upper rail and the lower rail with a standby intermediate rail for supporting the docking truck when the docking truck is separated from the surface treating truck.

3. An apparatus according to claim 2, wherein the surface treating truck comprises an elongate, substantially horizontal portion for mounting on the upper rail so as to run past an upper portion of the docking truck on its one side outward of the dock when the docking truck is supported on the intermediate rail, and a substantially vertical portion having an upper part fixed to the horizontal portion toward one end thereof and a lower part arranged to be movably supported on the lower rail, the docking truck being connectible to the horizontal portion of the surface treating truck on one side thereof inward of the dock.

4. An apparatus according to claim 3, wherein the docking truck is provided, at an upper portion thereof on its one side outward of the dock, with connecting pins downwardly insertable into or upwardly withdrawable from connecting holes formed in the surface treating truck and with raising pins upwardly retractable or downwardly projectable to slightly raise the docking truck relative to the surface treating truck.

5. An apparatus for hauling a ship into and out of a dock, substantially as hereinbefore described with reference to the accompanying drawings.