July 6, 1965 W. L. JOHNSON ETAL 3,192,677

ABRASIVE IMPINGEMENT CLEANING PROCESS

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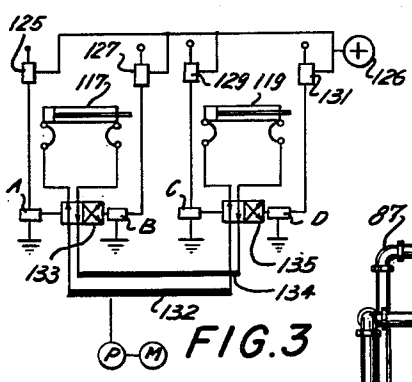


FIG. 3

FIG. 1

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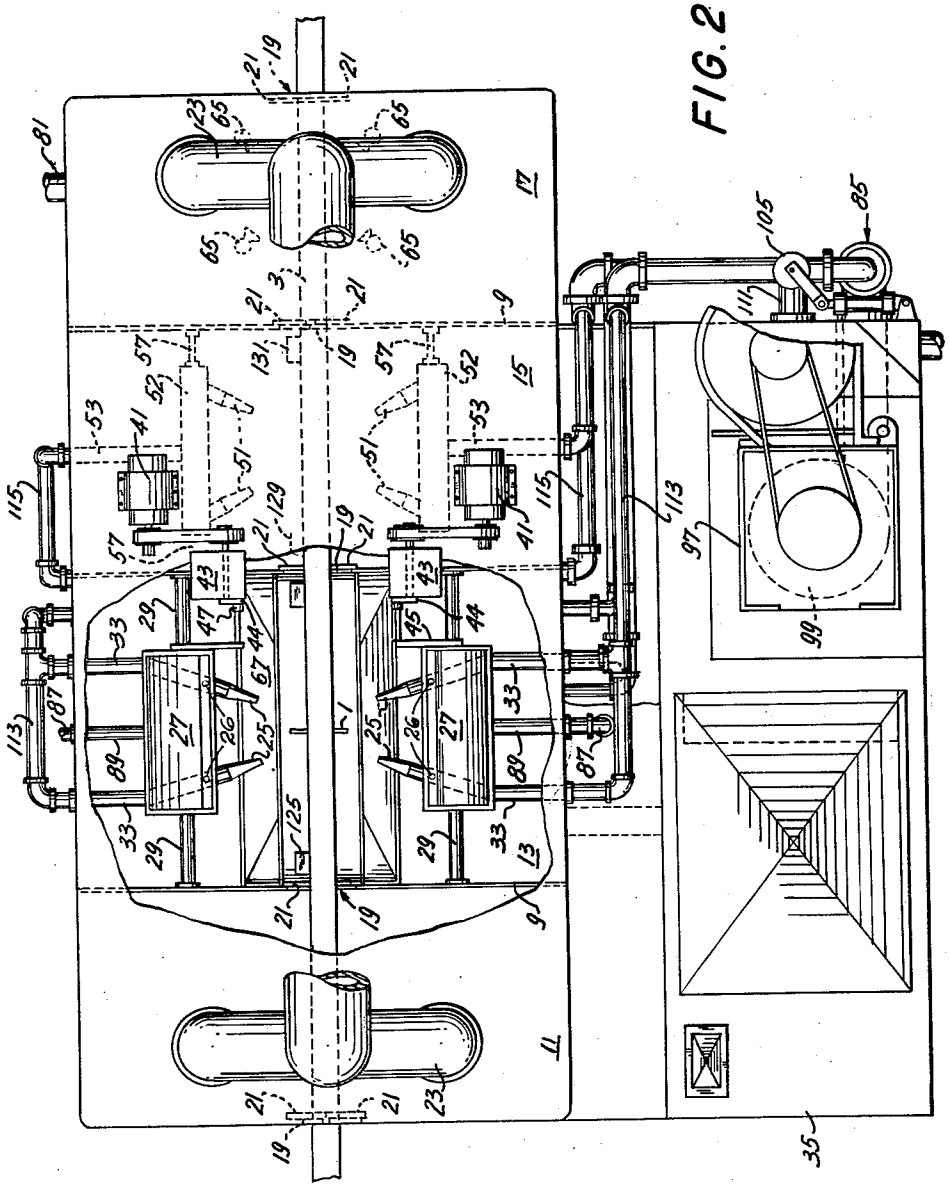
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FIG. 2



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United States Patent Office 3,192,677 Patented July 6, 1965

3,192,677

ABRASIVE IMPINGEMENT CLEANING PROCESS

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Filed Nov. 13, 1961, Ser. No. 152,379
8 Claims. (Cl. 51—321)

This invention relates to new and useful surface cleaning methods and, more particularly, to methods for removing paint or other stubborn coatings or accumulations from equipment or metal parts exposed to paint sprays or other materials which tend to accumulate thereon.

In modern production practices, parts to be processed are generally carried on hooks or other holders along an endless conveyor through a sequence of operations, often including, for example, painting, e.g., by dipping or spraying, of the parts. Whether the painting operation is effected by hand spraying, electrostatic spraying or by dipping or other methods, the parts carriers also receive a significant deposit of paint along with the part. On repeated trips through the painting operations, therefore, layers of paint are superposed on the parts carrier each of which, on drying, produces an adhering rigid coat or encrustation. Eventually, these build up an accumulation so thick as to prevent proper mounting and carrying of the parts to be painted. This build-up is particularly critical where spring clamps or other tension members are utilized in the parts carrier, as the paint accumulations may seriously impair the operation of such members.

Accordingly, it has been necessary regularly to shut down to strip the hardened paint from the parts carriers. Methods and apparatus heretofore employed for these purposes generally require the removal of the parts carriers from the conveyor system and this is made difficult by the accumulations of paint. Even at best such dismantling of the conveyor is highly objectionably due to the costly manual effort involved and also to the cost of shut-down of the conveyor system and consequent curtailment of production until the cleaned or substitute parts carriers can be put back into service.

In addition, the stripping of the paint accumulations very often has required treatments which create nuisance or health hazards for the workmen handling the parts. For example, hot caustic solutions have been used to loosen the dried paint, or volatile solvents and combinations of solvents, with inevitable, obnoxious odors and often toxic fumes may result, creating air pollution problems. Also there may be danger of fire from volatile solvents or from heat methods of loosening the paint accumulations.

Accordingly, an object of this invention is to provide for the safe and effective removal of paints or other stubborn coatings from a metal base surface.

Another object of this invention is to effect such removal of paint or other stubborn coatings from the surface of parts carriers and the like and/or parts thereon as they are carried along a conveyor system, without shut down.

Another object of this invention is to provide for the cleaning of paints or other stubborn coatings from a metal base surface without use of dangerous chemicals, noxious or objectionably odorous, or heat which could present a fire hazard and at best creates an odor or smoke nuisance.

In accordance with this invention we subject a "painted" parts carrier to an abrasive impingement process while it is carried along the conveyor system subsequent to the removal of the fully-treated part therefrom. Accordingly, each hardened deposit of paint on the parts carriers is stripped on each completed passage of the conveyor system, thus we avoid accumulations of a "build-up" of paint on the conveyor parts exposed thereto.

This abrasive cleaning is achieved by a grit blasting in accordance with another aspect of this invention by impinging grit particles entrained in converging, high velocity liquid streams upon the successive surfaces, e.g. of parts carriers as they progress along the impingement processing area. The grit used is, of course, abrasive to the coating to be removed but advantageously is not such as to abrade substantially the part from which the coat is being removed. To this end, short bits of cut wire have been used successfully with the metal of the wire of about the same order of hardness as said part. Harder, crystalline grains may have to be used to remove very resistant coatings and the pressure of the blast can be controlled so as to avoid damaging the parts by regulating the valve in pipe 115. Other kinds of blast grit may be used i.e., shot, crushed and graded iron grit, cut wire or crystalline grains, dependent upon the nature of the surface being treated and the finish required. It may not only remove paint but may leave the surface in a particular condition desired for a subsequent treatment (e.g., painting or electroplating, etc.). In general the grit should not be so hard as to seriously damage the part, nor so brittle as to shatter completely in the blasting operation. Very hard abrasives, such as corrundum, alundum, flint, etc., can be used, but may tend to abrade away metal from parts which should be preserved.

Moreover, these converging liquid grit blasts are advantageously oscillated transverse to the progression path of the parts carriers, so as to sweep over the entire surface of the parts carrier. These high velocity abrasive streams effectively cut and peel the paint and bare the surface of the parts carrier. Thereafter, the parts carriers are thoroughly washed to remove traces of these paint and grit materials and any other surface contaminants which might make trouble in subsequent painting.

The operating cost of the apparatus of this invention is substantially reduced by reclaiming the abrasive particles and blasting liquid for reuse in the process. This is described and claimed in prior applications.

At the same time, dirt, abrasive particles unsuitable for further reuse and bits of scale or paint or other material removed from the parts being treated are washed away and discarded or diverted to other uses.

A preferred embodiment of this invention is hereinafter shown and described. However, it is to be understood that this is not intended to be exhaustive of this invention but, rather, are given as illustrative and to instruct those skilled in the art to enable them to modify and adapt such embodiments of the invention to suit conditions of each particular use.

In the drawings:

FIGURE 1 is an end view, somewhat schematic, partly broken away and partly in cross-section, with exposed parts in elevation, showing a surface cleaning apparatus in accordance with this invention.

FIGURE 2 is a plan view, of the same partly in phantom and partly broken away, again somewhat schematic, of the same apparatus as in FIGURE 1; and

FIGURE 3 is a schematic representation of an automatic control circuit, both electrical and hydraulic, for the surface cleaning apparatus of FIGURES 1 and 2.

The apparatus of FIGURES 1 and 2 is located between those stages along a conveyor system where a fully painted part, not shown, is unloaded from, and a part to be painted is loaded, onto parts carrier 1.

These carriers 1 are secured on endless conveyor chains

and provided with wheels 5 running on the flanges of a rail 3.

The parts being painted come along the monorail 3 from a painting apparatus through a discharge station, where the painted parts are removed and then on into a treating chamber 7 wherein the abrasive impingement and washing processes are effected.

The treating housing 7 includes a number of tandem compartments effectively separated by partitions 9. The first compartment 11 is a vestibule. The next 13 is the abrasive impingement or blasting chamber. A flush chamber 15 follows and then a second vestibule 17.

Each parts carrier 1, after removal of a painted part therefrom, passes into and between these sections through slots 19 cut in the walls of chamber 7 and partitions 9, respectively. To more effectively separate these compartments, a pair of flexible strips 21, for example, of rubber or neoprene, are positioned as flap doors to seal slots 19, respectively. Monorail 3 and conveyor wheels 5 etc. are incased likewise from the abrasive blasting chamber 7 by baffles 22 provided along their adjacent edges with flexible strips 24, respectively. The strips 21 and 24 are sufficiently flexible to allow the parts carriers 1 to pass into and along the above defined sections and sufficiently stiff and resilient to keep the opening closed between the carriers. Thus, strips 21 and 24 substantially prevent contamination of one stage from the next and of the surroundings of the apparatus.

The vestibules 11 and 17, wherein no active treating of the parts carriers 1 is effected, are continuously exhausted through the ducts 23 by an exhaust pump, not shown, so as positively to eliminate any spray or other contaminants which may escape from the treating compartments of chamber 7.

When a parts carrier 1 has passed through the first vestibule 11 and entered into the blasing section 13, it passes between oppositely disposed pairs of blast tubes 25. Both blast tubes 25 of each pair are shown mounted in the same horizontal plane at about the same height and converging toward a target area through which the parts carriers 1 pass; but during operation the tubes rock so as to blast a broader scope; and, depending on the shape of the parts carrier, it may be advantageous to have the respective tubes at different heights.

As best shown in FIGURE 1, blast tubes 25 are connected by flexible hoses 33, respectively, to a liquid conduit 115. The liquid supply system of which conduit 115 is a part, forcefully directs a liquid, e.g., clear water or a washing solution, from clarification tank 25 of the apparatus through hoses 33 from which it is ejected as a high velocity jet into the blast tubes 25 just behind the grit feed holes 26.

Abrasive particles to effect the actual cutting and stripping of the hardened paint are fed through holes 26 from grit hoppers 27 and entrained by the high velocity liquid jets in the blast tubes 25. Each hopper 27 contains a slurry of abrasive particles which is continuously replenished, as hereinafter described. The resulting abrasive cutting blasts when directed onto the surface of parts carrier 1, quickly and effectively cut and loosen the hardened paint thereon.

To positively insure a cutting and loosening of the paint along the entire transverse dimension or length of the parts carrier 1, each hopper 27 is mounted and rocked on shafts 29, respectively, journaled in partition members 9.

The hoppers 27 are rocked by electric motors 41. Each motor, through a gear reducer 43, drives an eccentric 44 (FIGURE 2), connected to a hopper rocker arm 45 by a link 47. Each link 47 passes through a roof port 49 in chamber 7. A membrane type gasket 50 is positioned in each roof port 49 to allow vertical travel of the links 47 while effectively sealing the blasting chamber 13.

As each parts carrier 1 passes along the blasting chamber 13, it is simultaneously subjected to a multiplicity of converging, high velocity, abrasive blasts from blast tubes 25. As the hoppers 27 are rocked, these converging streams continually sweep back and forth over the surfaces of the parts carrier 1 to cut and remove the paint therefrom.

After the parts carrier 1 has been subjected to this abrasive blasting, it is moved on along the flush section 15 and between oppositely-disposed pairs of nozzles 51. See FIGURE 2. Thus, the parts carriers 1 are subjected to a thorough washing by the high velocity liquid jets from nozzles 51 to remove both loosened paint, scale, etc., and also abrasive particles and other surface contaminants.

The pairs of nozzles 51 are supported on and communicate with the pressure chambers or manifolds 52. Each manifold 52 is connected to a flexible hose 53 and by it to the liquid conduit system 85 beyond the wall of treating chamber 7. The nozzles 51, like the blast tubes 25, are supported in a horizontal plane near the central exposed portion of the parts carriers 1, and converge on an area of the progression path of the parts carriers 1 through the flush section 15. Also, the liquid manifolds 52 are pivotally mounted on shafts 57, respectively, journaled in the partition members 9 so as to be rocked by an arrangement, like that described above with respect to hoppers 27.

Each parts carrier 1 continues its travel along the monorail 3 into and through the second vestibule 17, and along the conveyor system to receive the next part to be painted. If desired, apparatus may be positioned in the second vestibule 17 to effectively dry off the parts carrier 1 prior to receiving the next part. For example, such apparatus may comprise a number of converging blow-off jets 65 disposed in the vestibule 17 to direct blasts of heated air onto parts carrier 1 advantageously from the loading station where parts to be painted are placed on the carriers 1.

The purpose of the vestibules 11 and 17 is now made apparent. As the abrasive cutting and washing streams in the blasting section 13 and flush section 15, respectively, impinge with very high velocity onto the surfaces of the parts carrier 1, a substantial amount of liquid solution is atomized and deflected along with abrasive particles within each of the blasting chambers. The partition and the pairs of strips 21 supported thereon as well as the strips 24 and gaskets 50 in the roof of chamber 7 confine these liquid and solid particles. Any small portion of these by-products which does escape into the vestibules 11 and 17, respectively, is confined and exhausted through ducts 23, as hereinabove indicated. Accordingly, there is virtually no loss from the treating chamber 7 to contaminate the surroundings of the apparatus.

All the blasting and washing liquids, abrasive or "grit," or pieces of removel paint, etc., from the blasting chambers 13 and flushing chambers 15 are collected in a hopper 67 as drainback and flow on downwardly within sectional conduit 69 to a classifying sump 71 having a weir edge 73. See FIGURE 1.

The conduit 69 extends below the weir level of the sump 71 to minimize turbulence of the surface liquid along the weir edge 73 so as to effect clarification and classification of the drainback material. Hydraulic classifiers and clarifiers of this type have been fully described, for example, in Serial No. 9,910 filed February 19, 1960, now Patent No. 3,150,467, dated September 29, 1964, and Serial No. 122,521 filed July 7, 1961, now Patent No. 3,146,550, dated September 1, 1964; excess surface liquid overflows the weir edge 73.

Particulate matter in the drainback material tends to settle out at varying rates into the sump 71 while carried along in bulk flow toward the weir edge 73. The flotsam and more readily suspendible matter, i.e. that suspended above the flow depth of the excess liquid is

carried over the weir edge into a trough 75. The less readily suspendible matter, i.e. abrasive particles and other particulate matter suitable for further impingement processes, is blocked at the weir edge 73 and settles into the funnel-shaped base of the classifying sump 71.

The flotsam and less readily suspendible matter unsuitable for further use in the impingement process are carried off in the liquid suspension along the trough 75 to the clarification tank 35, which is of sufficient capacity to receive this liquid suspension and allow settling of entrained solids.

Removal of sediment and other superfluous matter from the clarification tank 35 may be effected by known methods. Access doors 79 allow removal of accumulated sludge and outlet pipe 81 provides for draining the clarification tank 35.

To assist in the handling of abrasive particles and paint residues, appropriate chemicals can be introduced in solution into the clarification tank 35. Such use of appropriate chemicals facilitates and controls wetting, foaming, flotation and/or settling of particles and/or scales of the abrasive paints, etc., in the drainback material to prevent paint residues from clotting and sticking to and building up on the internal surfaces of the apparatus. Also, appropriate chemical solutions may be employed to prevent the grit particles, if ferrous, and also the internal surfaces of the apparatus conduit system from rusting.

The abrasive particles which settle into the base of sump 71 are eventually transferred from the sump 71 along a slurry conveyor system, generally indicated at 87 in FIGURE 1, to replenish hoppers 27. The slurry conveyor system 87 is substantially of the type described and claimed in Serial No. 117,444 filed on June 15, 1961. As shown, the slurry conveyor system 87 includes transfer pipes, extending from the bottom of the classifying sump 71 through the walls of housing 7, and flexible connections 89, extending to the hoppers 27, respectively. A propulsion jet (not shown) at the inlet end of the conveyor system 87 is connected to the liquid conduit system 85 by pipe 86. High pressure liquid thus supplied forces rapid streams of liquid from the clarification tank 35 along the system. Each of the elevator pipe lines 87 communicates with the lower portion of sump 71 through an orifice, not shown. The abrasive particles gravitate through the orifices and are entrained in large quantities into these liquid streams by ejector action of the jet from high pressure pipe 86, and thence are carried along the pipes 87 and 89 and introduced into the hoppers 27, respectively.

As shown, abrasive particles are introduced at the horizontal plane of the pivot axis of the hoppers 27, firstly to minimize the number of abrasive particles carried off by overflowing, and secondly to minimize flexing of the hoses 89 to reduce abrasive effects thereon. The overflow from hoppers 27 is collected in the drain back hopper 67 and returned to the classifying sump 71 with other drainback material.

The blast tubes 25 extend well beyond the hoppers 27.

Liquid conduit systems

The operation of the liquid conduit system is preferably intermittent and synchronized with the passage of the parts carriers I along the blasting chamber 13 and flush chamber 15, respectively. Such intermittent operation insures that (1) the impingement and flushing processes are effected only while a part is properly positioned with respect to the blast tubes 25 and the nozzles 51, respectively, and (2) the blasting chamber 13 and flush chamber 15 are effectively blocked off by the flexible strips 21 to confine all spray and solid particles therein before each blasting and jet impingement begins.

The liquid conduit system 85 includes a motor-driven pump 97 having its impeller section 99 immersed in the clarification tank 35. The impeller section 99 forces its intake from the clarification tank 35 along pipes 101 and 103 which connect to the inputs of diverting valves 105 and 107, respectively. The diverting valves 105 and 107 which direct the liquid solution first along by-pass pipes 109 and 111, respectively, back to the clarification tank 35 and then along pipes 115 and 113 respectively, to supply the high velocity jets 51 in the flush section 15, and the blast tubes 25 at the blast section 13, respectively. This intermittent diversion of the liquid by valves 107 and 109 avoids shocks such as "water hammer," which would result from sudden stoppage of flow, and maintains liquid pressure and velocity within the conduit system for quick return to maximum effectiveness of the jets after interruption.

The pump 97 is preferably a large capacity, high pressure, abrasive-free, non-clogging type with large internal clearances. Such a pump is especially adapted for this use as it has clearances (1) to accommodate passage of any fine abrasive which may not have been separated from recirculated liquid and (2) it permits a continuing small flow to keep flow channels open against tendency to block by settling of grit e.g., at the apex of sump 71 and of grit hoppers 27.

The diverting valves 105 and 107 are individually controlled by pneumatic, cylinder motors 117 and 119, respectively, having their piston rods jointed to clevis ends on the control arms 121 and 123 on the valves 105 and 107, respectively. The cylinder motor 117 is operated, i.e. extended and retracted by fluid pressure under control of solenoid valve 133, by means of switches 125 and 127 (see FIGURES 2 and 3) respectively, located adjacent the path of the parts carriers 1 at the blasting position in chamber 13 on which the blast tubes 25 converge before and beyond said position, respectively.

Cylinder motor 119, on the other hand, is operated by switches 129 and 131, respectively, located in the flush chamber 15 beside the path of the carriers 1 before and beyond, respectively, the area on which the nozzles 51 converge. (See broken lines in FIGURE 2.)

Feelers on switches 125–131 are positioned where they are engaged by the parts carriers 1 as they pass along the blasting chamber 13 and flush chamber 15 respectively, and thus switches 125–131 are operated at the proper times.

For purposes of description, we may now assume that a parts carrier 1 having a hardened paint coat thereon has passed from vestibule 11 into the focal area in blasting section 13. At first, the cylinder motor 119 is retracted, whereby the liquid solution flowing through pipe 101 is diverted through the valve 105 and along by-pass pipe 109 back to the clarification tank 35.

In this setting, the blasting section 13 has been inactive; but the hoppers 27 and liquid manifolds 52 have been continuously rocked as hereinabove described.

As the parts carrier 1 progresses along the monorail 3 to the blasting position, it engages the feeler element of, and operates, the first switch 125. This switch completes an actuating circuit from electrical source 126 to energize solenoid A which then shifts control valve 133, indicated to the condition in which it supplies fluid pressure to the cylinder motor 117 through passages represented in FIGURE 3 by the parallel arrows, and thus extends cylinder motor 117.

When the cylinder motor 117 is extended, it swings arm 123 of valve 107 forward to divert the liquid flow from liquid supply system 85 through pipes 113 to the blast tubes 25. The blasting stage 13 is now activated, and high velocity converging scouring blasts impinge on the entire surface of the parts carrier 1 to cut and strip the hardened paint coat.

As parts carrier 1 progresses further along the blasting section 13, it next contacts the feeler element of switch 127 and operates it to complete an operating circuit for solenoid B, thus operating control valve 133 to reverse the connections to pressure manifold 132 and exhaust

manifold 134, as indicated by the crossed arrows, and thus to retract cylinder motor 117 and return the control arm 123 to its position for diverting the liquid through the valve 107 and pipe 111 back to the clarification tank 35. The blasting section 13 is again inactive and the parts carrier 1 continues, entering the flush section 15 through the slot 19.

As hoppers 27 are continuously rocked while the blasting section 13 is inactive, grit particles in the liquid slurry gravitating toward orifices 26 and into blast tubes 25 are continuously agitated and thus kept mobile so as to be drained back to the sump 71 and thus to prevent grit particles from becoming packed so as to block flow to the blast tubes.

As each parts carrier 1 approaches the wash position in flush section 15, it engages the feeler element on, and operates, the switch 129 and as it passes beyond the wash position toward the exit it operates switch 131 to complete the operating circuits for solenoids C and D, respectively. The solenoid C when operated positions the control valve 135 to connect cylinder head of 119 to the pressure manifold 132 and the space behind its piston to the exhaust manifold 134, and thus to extend the piston rod of motor 119. In a similar manner as hereinabove described, motor 119 swings the arm 121 of valve 105 to direct liquid solution from the liquid conduit system 85 into pipes 115 and thence to the liquid pressure manifolds 52. When switch 131 is operated it energizes solenoid D, which shifts the valve 135 to its reversing position, represented by the crossed arrows; cylinder 119 is thus retracted, the arm 121 is returned and the liquid solution is again diverted through valve 105 and returned to the clarification tank 35 along pipe 109.

Thus, when in the progress of the parts carrier 1 through flush section 15 it is between the feeler elements of switches 131 and 133, it is swept by high velocity streams of clarified liquid solution which continuously sweep its entire surface to remove all loosened and foreign matter.

Instead of separately controlling the blasting jets and washing jets with diversion back to the reservoir, one may divert the flow back and forth from one to the other in synchronism with the movement of the parts into the blast position and wash position respectively.

Parts carriers 1, therefore, are each thoroughly cleaned, and are in excellent condition when they are successively presented at a loading stage to receive additional parts to be painted.

This application continues a part of the inventive disclosure set forth in a prior application Serial No. 837,872, filed September 3, 1959, now Patent No. 3,109,439, dated November 5, 1963.

We claim:

1. The method of removing paint accumulations which comprises subjecting such accumulations after initial drying, but before development of maximum tenacity and resistance to abrasion, to a jet blast with a high velocity liquid carrying abrasive grit and comprising a paint remover ingredient and a surfactant ingredient in an aqueous vehicle.

2. The method of removing paint accumulations which comprises subjecting such accumulations after initial drying, but before development of maximum tenacity and resistance to abrasion, to a jet blast with a high velocity liquid carrying abrasive grit and comprising a surfactant ingredient.

3. The method as defined in claim 2 which is further characterized in that said jet blast includes an anti-corrosion compound whereby metal surfaces exposed by said abrasive action are protected.

4. The method as defined in claim 2 which is further characterized in that said jet blast includes a paint repellant material, whereby paint accumulations from subsequent painting operations, to which the treated parts may be subjected, will be more readily removed.

5. The method as defined in claim 2 which is further characterized in that said jet blast includes a foam inhibitor.

6. The method as defined in claim 2 which is further characterized in that said jet blast includes a flotation agent to facilitate separation of abraded paint materials from reusable grit and reusable liquid.

7. The method of removing accumulations of paint and similar coatings from parts which comprises successively transporting said parts through respective stripping, washing, and drying zones, in said stripping zone subjecting such accumulation to high velocity liquid impelled abrasive blasts which oscillate to transversely impinge on said parts from a variety of angles, in said washing zone directing jets of washing liquid onto said parts, collecting the drain-back material in said stripping and washing zones and separating the reuseable abrasive in a liquid suspension and returning the suspension to the stripping step for further use, removing the dirt and other unsuitable material in a liquid overflow, confining said stripping and said washing steps strictly within their respective and separate zones, and interrupting active stripping and washing when said parts are entering and leaving said respective zones.

8. The method as defined in claim 7 wherein said parts in said stripping zone are successively subjected to a series of differently oriented oscillating abrasive blasts created by a continuous flow of impeller fluid being diverted from one blast to the next.

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