Jan. 10, 1956 W. N. VAN DENBURGH 2,729,918

BLAST CLEANING APPARATUS

Filed April 6, 1954 3 Sheets-Sheet 1

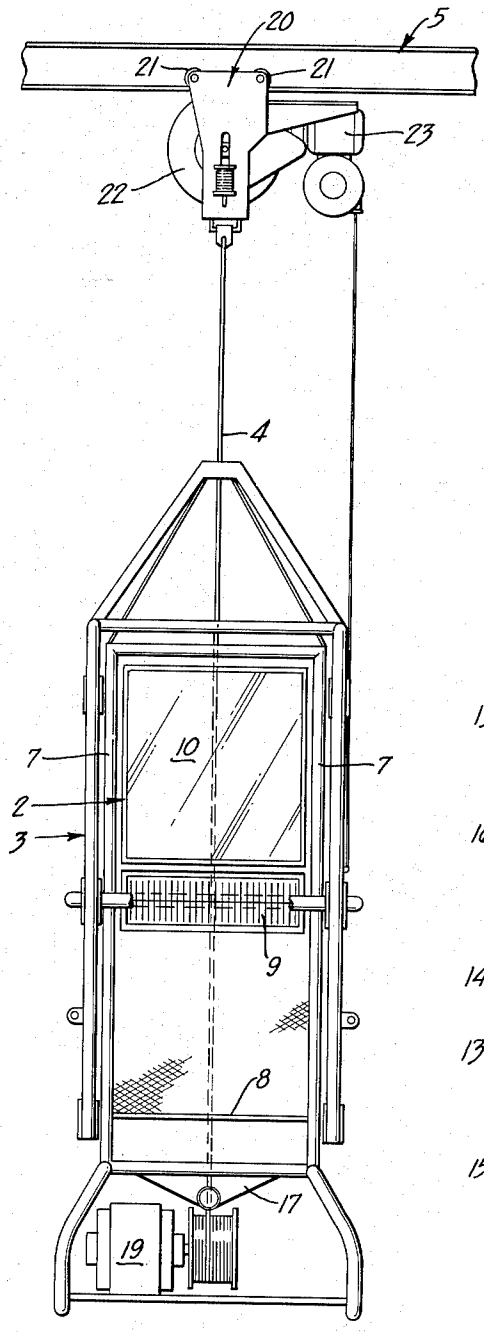

FIG. 1

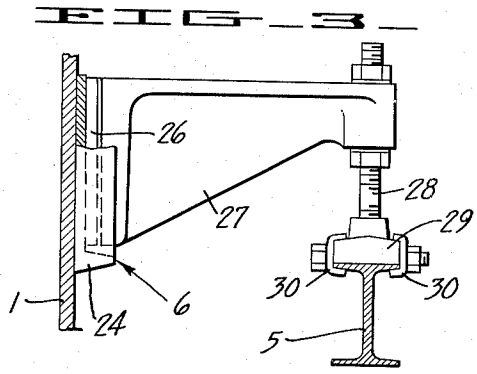

FIG. 3

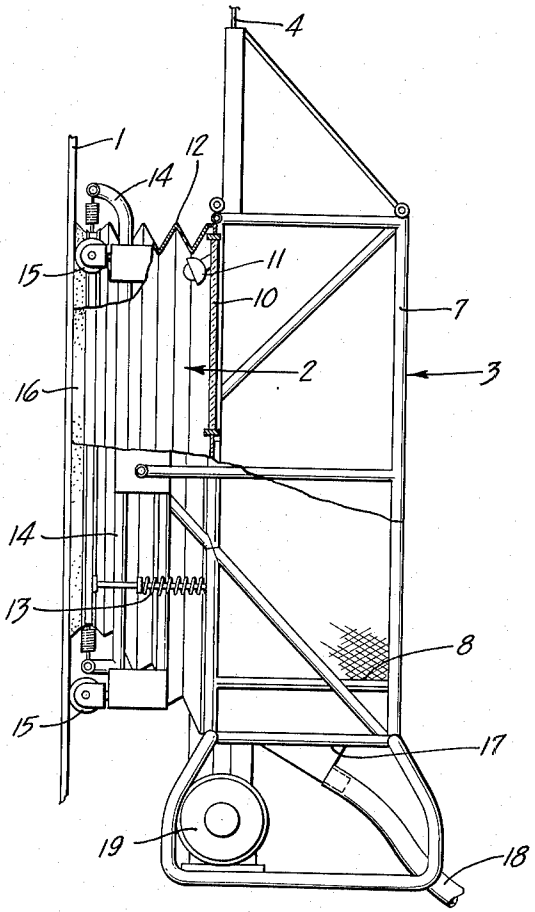

FIG. 2

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BLAST CLEANING APPARATUS

Filed April 6, 1954 3 Sheets-Sheet 2

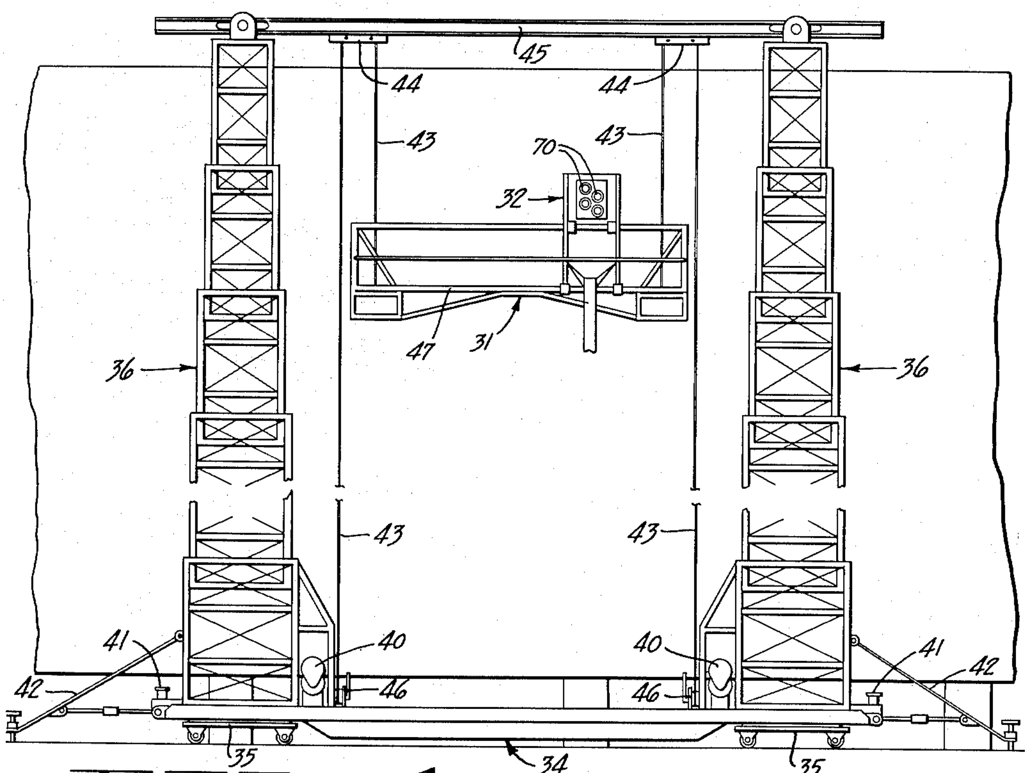

FIG. 4

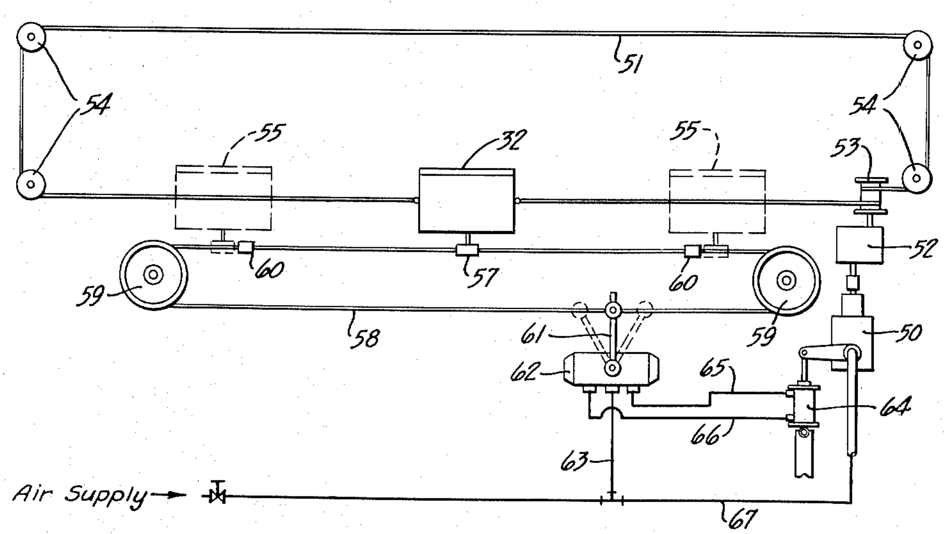

FIG. 5

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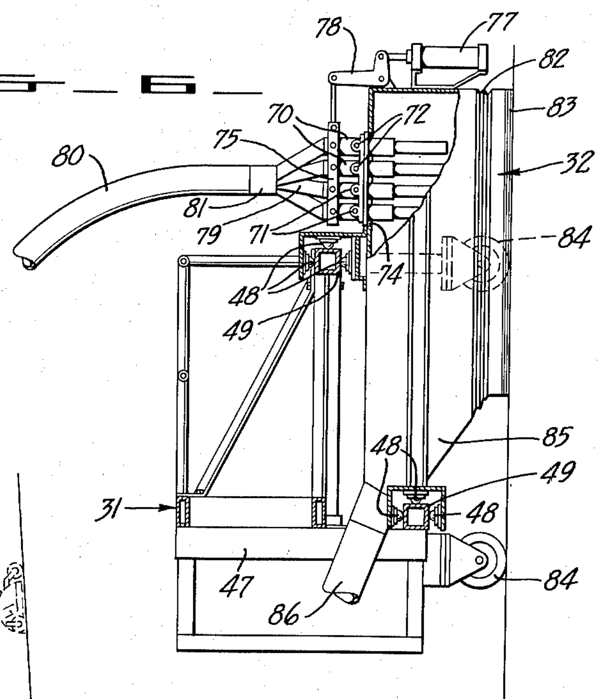
FIG_6_



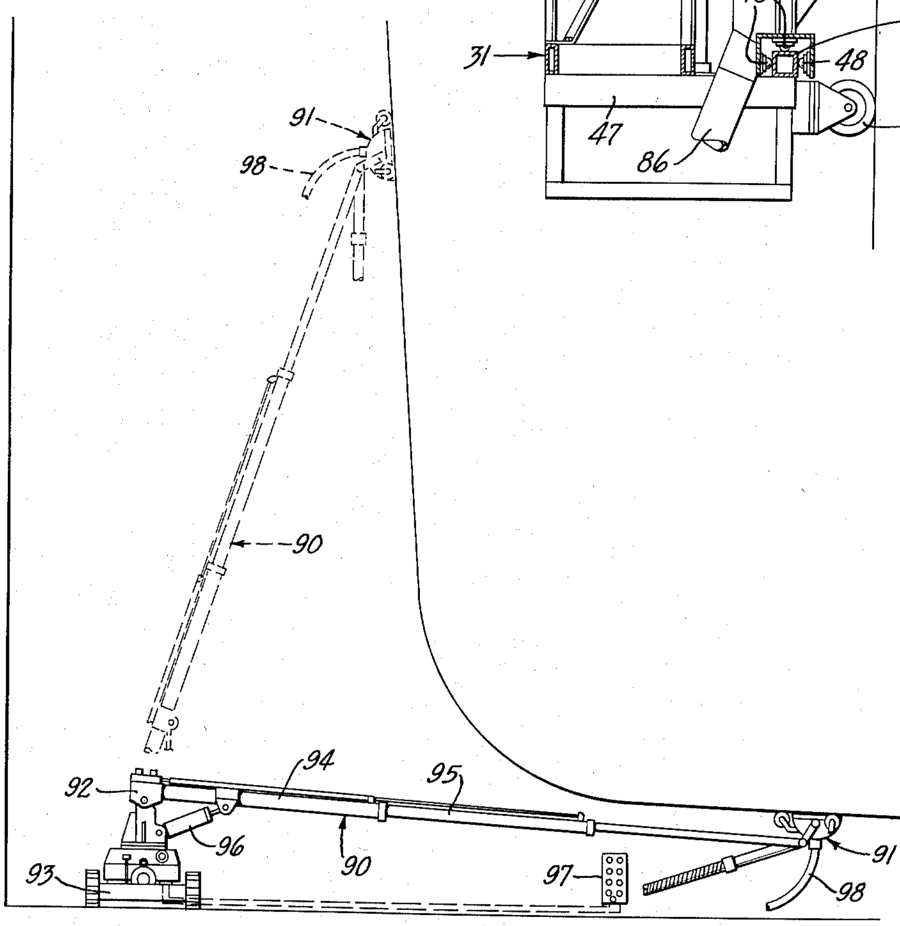


FIG_7_

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BLAST CLEANING APPARATUS

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Application April 6, 1954, Serial No. 421,455

6 Claims. (Cl. 51—8)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to cleaning apparatus and, more particularly, to abrasive blast apparatus for cleaning wall surfaces, such as ship hulls.

The cleaning of large walls preparatory to painting always has been a time-consuming and laborious operation to the extent that, when conducted on drydocked vessels, the cleaning time usually is an important factor in the ship's drydock availability. Some conception of the time and labor involved can be appreciated by considering the present common cleaning practices which mostly employ either bosun chairs suspended along the ship's side or extensive fabricated staging erected on the drydock bottom. As will be recognized, the use of these bosun chairs and staging entails obvious disadvantages in that speed can be obtained only through the employment of many operators, or, in the event cranes are used to suspend the operators, additional personnel are required for the cranes and, even more wasteful, the expensive and otherwise useful cranes are tied-up for excessively long periods. Of course, where staging is considered preferable, a great deal of unnecessary expense and labor must go into their assembly, as well as disassembly.

Yet another deficiency of the conventional cleaning practices is the fact that the cleaning is performed by operator-directed, unconfined jets of sand or metal particles, or by chipping hammers and the like, the spent particles and dirt then being permitted to fly about freely and create a serious personnel hazard, as well as a hazard to ship and other proximate machinery. Not only is such unconfined blasting a hazard but, further, it creates a sizeable cleaning job that involves much additional time, labor and expense, and, when the abrasive particles are to be reclaimed, the man-hours are even further multiplied.

In spite of these difficulties, no serious attempts have been made to avoid the problems created by the unconfined, freely-flying blast particles. In other operations, such as in the cleaning of small objects or surfaces, blast nozzles have been enclosed in specially-designed casings capable of being "vacuumized" so as to carry away these spent particles and waste as it is blasted free. However, as conceived, these small tools apparently required such special features as built-in flow-passageways to enable the spent particles to be carried away, and this fact, as well as the fact that these tools had to be moved by hand over the surfaces, rendered them totally impractical for large-scale ship hull or wall cleaning.

It is, therefore, a principal object of this invention to provide abrasive blast-cleaning apparatus capable of covering large surface areas in a relatively quick time and also capable of confining the blast jets so as to avoid as far as possible injury to personnel and machinery.

Another related object is to provide an apparatus particularly adapted to ship-side cleaning of vessels in drydock and, more specifically, apparatus capable of being quickly movable around the ship's circumference as well as up and down so as to cover all surfaces of the ship's hull in an efficient and thorough manner.

A further object is to provide a vacuumized cleaning apparatus with means for maintaining the mouth of the vacuumized cabinet in continuous contact with a surface to be cleaned, whether the surface be flat, curved or irregular.

Still another object is to provide a vacuumized cabinet which can be reciprocated adjacent the surface independently of the suspension means, and also to provide an oscillating movement to the nozzles independent of this reciprocable movement.

Other objects will become apparent from the drawings and detailed description.

According to the invention, the cleaning apparatus is constructed with an open-sided cabinet in which are mounted one or more conventional blast nozzles, the open side of the cabinet being maintained in contact with the surface throughout the cleaning operation, preferably, by means of a bellows mounted along its outer edge. The bellows being flexible conforms to large variations in the contour of the surface and confines the spent abrasives and surface grit to the cabinet from which they are withdrawn by a suitable vacuum system to a reclaimer for recirculation.

Another important feature of the invention involves the provision of means for suspending the cabinet adjacent the surface and moving the cabinet in this suspended position either vertically or horizontally to sweep a cleaning path over the full surface to be treated. In one modification the cabinet is suspended from a ship-mounted monorail and it is provided with suitable power means controlled by an operator located either remotely or on the cage to raise and lower the structure, or to move it laterally along the rail. This construction is particularly advantageous as the cleaning apparatus is not limited to use on drydock ships since the rails and the cabinet may be easily stowed and used whenever the need arises.

If it should not be desirable to suspend the cleaning apparatus from the ship's hull, other modifications of the present invention permit the supporting of the cage from the drydock and, preferably, these other modifications contemplate a moving vehicle on which are mounted cage-supporting beams, these beams being telescopically or otherwise adjustable in height so as to carry the cage vertically along the ship's hull surfaces. Longitudinal movement of the cage along these surfaces then is permitted either by a drive of the vehicle or carriage itself or by so mounting the cabinet on the supporting beam that it can be reciprocated independently of carriage movement. When such reciprocal movement of the cage is desired, the support may consist of a pair of laterally-spaced telescoping towers between which is supported a horizontal beam from which the cage is reciprocably suspended. In this reciprocating modification, the cage can be constructed to support an operator and the reciprocating drive can be a motor also mounted on it. preferably, as the cage is reciprocated, it is desirable to oscillate the nozzles so as to completely sweep the level at which the cleaning is being conducted. This oscillation may be accomplished by power-driven nozzles synchronized with the reciprocating mechanism so as to oscillate the nozzles in a desired pattern dependent upon the amount of reciprocable movement.

Another carriage-mounted, cage-supporting means which has proven its practicability for use in confined drydock space is a telescoping, vertically-swingable boom.

Such a boom, most suitably, has a universal mounting on its carriage that permits its cage to be moved in any desired direction along the flat or curved surfaces of the hull and, for this reason, it becomes unnecessary to provide any means for independently reciprocating this cage or for independently oscillating its nozzles. In addition to the relatively small space occupied by such telescopic boom it has further obvious advantages in that it can be telescoped either in a vertical direction to reach all heights of the hull or it can be telescoped in a horizontal direction to reach in beneath the ship's hull and clean the ship's bottom. The detailed structure of all of these modifications is subsequently described.

The invention is illustrated in the accompanying drawings of which Fig. 1 is a rear elevational view showing the apparatus suspended from a monorail detachably mounted on a ship; Fig. 2 is a partially sectioned view taken along line II—II of Fig. 1; Fig. 3 is a side elevation of a hanger assembly used to support the monorail; Fig. 4 is a rear elevation of a modified apparatus employing the use of carriage-mounted towers; Fig. 5 is a schematic of the reciprocating drive for the cleaning cage of Fig. 4 modification; Fig. 6 is a side elevation of the Fig. 4 cage, and Fig. 7 is another modification of a cleaning apparatus in which the cage is mounted on a telescoping universally-mounted boom.

In the modification of the invention illustrated in Figs. 1 to 3, the cleaning of a surface, such as a ship's hull **1**, is accomplished by the use of an apparatus which, among other things, incorporates an open-faced blast cabinet **2** in which are mounted one or more conventional blast nozzles, the cabinet functioning primarily to confine the abrasive blast of the nozzles to the surface being cleaned. For support and movement of the cabinet, it is rigidly secured to a cage **3** that is swingably suspended along the ship's hull by means of a cable **4**, this cable being secured at its upper end to a trolley rail assembly **5** detachably supported along the ship's coaming by hanger assemblies **6**. Cage **3**, as may be noted, is constructed with an open tubular frame **7** a portion of which forms a platform **8** for an operator who is permitted both to manually direct the blast nozzles by extending his arms through an elasticized opening **9** and, at the same time to observe the effect of the blast through a window **10**; a light fixture **11** being provided to facilitate his observations.

As will be appreciated, one of the important features of the invention resides in providing means for maintaining the cabinet in constant flush contact with the surface being worked and, in the present modification, such contact is assured by the fact that the suspended weight of the cabinet constantly exerts a pressure sufficient to hold the open face of the cabinet against the hull, while the peripheral edge of this open face mounts a bellows **12**, preferably formed of a flexible, impermeable material. The bellows may be of most any desired construction providing its extended length is sufficient to permit a compression that will enable the bellows to travel over uneven surfaces without losing contact. The bellows may be urged against the surface by compression spring **13**, the free end of the bellows being supported by a frame **14** pivotally mounted to the cage and carrying swivel rollers **15** to limit the compression of the bellows and permit the cage to roll vertically and horizontally along the surface. The mouth of the bellows may be provided with a peripheral rubber or brush lip **16** of sufficient density to prevent the escape of the abrasive and surface particles while permitting the bellows to slide along the surface under the reduced pressure conditions existing within the cabinet. Also, if desired, this lip can be made air permeable so as to admit sufficient atmosphere to create the air current necessary to carry the spent particles out of the cabinet and, as may be noted, these spent particles are evacuated from the bottom of the cabinet through a hopper **17** connected to a suction hose **18** to a commercially-available reclaimer apparatus, not a part of this invention.

Surface cleaning is accomplished by moving the cage vertically and horizontally in a prescribed path with the bellows flush against the surface. Vertical movement is achieved by shortening or lengthing cable **4** by use of any hoisting means, such as a pneumatic motor **19** mounted at a protected position in the base of the cage. The horizontal movement may be effected in most any suitable manner, the preferred construction being a motor-powered trolley riding on monorail or I-beam **5**. As illustrated in Figs. 1 and 3, cable **4** is attached at its upper end to a carriage **20**, this latter element having a set of suspension rollers **21** adapted to ride on the flange of the rail and being propelled by a pneumatic tire drive wheel **22** spring mounted to the carriage for increased traction. Wheel **22** is chain driven by a carriage-supported, low voltage, D. C. motor **23** suitably controlled by the cage-supported operater, as is hoist motor **19**. Monorail **5** is supported at the ship's gunwale by a plurality of spaced hanger assemblies **6**, each of which is formed with a foundation plate **24** welded or detachably mounted to the hull and having one or more elliptical sockets adapted to receive in a wedged-fit a pair of ear-like flanges **26** of a bracket **27**. A vertical stud bolt **28** is threaded at one end in the bracket and at the other end to a pad **29** supporting a pair of bolt-operated clamps **30** for attachment to the head of the monorail.

The operation of the apparatus illustrated in Figs. 1 to 3 should be quite clear from the foregoing description. The cage is suspended along the ship's side with the bellows pressed in contact with the surface to be cleaned. The cage-supported operator positioned behind the bellows directs the blast gun throughout the area defined by the bellows' mouth and also controls the vertical hoist movement and the horizontal movement on the monorail. If desired, one or more automatically operated nozzles may be mounted in the cabinet and driven in a vertically-oscillating path during the horizontal reciprocation of the cage although such a structure is illustrated in and better adapted to another modification presently to be described.

The modification illustrated in Figs. 4–6 is basically similar to the previously described apparatus differing principally in the manner of suspending its cage **31**, as well as the utilization of a reciprocable cage-supported cabinet **32**. Referring to Fig. 4, the apparatus generally comprises a vehicle or carriage **34** having a set of dollies **35** for movement on the bottom or stepped sides of the drydock, the carriage supporting a pair of spaced, vertically-collapsible towers **36**, preferably constructed of telescopic sections, and being of conventional design and commercially available. The sections of each tower are suitably interconnected and raised or lowered by an air hoist motor **40**. Air-driven capstans **41** at each end of the carriage provide means for pulling the carriage longitudinally around the hull. Folder outriggers **42** also may be used to stabilize the carriage during the cleaning of the hull section between the towers.

Cage or carrier **31** is suspended adjacent the ship's hull by a pair of cables **43** connected by pulleys **44** to a monorail **45** extending across and supported to the upper ends of the towers. The raising and lowering of the carriage may be effected by winding each cable on a manually operated rachet drum **46** fixed to the carriage or, if desired, by a suitable power means. In a manner similar to cage **3** of the previously-described modification, the carrier is formed of a prefabricated strut construction providing a platform or catwalk **47** to accommodate an operator, although the presence of an operator in this modification is less of a necessity except for manual touch-up work, since the blast nozzles and cabinet are automatically operated.

The major portion of the hull section between towers is cleaned by reciprocating horizontal sweeps of the cab-

inet achieved by movably mounting the blast cabinet on ball bearing 48 riding on upper and lower tracks 49 fixed to the carrier. The drive mechanism for reciprocating the cabinet is shown in Fig. 5 and it includes a small reversible air motor 50 that drives a cable 51 through a speed reducer 52 onto a take-up cable drum 53, cable 51 being connected to both sides of the blast cabinet and being looped around a system of oppositely positioned pulleys 54. The limit of cabinet travel is illustrated by the broken-line positions 55 of the cabinet, and at each location the direction of travel is automatically reversed. To cause the reverse, a slide 57 fixed to the cabinet is adapted to pass freely over a one leg of a second cable system 58 looped around two oppositely positioned pulleys 59. As shown, between its respective end pulleys the loop of cable 58 extends horizontally a distance greater than the maximum limit of cabinet travel, and this loop portion mounts two oppositely-positioned, adjustable stops 60 adapted to be contacted by slide 57 at selected limits in the cabinet travel. Upon impacting of these stops a force is exerted on the cable and the pull of this force is used to operate a four-way, valve-operating arm 61 connected in the other cable leg. In this manner, four-way valve 62 may be positioned to by-pass the operating air supply in a line 63 to one or the other side of air cylinder 64 through lines 65 and 66. Air cylinder 64 is driven by operating air in a line 67 and is articulated to air motor 50 so that the reversal of the motor rotation by the cylinder drives the cabinet in the opposite direction.

Another important feature of this modification resides in so mounting the blast nozzles in cabinet 32 as to obtain a wide cleaning sweep. In this regard it might be noted that the task of manually directing a blast nozzle, such as is described with reference to the Fig. 1 modification, has limitations in large scale cleaning operations since only one, or perhaps two nozzles can be so manipulated and the efficiency is to some extent dependent upon personal skill. These disadvantages may be avoided by providing the power-driven oscillating nozzles shown in Fig. 6 in which a plurality of nozzles 70 are arranged in a nest, each having a trunnion 71 pivoting in a pair of hinge brackets 72 fixed to a rear cabinet wall 73, the nozzles extending through an oval-shaped opening 74 in the wall to permit freedom of vertical movement. Elevation and depression of the nozzles is accomplished by a cantilever support 75, the nozzles being vertically oscillated, preferably by a motor, such as a reversible air cylinder 77 mounted on the top of the cabinet and connected to support 75 through a bell crank 78. The rate of oscillation can be varied in accordance to the reciprocating speed of cabinet to insure a wide and thorough cleaning sweep.

Each lead-in nozzle hose 79 is connected to a main hose 80 through a distribution fitting 81, the entire assembly being suitably suspended from the carrier in a manner adapted to relieve strain on the nozzle connections and permit slack for the oscillatory movement. Cabinet 32 may be of a design similar to previously described cabinet 2 in that it mounts a bellows 82 terminating in a peripheral lip 83 for intimate contact with the surface to be cleaned. Further, a set of guide wheels 84 extend from the carrier for rolling engagement with the surface, and a hopper portion 85 of the cabinet is connected to a vacuum exhaust hose 86 leading to a reclaimer system.

In operation, carriage 34 is rolled into position below the surface section to be cleaned and rail 45 adjusted in height to accommodate carrier 31 which is adjustably positioned during the cleaning operation by lengthening or shortening the support cables 43. Cabinet bellows 82 being resiliently extended into contact with the surface to confine the spent abrasives, the cabinet then is reciprocated horizontally along tracks 49 on the carrier and simultaneously the pivotally mounted nozzles are vertically oscillated to clean a horizontal strip as long as the adjusted reciprocable travel and as wide as the sweep

of the nozzles. After this initial horizontal strip has been cleaned, the hoisting mechanism is operated to move the carrier to an adjacent vertical section and so on until the entire vertical section of the surface is cleaned. The horizontal position of the entire cleaning apparatus then is shifted to the next adjacent section of the surface by movement of the carriage on the drydock. Thus, the blast apparatus is worked up and down one section of the ship and then moved to a new section until the entire surface area is cleaned, although, of course, other cleaning patterns may be dictated in unusual situations.

A third modification of the invention is illustrated in Fig. 7, this modification employing a telescoping boom 90 for supporting and pressing its blast cabinet 91 against the surface to be cleaned. In drydock cleaning practices, this modification may be preferred over the Fig. 4 modification due to its relative simplicity and space-saving compactness. As will be seen, boom 90 is formed of three telescoping sections, the lower one of which is mounted on a turret 92 that, in turn, is rotatably supported about a vertical axis on a caterpillar type vehicle or carriage 93. The particular details of construction and operating mechanism for this boom and carriage are not shown because the apparatus, at least so far as the boom support is concerned, is commercially obtainable from several sources. Caterpillar 93 also is of standard construction except for the fact that it mounts certain obvious and conventional controls for driving the carriage and swinging the boom. In general, it will be seen that the boom is capable of extension by hydraulic power supplied through an electric motor hydraulic pump that may be mounted on the carriage body, this power being supplied to piston arms 94 and 95 to extend or retract the structure. Further, the same source of hydraulic power may be supplied to a piston 96 to swingably raise or lower the boom as a whole. With this arrangement, it will be seen that the carriage can be moved horizontally to any desired location at which the turret can be pivoted and the boom extended to place cabinet 91 at any desired location along the ship's hull, one of the particular advantages of this arrangement being that the boom can be extended beneath the ship to clean its bottom.

Blast cabinet 91 is similar in construction to the cabinet described with respect to Fig. 1 modification, although, as will be apparent, there is no need or even a desirability of providing an operator platform on the cabinet. Instead, control of the cleaning is performed either on carriage 93 or at a remote control station 97. However, it is desirable to provide a universal mounting for cabinet 91, or, in other words, such a mounting as will permit its supply nozzle 98 to maintain an untwisted position as the cabinet is moved or swung from place to place. Although such a universal mounting of the cabinet is desirable, it is not essential to, nor does it form a part of the present invention and, accordingly, its details are not illustrated. Further, in this modification there is little need to oscillate the nozzles as the cabinet traverses the surface being worked, and, of course, the elimination of this oscillation is possible because the boom permits a compassing coverage of unusually wide areas without the necessity of moving the carriage. Aside from the distinctions noted, the cabinet corresponds to those previously described in that it mounts a spring-pressed bellows provided at its outer edge with a rubber or bristle lip portion, and the supply and recovery of the sand or steel grit may be identical.

In all modifications of the invention a "vacuumized" blast cabinet is movably suspended and pressed against the surface to be cleaned and, further, the cabinet is capable of being driven either vertically or horizontally so as to effectively and expeditiously clean all surfaces encountered. In comparison with the tedious, inefficient and sometimes ineffective shipside cleaning practices of the prior art, the present apparatus is capable of continuous operation that has a minimum blast speed of about 10

square feet per minute and, further, the efficiency of its operation can be appreciated by the fact that the mechanism is capable of handling approximately 700 pounds of steep grit per minute. These manifest operating advantages are attributable not only to the fact that a practical means has been found for supporting a blast cabinet of this nature against the hull of the ship or other vertical surfaces, but also to the provision of the bellows and its surface engaging lip that permits the cage to be moved over the surface without losing cabinet pressure. The fact that certain of the modifications provide an independently reciprocable cabinet in which oscillating nozzles are mounted also clearly increases efficiency in circumstances dictating the use of these modifications. In general, the speed, effectiveness and safety with which shipside cleaning operations can be performed with the present apparatus bears little resemblance to the laborious and expensive hand cleaning operations which have been prevalent in this art for many years.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. Blast apparatus for use on vertically inclined surfaces, the apparatus including a cabinet provided with an open end and with a discharge opening, means for suspending said cabinet in a freely-swinging position with its open end adjacent the surface to be worked, a blast nozzle projecting into said cabinet toward said open end, pressure-reducing means operative during blasting for creating a differential pressure within the cabinet capable of moving blast products outwardly through said discharge opening, and compressibly-resilient means extending outwardly from said open end for engaging the surface to be worked, said suspension means including a trolley assembly adapted to be detachably supported above said surface, a cable suspending said cabinet from said trolley assembly, means for driving said trolley horizontally of said surface, and means for adjusting said cable length whereby said cabinet is movable horizontally and vertically with respect to said surface for positioning the cabinet over all surface areas, resilient means whereby said blast products are contained and said differential pressure discharge is accomplished.

2. Blast apparatus for use on vertically inclined surfaces, the apparatus including a cabinet provided with an open end and with a discharge opening, means for suspending said cabinet with its open end adjacent the surface to be worked, a blast nozzle projecting into said cabinet toward said open end, pressure-reducing means operative during blasting for creating a differential pressure within the cabinet capable of moving blast products outwardly through said discharge opening, and compressibly-resilient means extending outwardy from said open end for engaging the surface to be worked, said suspension means including a vehicle, a pair of towers on said vehicle, a horizontal beam supported by the towers, and a cabinet carrier adjustably suspended from said beam, said cabinet being mounted for horizontal reciprocation on said carrier whereby said towers are movable with said vehicle and the cabinet is movable horizontally and vertically between the towers for covering all surfaces, said resilient means yielding in conformity with curvatures encountered during said movements for maintaining said cabinet in flush contact with said surface, whereby said blast products are contained and said differential pressure discharge is accomplished.

3. Blast apparatus for use on vertically inclined surfaces, the apparatus including a reciprocating cabinet provided with an open end and with a discharge opening, means for suspending said cabinet with its open end adjacent the surface to be worked, a pivotally-mounted blast nozzle projecting into said cabinet toward said open end,

pressure-reducing means operative during blasting for creating a differential pressure within the cabinet capable of moving blast products outwardly through said discharge opening, means for pivoting said nozzles in synchronism with the cabinet reciprocations and compressiby-resilient means extending outwardly from said open end for engaging the surface to be worked, said suspension means including a vehicle, a pair of towers on said vehicle, a horizontal beam supported by the towers, and a cabinet carrier adjustably suspended from said beam, said cabinet being mounted for horizontal reciprocation on said carrier whereby said towers are movable with said vehicle and the cabinet is movable horizontally and vertically between the towers for covering all surfaces, said resilient means yielding in conformity with curvatures encountered during said movements for maintaining said cabinet in flush contact with said surface, whereby said blast products are contained and said differential pressure discharge is accomplished.

4. Blasting apparatus for use on vertically inclined surfaces, the apparatus including a hollow cabinet formed with an open side and with a hopper-shaped bottom provided with a discharge opening, means for supporting said cabinet in an elevated upright position with its open side facing said vertically inclined surface, a blast nozzle mounted in said cabinet in position to direct its blast toward said open side, pressure-reducing means communicated with said cabinet through said discharge opening for creating a differential pressure within the cabinet capable of moving blast products outwardly through said discharge opening, a compressibly resilient bellows extending outwardly from the lip portion of said open side for tightly engaging the surface to be worked and thereby containing said blast products within the cabinet, and guide rollers projecting outwardly from said open side for engaging said surface and for limiting said bellows compression, said suspension means including means for pressing said upright cabinet against said vertically inclined surface, and means for moving said pressured cabinet horizontally and vertically across said surface, said bellows yielding in conformity with curvatures encountered during said movement for maintaining said cabinet in flush contact with said surface, and said guide rollers being projected outwardly a predetermined distance sufficient to limit said bellows compression when the bellows engage a flat surface, said bellows thereby being capable of compressing further when passing over an uneven surface.

5. Blasting apparatus for use on vertically inclined surface, the apparatus including a hollow rigid cabinet formed with an open side and with a hopper-shaped bottom provided with a discharge opening, means for supporting said cabinet in an elevated upright position with its open side facing said vertically inclined surface, a blast nozzle mounted in said cabinet in position to direct its blast toward said open side, pressure-reducing means communicated with said cabinet through said discharge opening for creating a differential pressure within the cabinet capable of moving blast products outwardly through said discharge opening, a compressibly resilient bellows extending outwardly from the lip portion of said open side for tightly engaging the surface to be worked and thereby containing said blast products within the cabinet, and guide rollers projecting outwardly from said open side for engaging said surface and for limiting said bellows compression, said suspension means including a vehicle, a telescoping boom pivotally and swingably carried by said vehicle, means for telescopically varying the extension of said boom, and means mounted on the free end of the boom for pivotally supporting the cabinet, said bellows yielding in conformity with curvatures encountered during said movement for maintaining said cabinet in flush contact with said surface, and said guide rollers being projected outwardly a predetermined distance sufficient to limit said bellows compression when the bellows engage

a flat surface, said bellows thereby being capable of compressing further when passing over an uneven surface.

6. Blasting apparatus for use in vertically inclined surface, the apparatus including a hollow rigid cabinet formed with an open side and with a hopper-shaped bottom provided with a discharge opening, means for supporting said cabinet in an elevated upright position with its open side facing said vertically inclined surface, a blast nozzle mounted in said cabinet in position to direct its blast toward said open side, pressure-reducing means communicated with said cabinet through said discharge opening for creating a differential pressure within the cabinet capable of moving blast products outwardly through said dscharge opening, a compressibly resilient bellows extending outwardly from the lip portion of said open side for tightly engaging the surface to be worked and thereby containing said blast products within the cabinet, and guide rollers projecting outwardly from said open side for engaging said surface and for limiting said bellows compression, said suspension means including an endless track vehicle, a telescoping boom pivotally and swingably carried by said vehicle, means for telescopically varying the

extension of said boom and means mounted on the free end of the boom for pivotally supporting the cabinet, said bellows yielding in conformity with curvatures encountered during said movement for maintaining said cabinet in flush contact with said surface, and said guide rollers being projected outwardly a predetermined distance sufficient to limit said bellows compression when the bellows engage a flat surface, said bellows thereby being capable of compressing further when passing over an uneven surface.

References Cited in the file of this patent

UNITED STATES PATENTS

1,342,488	Woods	June 8, 1920
1,752,664	Forcier	Apr. 1, 1930
1,964,920	Ladrie	July 3, 1934
1,977,386	Holes	Oct. 16, 1934
2,326,264	Stetler	Aug. 10, 1943
2,494,773	Mead	Jan. 17, 1950
2,559,295	Grossenbacher	July 3, 1951
2,628,455	Webster	Feb. 17, 1953