

PATENT SPECIFICATION

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- (21) Application No. 44347/72 (22) Filed 26 Sept. 1972
 (31) Convention Application No. 229 842 (32) Filed 28 Feb. 1972 in
 (33) United States of America (US)
 (44) Complete Specification published 16 July 1975
 (51) INT. CL.² B24C 3/06
 (52) Index at acceptance
 B3D 8A3
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(54) APPARATUS FOR ABRASIVE TREATMENT OF UPWARDLY DIRECTED SURFACES

(71) I, ROBERT TIVIS NELSON, a citizen of the United States of America, of 715, East Reno, Oklahoma City, Oklahoma, United States of America, do hereby declare the invention for which I pray that a patent may be granted to me and the method by which it is to be performed to be particularly described in and by the following statement:—

10 This invention relates to the treatment of upwardly directed surfaces and more particularly it pertains to means for cleaning such upwardly directed surfaces with particulate abrasive material which is projected at high velocity against the surface to be treated in order to remove rust, dirt, paint and other deposits therefrom. This invention is directed to an apparatus which is mobile and is continuously operable for cleaning surfaces such as metal. In addition the apparatus is provided with means for recovering the particulate abrasive material for reuse and means for separating the particulate abrasive material from dust and other light particles which result from the cleaning of the surface.

Heretofore vertically disposed surfaces have commonly been air blasted with crushed slag, sand and other abrasives as the abrasive in order to provide the desired cleaning action. Crushed slag abrasive, sand and other abrasive, however, are subject to considerable disintegration and hence no attempts are made for its recovery, and the abrasive is simply disposed of after a single use. Air blasting has several other disadvantages. For instance, the compressed air which is required is relatively expensive and contains significant amounts of moisture, and even condensed water, which tend to enhance reoxidation of treated surfaces before protective coatings can be applied. Additionally, air blasting equipment usually necessitates a crew of three men for the operation of a single

[Price 33p]

head; additional labour and equipment must be used to remove the abrasive and disposal of the large amounts of abrasive that is continuously being spent is an additional consideration. Furthermore, air blasting can be a health hazard due to the excessive amounts of dust created, and thus, protective means must be provided to maintain the safety of personnel in the area surrounding the air blasting operation.

As an alternative, it has been proposed to employ centrifugal blasting wheels to propel the particulate abrasive material. One system having a centrifugal blasting wheel is described in U.S. patent 3,566,543, issued to Fogel. The patentee discloses a blasting head comprising a housing, a centrifugal blasting wheel, an opening in the housing through which the particulate abrasive is projected onto the surface to be cleaned, and a pair of resilient sealing members extending continuously around the opening in the housing positioned so as to effect a seal between the surface to be treated and the housing. However, several disadvantages exist in the prior art device such as the necessity of replacement of the pair of resilient seals which are subject to wearing due to their contact with the surface undergoing cleaning, the extensive frame required to support and move the blast head which substantially reduces its portability, and the necessity of an operator to be positioned relatively close to the blast head and thus often expensive safety equipment must be incorporated into the blast head.

According to the present invention, apparatus for the treatment of an upwardly directed surface with particulate abrasive material, which is projected at high velocity against the surface, comprises an enclosure in the form of a housing having an opening in one wall; projecting means within the enclosure for propelling a

stream of particulate abrasive material through the opening in the enclosure; resilient sealing means located on the wall of the enclosure around the opening and being adapted to contact the surface to establish a sealing relationship between the surface and the enclosure; storage means for the particulate abrasive material, which storage means is adapted to supply the projecting means with the particulate abrasive material, and which has an inlet port communicating with the enclosure at an upper part thereof; exit port means in the upper portion of the enclosure for drawing air from the enclosure, the exit port means being so located that the air from the enclosure inlet port is drawn across the storage means to the exit port means; and recirculation means adapted to collect the propelled particulate abrasive material from a lower portion of the enclosure, to convey the collected particulate abrasive material to the upper portion of the enclosure, and to deliver the particulate abrasive material at a delivery zone into the storage means, the delivery zone being so located that the air from the inlet port, which is drawn across the storage means, is drawn across the delivery zone.

The invention will be more readily understood by way of example from the following description of apparatus in accordance therewith for the abrasive treatment of surfaces, reference being made to the accompanying drawings, in which

Figure 1 is a perspective view of the apparatus;

Figure 2 is a front elevational view with a break away section of the apparatus; and

Figure 3 is a schematic view of the apparatus in a suitable rigging for operation to treat a vertically disposed surface.

With reference to Figure 1, the apparatus, or blast head, is generally indicated at 10. The blast head 10 comprises an enclosure or housing 12 which defines a blast chamber having opening 14 through which particulate abrasive material is passed to contact the surface to be treated. Opening 14 also receives rebounding particles from the surface being treated and the scale, deposits or other material being removed from the surface. The shape of the opening may be of various configurations. Preferably, the opening is oblong, i.e. has an oval or rectangular shape, with the major axis of the opening parallel to the projecting means, for example a centrifugal throwing wheel, located in the housing and is more preferably at or near perpendicular to the desired direction of travel of the blast head. When, for example the apparatus is traveling in a horizontal direction, the major axis of the opening is vertical.

Means are provided to effect a sealing

relationship between the surface being treated and the housing. The sealing means is advantageously designed to abate the release of dust, scale or other deposits to the atmosphere at the point of contact with the surface and the loss of the particulate abrasive material from the housing. The sealing means is preferably sufficiently resilient to pass over obstructions present on the surface being treated and to allow sealing over a moderately curved surface which is sufficient to prevent release of dust or other material through gaps which would otherwise be formed. The sealing means can be constructed out of any suitable material such as natural rubbers, synthetic rubbers and other elastomeric materials. For instance, polyurethane elastomerics, butadiene rubbers and the like may be advantageously employed. The sealing means 16 is depicted as extending from the boundary of opening 14, although it may be located in any manner on the housing which would enable the desired result to be obtained. The sealing means can advantageously be of a design which enables its easy replacement on the housing. Beneficially, at least the lower portion of the sealing means, that is, the section of the sealing means which is positioned at the bottom of opening 14 during normal operation of the blasting head, projects angularly and outwardly from the housing in a direction toward the axis perpendicularly extending from the centre of the plane of the opening. The angular projection of the sealing means facilitates the passage of any material deposited thereon to the housing. Suitable sealing has been observed using a single resilient member for the sealing means.

The movement of the blast head over the surface to be treated is facilitated by castors 18 which are mounted on the housing. The castors are rotably mounted and are affixed to the housing by clamps 20. Clamps 20 permit the castors to be positioned either a greater or lesser distance from the housing, and the positioning of the castors can be done manually or remotely. Thus, the working compression upon sealing means 16 can easily be adjusted to provide a seal which is sufficient for the nature of the surface being treated. For example, a greater working compression will be necessary when treating a rough, irregular surface in order to abate the escape of dust and the like, whereas a relatively smooth surface may require a substantially lesser working compression on the sealing means. Additionally, the castors can be positioned to control the attitude of the apparatus. It is readily seen that by the use of castors, the use of a complex support frame means to

position the apparatus with respect to the surface being treated may not be required. Nor is continual readjustment of the castors necessary to provide a sufficient seal with the surface. The castors are shown as being laterally positioned on the housing. Other placements of the castors can be made; for instance, a set of three castors placed on the housing in a triangular configuration may be employed.

Shown in Figure 1 is a fan housing 22. While the fan means is depicted as being directly attached to the housing, the fan means may also be located more distant from the apparatus and employed with, for example, a flexible line, to provide the desired effect. The fan in fan housing 22 is designed to draw air in from the chamber formed by housing 12 via vacuum air line 24. The fan draws in air from the chamber which is laden with dust and fine particles resulting from the cleaning operation. The air and materials in association therewith are expelled from the fan to air exhaust duct 26. The fan is powered by a fan motor which is contained in fan motor housing 28 which is shown as attached to fan housing 22. The air fed to the chamber in housing 12 is desirably provided in association with the particulate abrasive material and is circulated in the chamber by the projecting means. Desirably, the projecting means forces air toward the surface being treated, the air being drawn upward under the influence of the fan means. The air serves to separate fines created by the treatment of the surface from heavier particles such as the particulate abrasive material and larger pieces of scale or deposit which is removed from the surface. Also, the circulation of air and its exhaust from the blast head prevents heat buildup in the abrasive and in the various components of the blast head assembly. The importance of this feature is readily understood when it is realized that large amounts of heat are generated by the impact of the abrasive against the surface to be treated. Thus, by the circulation of air it becomes possible to operate the apparatus continuously over relatively long periods of time with little, if any, heat buildup in the particulate abrasive material.

If desired, the air exhausted from the blast head via exhaust duct 26 can be transmitted to a conventional dust collector (not shown) for removal of the particulate contaminants in the air. The dust collector can be separate from the blast head and, in that case, the communication means between exhaust duct 26 and the dust collector is preferably flexible and allows movement of the blast head over the surface being treated. On the other hand, the

dust collector may be affixed securely to the housing of the blast head. The release of dust and the like from between the sealing means and the surface being treated can, in part, be abated by operating the apparatus so as to maintain subatmosphere pressure, i.e., a pressure lower than ambient, in the chamber. Then, if any gap occurs between the sealing means and the surface being treated by reason of, for example, an irregularity on the surface being treated, the atmospheric air, being at the higher pressure, will be drawn into the chamber at the point of the gap and carry with it material which might otherwise escape to the surroundings.

Projection means motor housing 30 is affixed to housing 12. Also shown in Figure 1 is elevator motor housing 32. The elevator motor therein powers a conveyor means which returns the discharged particulate abrasive material to the projecting means to be reused. A motor to propel the blast head in a horizontal direction is provided in drive motor housing 34. The motor is used to drive horizontal track engaging means 36. The horizontal track engaging means is designed to provide a friction contact or other essentially non-slipping contact with a horizontal track means and thereby to propel the blast head. The horizontal track means can be, for example, a cable, rigid or flexible track, chain or other suitable device. One particularly advantageous means of providing frictional contact of the engaging means 36 to, for example, a cable is to provide a freely rotatable pulley on the opposing side of the cable from the engaging means. The freely rotatable pulley can then be drawn towards the engaging means by, for example, a tension spring, pneumatic or hydraulic means, or other suitable means to force the cable into contact with the engaging means to provide the desired, frictional contact. Desirably, the horizontal track means is relatively flexible and positioned such that the track means is bowed with an apex at the engaging means or adjacent to the engaging means. When, for instance, a cable is employed as the track means, friction suitable for traction can be achieved by providing a pulley means which can be activated in a direction essentially perpendicular to the surface being cleaned to engage the cable and increase the tension in the cable. Suitable activation means are, for instance, a pneumatic or hydraulic cylinder. Beneficially, the pulley and the engaging means can be cable sheaves, each with three grooves. The cable can be threaded on the side furthest from the surface being treated of one sheave, across to and around the second sheave and back to and around the first sheave and across over the last groove

of the second sheave. By increasing the distance, in any desirable direction, between the pulley and engaging means, the tension in the cable can be increased.

- 5 Winch means 38 are provided on both sides of the housing 12 and preferably extend perpendicularly therefrom. The winch means are adapted for engaging a vertically support means, which can be, for example, 10 a flexible cable, whereby the vertical support means can be wound on the winch means to elevate the blast head. The winch means are preferably interconnected by a rigid shaft means and are powered by a 15 hoist drive means. Desirably, a hoist drive means employed to activate the winch means is provided with a self-braking gear drive. The vertically disposed cable can be supported by a frame means having pulley 20 means thereon, the cable being attached to housing 12, passed over the pulley means on the frame and back to winch means 38.

- Figure 2 depicts the apparatus of Figure 1 in a front-elevational view with a break 25 away section to permit viewing of chamber 40 which is enclosed by housing or enclosure 12 and a further break away to permit viewing of the supply means to supply particulate abrasive material to the 30 projecting means. Projecting means 42 is represented as a centrifugal throwing wheel driven by a centrifugal throwing wheel motor in housing 30. A drive means 44 can be employed to transmit the power 35 from the motor to projecting means 42. Projection means 42 can be of a conventional centrifugal throwing wheel which can be commercially obtained such as the type manufactured and sold by The 40 Wheelabrator Corporation and described in U.S. Patents Numbers 2,708,814 and 2,819,562 or as the type manufactured and sold by the Pangborn Corporation, a division of the Carborundum Company. In 45 general, the wheels of The Wheelabrator Corporation comprise a plurality of radially extending blades 43 arranged in circumferentially spaced apart relation between confining disc plates. The particulate 50 abrasive material, which can be metallic particles, for example, steel shot, steel grit, crushed iron, chilled iron grit, glass beads, aluminum oxide particles, silica or the like, can be fed into the inner ends of the 55 blades, and the particulate abrasive material is shown centrifugally at high velocity from the outer ends of the blades since the wheel is rotated at high speed about its axis, typically at about 1000 to 60 4000 rpm. The particulate abrasive material is thrown forward by and through opening 14 into engagement with the surface being treated. The abrasive may contact the surface at a slight angle to per- 65 pendicular in order to improve the cleaning

action.

The particulate abrasive material is stored in storage means 46. Storage means 46 is provided with abrasive material transfer means 48 to supply the abrasive 70 material to projecting means 42. As depicted, the abrasive material transfer means is located outside of the housing and communicates with the storage means 46 which is depicted as in the interior of 75 the housing. The abrasive particles flow by gravity through abrasive material transfer means, shown as a conduit, to a charging means 50 which is shown as a funnel having the large opening at the top and which is 80 curved in a manner to provide release of the particulate abrasive material to the centre, for example, of the centrifugal throwing wheel. Desirably, the top of the funnel surrounds the lower end abrasive 85 material transfer means 48 and provides a gap sufficient to allow passage of air into the funnel but yet is preferably designed such that the particulate abrasive material does not escape. The centrifugal throwing 90 wheel can simultaneously perform as a centrifugal air fan. Thus, during operation, the low pressure area which exists at the centre of the throwing wheel can be employed as a motivational force to draw in 95 air through the gap formed at the top of the funnel. Additionally, the presence of air being drawn into the centre of the throwing wheel assists the flow of particulate abrasive materials into the throwing wheel. 100 The air exhausted by the centrifugal throwing wheel can circulate within the chamber of the housing and desirably flow through the particulate abrasive material after impinging upon the surface being 105 treated so as to wash the abrasive material and remove fine particles such as dust and the like. The abrasive material supply means may be provided with a valve means or motive means to control or 110 facilitate flow of the particulate abrasive material to the projecting means.

The particulate abrasive material, after impinging upon the surface being treated, 115 falls by the force of gravity to the bottom of the chamber formed by housing 12. The spent abrasive material is picked up by particulate abrasive conveyor means 52 to be recycled to the projecting means 42. 120 Conveyor means 52 is depicted as an endless belt running in a clockwise direction on a loop around the inside of housing 12; however, other elevator means might be used such as pneumatic lift devices and other conventional mechanical elevators. 125 The endless belt may employ scoops or bucket means attached thereto at various intervals. When operating, the scoop or bucket means is empty on the vertical downpath of the continuous loop. As the 130

belt passes horizontally through the lower portion of the housing, the scoop itself can be in a vertical collecting position. Continuing its course on the vertical up path, the scoop or bucket means contains the abrasive material. Upon reaching the top of the vertical up path which is preferably located in the upper portion of the housing, the scoop or bucket passes horizontally across the top, itself in a vertical dumping position. The conveyor means, in this delivery zone, releases the particulate abrasive material to the storage means. The scoops or bucket means are preferably below the belt during the lower horizontal pick up flight, and hence, are above the belt during the upper horizontal dumping flight. The scoop or bucket means is essentially free from contact which may result in friction caused wear. Additionally, by employing a conveyor belt having the scoop or bucket means, less power is required for its operation than, for example, a pneumatic elevator. The scoop or bucket means can be designed so that a high percentage of the particulate abrasive material, often in the neighbourhood of 95% or more falls into storage means 46.

The continuous belt can be a V-belt made of sturdy, flexible material such as synthetic resins or natural rubber. The continuous belt can contact pulleys 54 located at three corners of housing 12 and power pulley 56 in the remaining corner and thus form the configuration of the continuous loop. Rather than a V-belt and pulley system, the conveyor means may comprise, for example, a chain and sprocket system wherein the pulleys are replaced by sprockets. Power pulley 56 is depicted as engaging with conveyor means 52 in order to move the conveyor means in a clockwise direction. Power pulley 56 is driven by elevator motor in housing 32. The elevator motor may be attached to suitable drive means to transmit the power to power pulley 56. An abrasive collector means may optionally be provided in the lower portion of housing 12 to assist the recovery of the particulate abrasive material. The abrasive collector means may be, for instance, a hopper which is adapted to localize the particulate abrasive material to facilitate its pick up by the conveyor means.

The particulate abrasive material drops from conveyor means into storage means 46. Air which is drawn from chamber 40 to the fan means in fan housing 22 exits the chamber by exit port means (not shown) which is in communication with the fan by means of vacuum air line 24 and which is located on housing 12 behind the upper horizontal path of conveyor means 52. The air circulation in chamber 40 can

be approximately as follows. Air enters centrifugal throwing wheel 42 and is circulated in a direction towards the surface being treated. The air can serve to wash the particulate abrasive material of fine particulate matter generated due to the action of the abrasive material on the surface. Also, the forced air may serve to dislodge particles on the surface that are not removed by the impact of the particulate abrasive material. The air, carrying with it dust and other fine particulate materials generated in the course of the treatment of the surface, is then swept upwards and enters the storage hopper 46 through an inlet port 57, which is in an upper part of the chamber 40 and is shown as being on storage hopper 46. Due to the location of the exit port, which is not illustrated since it is on the upper part of the housing 40 and to the rear of the inlet port 57, the air passes around the conveyor means. The proximity of the exit port to the horizontal path of conveyor means allows the maintenance of relatively high air velocities past the conveyor means at the delivery zone of the conveyor means. These higher air velocities can beneficially be employed to separate particles of a lower specific gravity which are transported by the conveyor, from the particulate abrasive material. For instance, when steel shot or the like is used as the particulate abrasive material, relatively large particles, such as rust or paint, which are not washed from the particulate abrasive material by the air circulated by the centrifugal wheel, may be carried by conveyor means 52 with the steel shot to be returned to storage means 46. The velocity of air sweeping across the delivery means may, however, be sufficient to remove the relatively large particles of lower specific gravity before they enter storage means 46 and essentially evacuate the lower density particles from chamber 40. The laden air can be exhausted from the system via the fan and exhaust port 26. Particles which may not be removed from the steel shot are normally sufficiently fragile that upon being propelled by centrifugal throwing wheel 42 and impacting upon the surface being treated, they disintegrate to a particle size which can be readily removed from the system.

A valve means can be provided in connection with the exit port means to adjust the rate of air withdrawal from chamber 40 through vacuum line 24, and hence, the velocity of air over conveyor means 52 at the delivery zone. An additional vacuum line may communicate from the fan means to the housing and be adapted to sweep air from other portions of the enclosure.

Motor housing 58 contains a hoist motor to actuate winch means 38 to provide

means for moving the blast head vertically. The motor is preferably attached to a drive means to power shaft 60 which is connected to winch means 38. As stated previously, the drive means for winch means 38 is desirably self-braking.

Figure 3 illustrates the apparatus in connection with a suitable rigging means for transporting the apparatus over the surface being treated. In particular, the surface 10 being treated is indicated as 62 and has thereon a deposit or scale represented by the shaded area. The blast head 10 is positioned upon surface 62 in such a manner that the sealing means contacts the surface to provide a relatively air tight seal. In actual operation, the seal of the sealing means with the surface will be broken by, for example, abrupt protrusions or indentations on the surface and thus surrounding air will be drawn into the chamber. Castors 18 contact surface 62 and serve to position the blast head a desired distance away from the surface so as to enable the sealing means to contact the surface properly.

The apparatus is vertically supported by vertical support frame means 64. Frame means 64 is depicted as comprising a plurality of support members 66 adapted to support themselves and the blast head when positioned at the upper edge of the surface. The frame means can preferably run along track means 67 which is located adjacent to the upper edge of the surface. Desirably, the track means provides support for the frame means for vertical forces, e.g., to counteract gravity, and for a lateral force in a direction perpendicular and away from the surface. Castor means 68 are provided on the frame means and contact the front of the surface and reduce friction of movement of the frame means over the surface. Thus, the frame means will be in equilibrium by its contact with the track means and the front of the surface and is adapted to move freely along the edge of the surface. Pulley means 70 are shown as affixed to the upper lateral support members of frame means 64 and are adapted to receive vertical support means 72. The vertical support means attach to housing 12 at attachment means 74 pass over pulley means 70 and attach to winch means 38. By drawing more of vertical support means 72 onto winch means 38, the blast head can move in an upwardly direction, and, by releasing a length of vertical support means 72, the blast head can be lowered. Preferably, frame supports means 64 is designed to enable passage of the blast head at least partially into its interior. By locating pulley means 70 to the interior of frame means 64, it is possible to raise the blast head to a position to enable

the sealing means to reach or surpass the upper edge of the surface.

The track means on which frame means 64 rides may be a rail or groove in which wheel means 75, or the like, affixed to frame means can engage. If a rail is employed, the wheel means are preferably designed such that vertical forces and lateral forces developed by the frame means are counteracted by contact of the wheel means and the track means. The rail can be rigid or somewhat flexible. The track means may be permanently secured or may be detachable. Affixing means operable are, for example, vacuum cups, magnets, clamps, or other fastening devices.

Attached to the surface being treated on opposing sides of the blast head are horizontal track securing means 76. The securing means may be permanently attached to the surface being treated or may be detachable. Attachment means include vacuum cups, magnets, clamps and the like. Securing means 76 can be in the form of a grooved track wherein the point of attachment of horizontal track means can be quickly adjusted to the desired height, either manually or remotely, and even automatically. Since the blast head traverses horizontal track means, 78, it is often advantageous to maintain about equal the distances from the top edge of the surface to the points at which the track means is secured to the respective securing means 76. Thus, for a given vertical position of the blast head, a horizontal pass may be made, and minimal, if any, concurrent readjustment of the vertical position need be made. The blast head pulls itself along the horizontal track means by engaging means 36 which is driven by a horizontal drive motor contained in housing 34. Normally, to effect engagement of engaging means 36 with the track means to provide necessary frictional contacts, a tensioning means is provided on the blast head. However, the tension of the track means against the engaging means may be increased by shortening the length of track means between the securing means. This can be done by providing, for instance, a winch means on one of the securing means. The track means may also be provided with a turnbuckle means for decreasing its length.

In the operation of an apparatus of the type depicted in the drawings, the frame means 64 is at the upper edge of the surface to be treated and above the blast head. The vertical support means 72 is attached to the blast head housing, passed over pulley means 70 and attached to winch means 38. The winch means is activated and the blast head is

elevated to the desired position. Horizontal track means is then affixed to securing means 76 so that it is equidistant from the top edge of the surface and contacts engaging means 36. The horizontal drive motor can be activated to move the blasting head horizontally across the surface. Upon starting the projection means and conveyor means, the treatment of the surface commences. The control of the apparatus can be operated remotely, and thus the operator need not be closely positioned to the blast head. After a horizontal pass, the horizontal track means can be released from engaging means 36, and the blast head can be raised or lowered to place it in position for additional passes over the surface. The horizontal track means can be repositioned to engage with the blast head and operation can continue.

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While the description of the apparatus has been in terms of travel in a horizontal direction, it is apparent that the apparatus is not limited to such horizontal operation.

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- For example, the opening in one side of the enclosure may have its major axis essentially horizontal. Vertical drive can be effected by actuating the winch means. The horizontal drive track is no longer needed and the blast head is held against the surface being treated by a vertical tension which is additional to the vertical drive and which extends from a point above the apparatus to a point below the apparatus. The vertical tension line contacts a freely rotatable pulley located on the housing in a manner which enables the tension line to force the apparatus into contact with the surface being treated.

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- While the apparatus is intended to be used primarily with vertical surfaces, it may be used on surfaces which are moderately inclined to the vertical provided that the angle to the vertical is not so great as to impair the performance of the abrasive recirculation means.

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- The equipment described provides a portable, continuously operable surface treating apparatus for the cleaning of vertically disposed surfaces. The novel apparatus is economical to manufacture and simply constructed yet sturdy and durable upon extended use and operates with relative freedom from wear. Furthermore, the operation of the apparatus requires minimal expense in labour and operating costs. A highly efficient means is provided to prevent loss of particulate abrasive materials and for the isolation of the particulate abrasive materials for recycling. Also, means are provided for removal of dust and grit from the surface undergoing cleaning. Hence, this invention can operate with almost complete elimination of the passage of grit and dust to the atmosphere and

thus can provide a highly acceptable reduction in pollution normally attendant in the use of conventional surface treating apparatus.

Importantly, the highly portable nature of the apparatus allows the apparatus to be used without concern to geographic location of the vertically disposed surface to be treated. The apparatus may be employed over rough terrain, water, oil, etc. Without the necessity to provide support for a frame external from the surface being treated. An extensive frame is not required for its operation. Thus, the apparatus may be set up for operation quickly and easily and its use is not prohibited or restricted by the terrain surrounding the vertically disposed surface to be treated. The apparatus is adapted for uniform coverage of surfaces of variable or changing contour, e.g. vertical curvature as well as horizontal curvature. The apparatus can be operated remotely, adding greater safety to its operation.

The apparatus is generally easily adaptable to numerous uses and is thus broadly practical and salable. For instance, the apparatus may be used to clean the outer side walls of a ship's hull, large conservation tanks for water, gas petroleum or other fluids or solids, walls, exteriors of buildings and the like. The material treated may be metal, concrete or other material where abrasive cleaning may be desired.

WHAT I CLAIM IS:—

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1. Apparatus for the treatment of an upwardly directed surface with particulate abrasive material which is projected at high velocity against the surface, the apparatus comprising an enclosure in the form of a housing having an opening in one wall; projecting means within the enclosure for propelling a stream of particulate abrasive material through the opening in the enclosure; resilient sealing means located on the wall of the enclosure around the opening and being adapted to contact the surface to establish a sealing relationship between the surface and the enclosure; storage means for the particulate abrasive material, which storage means is adapted to supply the projecting means with the particulate abrasive material, and which has an inlet port communicating with the enclosure at an upper part thereof; exit port means in the upper portion of the enclosure for drawing air from the enclosure, the exit port means being so located that the air from the inlet port is drawn across the storage means to the exit port means; and recirculation means adapted to collect the propelled particulate abrasive material from a lower portion of the enclosure, to convey the collected particulate abrasive material

elevated to the desired position. Horizontal track means is then affixed to securing means 76 so that it is equidistant from the top edge of the surface and contacts engaging means 36. The horizontal drive motor can be activated to move the blasting head horizontally across the surface. Upon starting the projection means and conveyor means, the treatment of the surface commences. The control of the apparatus can be operated remotely, and thus the operator need not be closely positioned to the blast head. After a horizontal pass, the horizontal track means can be released from engaging means 36, and the blast head can be raised or lowered to place it in position for additional passes over the surface. The horizontal track means can be repositioned to engage with the blast head and operation can continue.

While the description of the apparatus has been in terms of travel in a horizontal direction, it is apparent that the apparatus is not limited to such horizontal operation. For example, the opening in one side of the enclosure may have its major axis essentially horizontal. Vertical drive can be effected by actuating the winch means. The horizontal drive track is no longer needed and the blast head is held against the surface being treated by a vertical tension which is additional to the vertical drive and which extends from a point above the apparatus to a point below the apparatus. The vertical tension line contacts a freely rotatable pulley located on the housing in a manner which enables the tension line to force the apparatus into contact with the surface being treated.

While the apparatus is intended to be used primarily with vertical surfaces, it may be used on surfaces which are moderately inclined to the vertical provided that the angle to the vertical is not so great as to impair the performance of the abrasive recirculation means. The equipment described provides a portable, continuously operable surface treating apparatus for the cleaning of vertically disposed surfaces. The novel apparatus is economical to manufacture and simply constructed yet sturdy and durable upon extended use and operates with relative freedom from wear. Furthermore, the operation of the apparatus requires minimal expense in labour and operating costs. A highly efficient means is provided to prevent loss of particulate abrasive materials and for the isolation of the particulate abrasive materials for recycling. Also, means are provided for removal of dust and grit from the surface undergoing cleaning. Hence, this invention can operate with almost complete elimination of the passage of grit and dust to the atmosphere and

thus can provide a highly acceptable reduction in pollution normally attendant in the use of conventional surface treating apparatus.

Importantly, the highly portable nature of the apparatus allows the apparatus to be used without concern to geographic location of the vertically disposed surface to be treated. The apparatus may be employed over rough terrain, water, oil, etc. Without the necessity to provide support for a frame external from the surface being treated. An extensive frame is not required for its operation. Thus, the apparatus may be set up for operation quickly and easily and its use is not prohibited or restricted by the terrain surrounding the vertically disposed surface to be treated. The apparatus is adapted for uniform coverage of surfaces of variable or changing contour, e.g. vertical curvature as well as horizontal curvature. The apparatus can be operated remotely, adding greater safety to its operation.

The apparatus is generally easily adaptable to numerous uses and is thus broadly practical and salable. For instance, the apparatus may be used to clean the outer side walls of a ship's hull, large conservation tanks for water, gas petroleum or other fluids or solids, walls, exteriors of buildings and the like. The material treated may be metal, concrete or other material where abrasive cleaning may be desired.

WHAT I CLAIM IS:—

1. Apparatus for the treatment of an upwardly directed surface with particulate abrasive material which is projected at high velocity against the surface, the apparatus comprising an enclosure in the form of a housing having an opening in one wall; projecting means within the enclosure for propelling a stream of particulate abrasive material through the opening in the enclosure; resilient sealing means located on the wall of the enclosure around the opening and being adapted to contact the surface to establish a sealing relationship between the surface and the enclosure; storage means for the particulate abrasive material, which storage means is adapted to supply the projecting means with the particulate abrasive material, and which has an inlet port communicating with the enclosure at an upper part thereof; exit port means in the upper portion of the enclosure for drawing air from the enclosure, the exit port means being so located that the air from the inlet port is drawn across the storage means to the exit port means; and recirculation means adapted to collect the propelled particulate abrasive material from a lower portion of the enclosure, to convey the collected particulate abrasive material



at a delivery zone into the storage means, the delivery zone being so located that the air from the inlet port which is drawn across the storage means, is drawn across the delivery zone.

2. Apparatus for the treatment of an upwardly directed surface with particulate abrasive material which is projected at high velocity against the surface, the apparatus comprising an enclosure in the form of a housing having an opening in one wall; projecting means within the enclosure for propelling a stream of particulate abrasive material through the opening in the enclosure; resilient sealing means located on the wall of the enclosure around the opening and being adapted to contact the surface to establish a sealing relationship between the surface and the enclosure; storage means which is adapted to supply the projecting means with the particulate abrasive material, and which has an inlet port communicating with the enclosure in an upper part thereof; exit port means located above the storage means and disposed in the wall of the enclosure, for drawing air from the enclosure; and recirculation means adapted to collect the propelled particulate abrasive material from a lower portion of the enclosure, to convey the collected particulate abrasive material to the upper portion of the enclosure, and to deliver the particulate abrasive material at a delivery zone into the storage means, the delivery zone being so located that the air which is drawn across the storage means to the exit port means is drawn across the delivery zone.

3. Treatment apparatus according to claim 1 or claim 2, wherein the projecting means is a centrifugal throwing wheel which is adapted to force circulation of air through the opening in the enclosure and towards the surface to be treated.

4. Treatment apparatus according to any one of the preceding claims, which is

self propelled and includes therein hoisting means to propel the apparatus in a vertical direction.

5. Treatment apparatus according to claim 4, which further includes horizontal drive means to propel the apparatus in a horizontal direction.

6. Treatment apparatus according to any one of the preceding claims, wherein the opening in the enclosure is oblong and has a major axis which extends vertically and wherein the apparatus moves in a horizontal direction during treatment of the surface.

7. Treatment apparatus according to any one of the preceding claims, wherein the resilient sealing means is a single resilient member extending outwardly from the enclosure.

8. Treatment apparatus according to any one of the preceding claims, wherein the exit port means is in communication with fan means located on the housing.

9. Treatment apparatus according to claim 8, wherein the fan means is a centrifugal fan.

10. Treatment apparatus according to any one of the preceding claims, wherein the recirculation means is a conveyor means comprising an endless belt having attached thereon at intervals, scoop or bucket means which are adapted to collect the particulate abrasive material and deliver that material to the storage means.

11. Apparatus for the treatment of an upwardly directed surface with particulate abrasive material which is projected at high velocity against the surface, substantially as herein described with reference to the accompanying drawings.

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