

Nov. 8, 1966

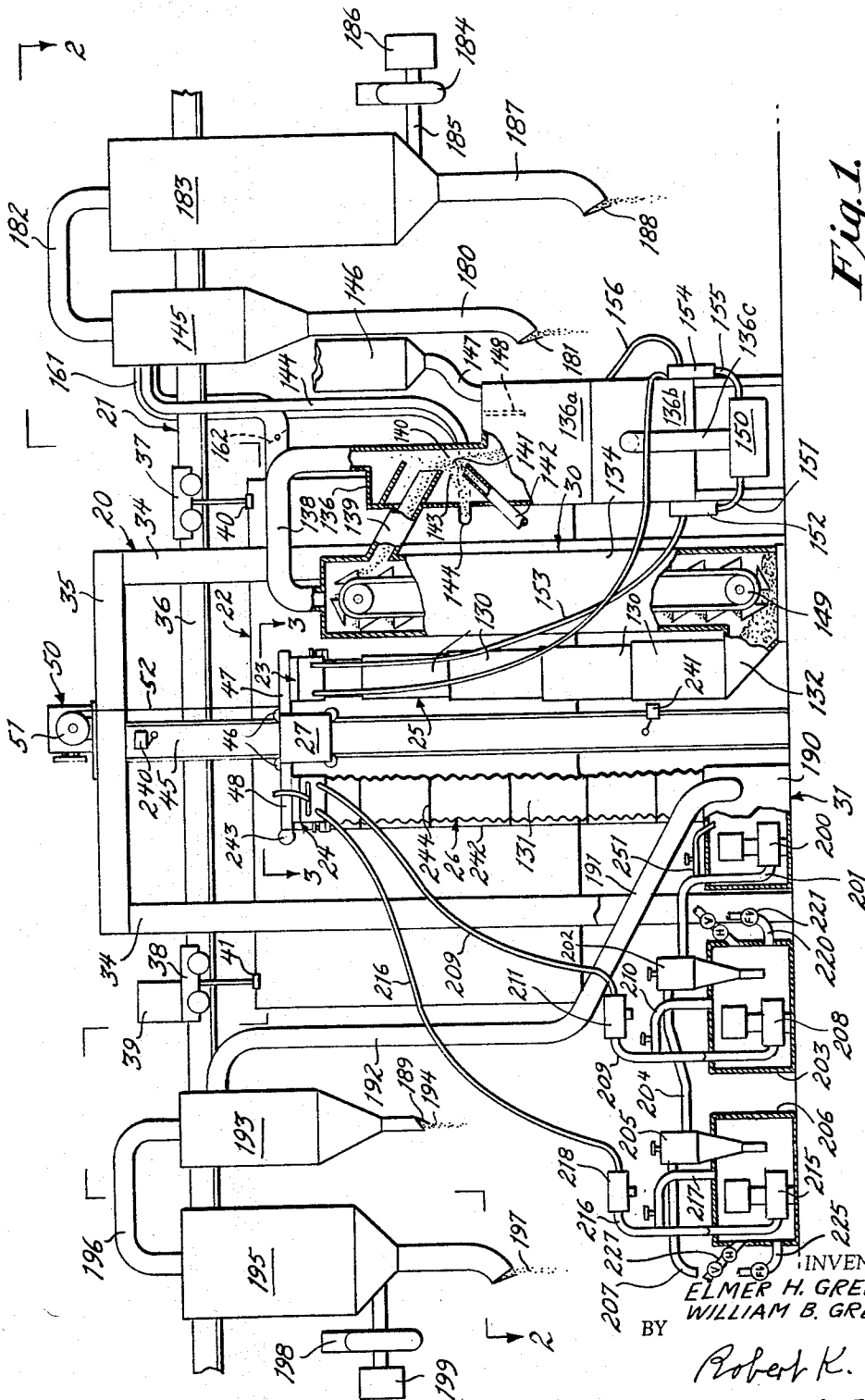
E. H. GREENBERG ETAL

3,283,450

METHOD FOR SURFACE-FINISHING METALWORK

Filed Oct. 8, 1963

7 Sheets-Sheet 1



Nov. 8, 1966

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3,283,450

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7 Sheets-Sheet 2

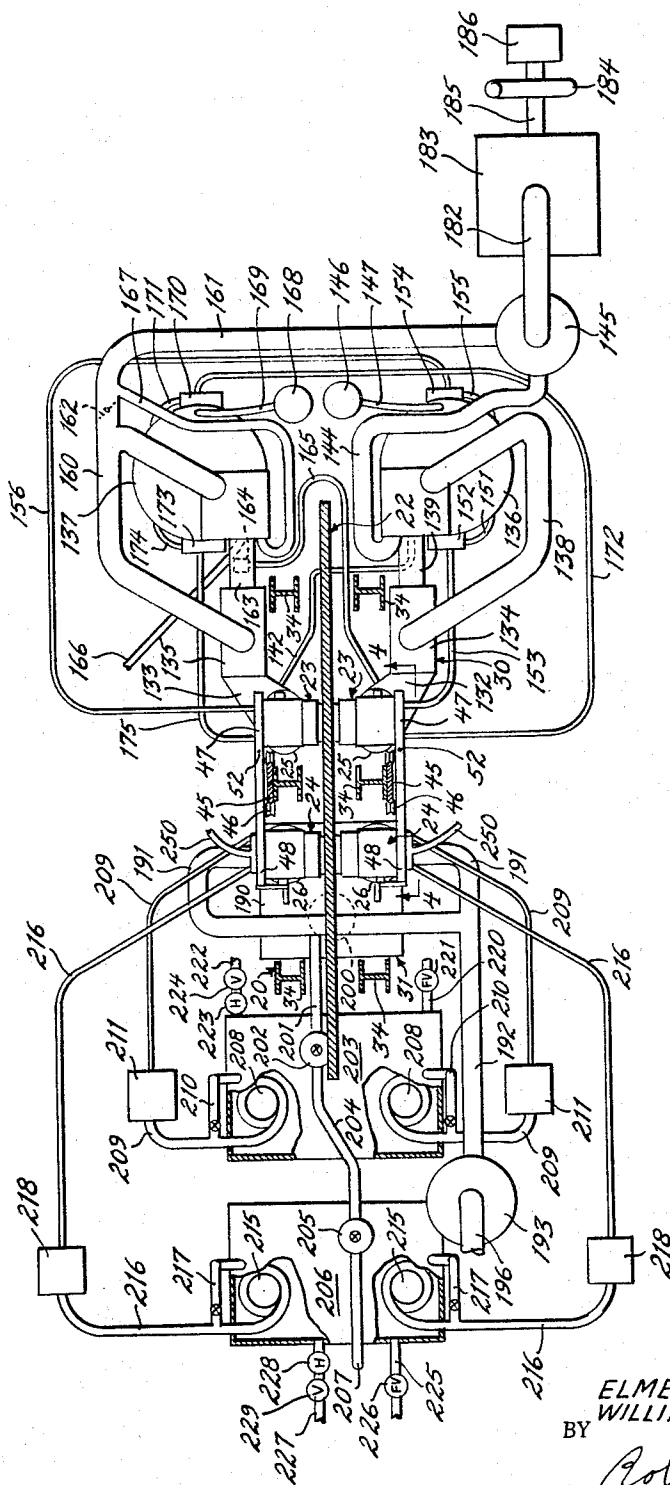


Fig. 2.

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7 Sheets-Sheet 5

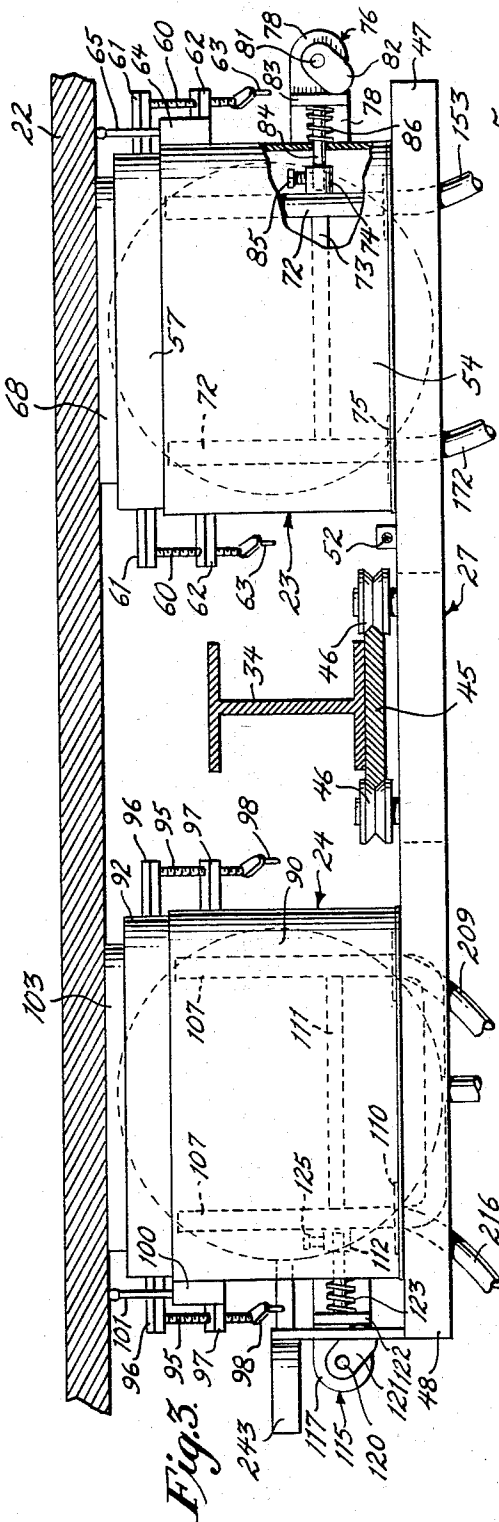


Fig. 3.

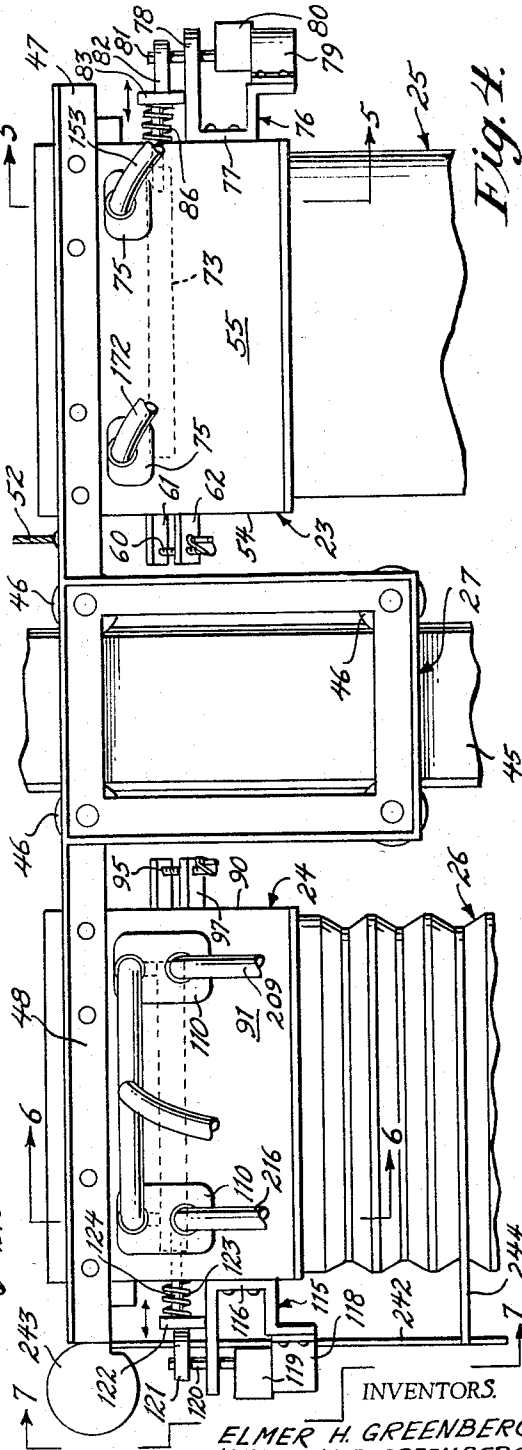


Fig. 4.

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7 Sheets-Sheet 4

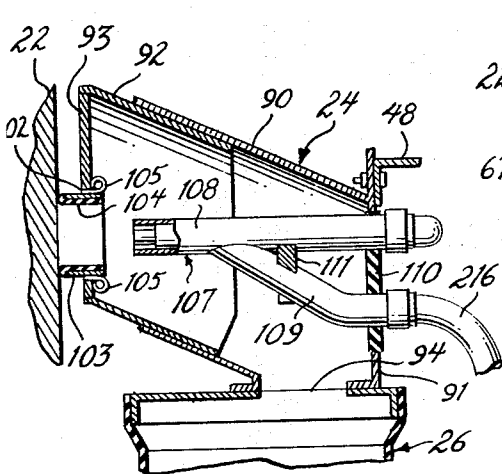


Fig. 6.

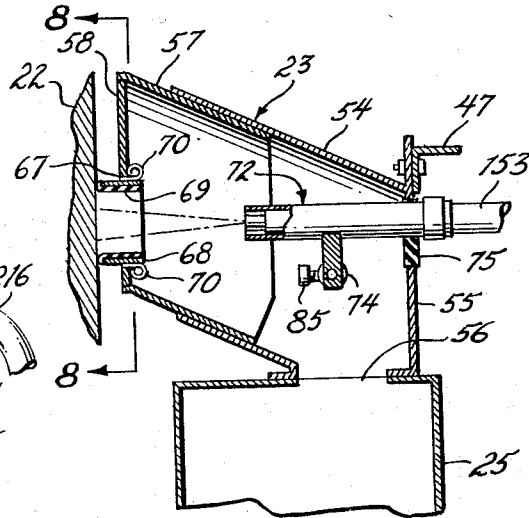


Fig. 5.

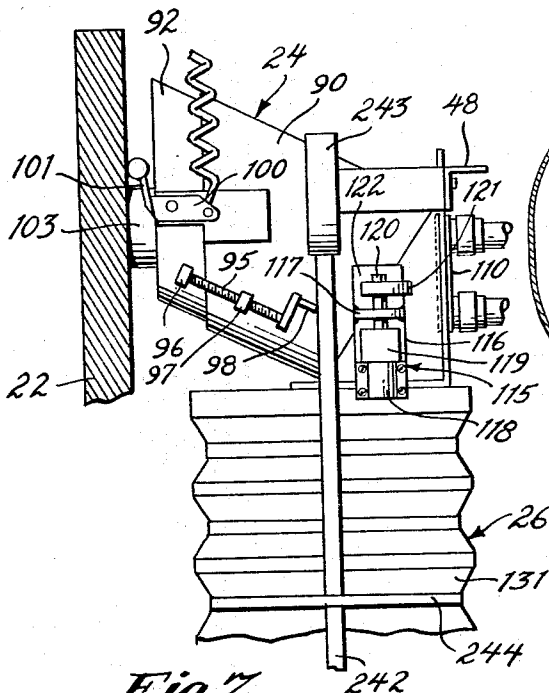


Fig. 7.

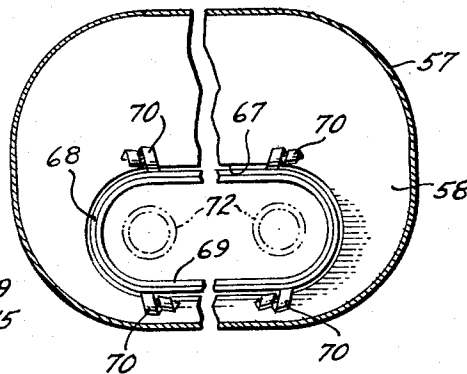


Fig. 8.

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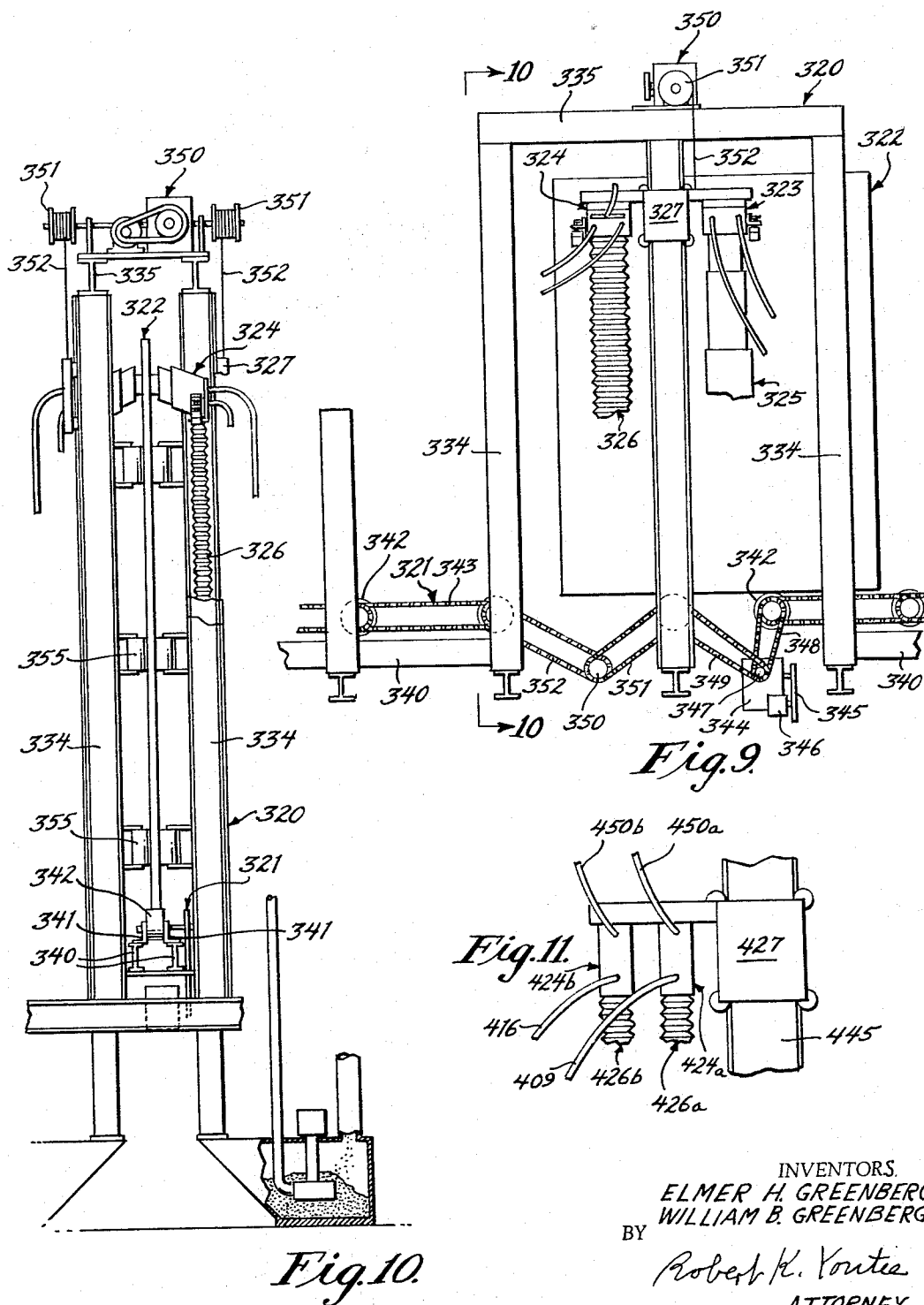
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7 Sheets-Sheet 5



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3,283,450

METHOD FOR SURFACE-FINISHING METALWORK

Filed Oct. 8, 1963

7 Sheets-Sheet 6

Fig. 12.

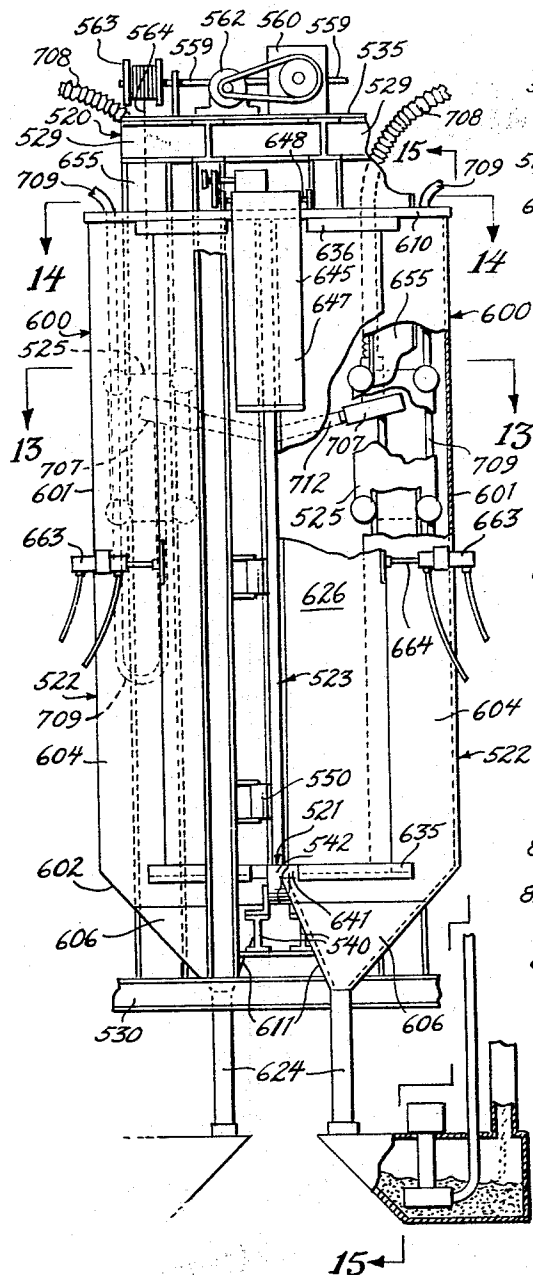


Fig. 13.

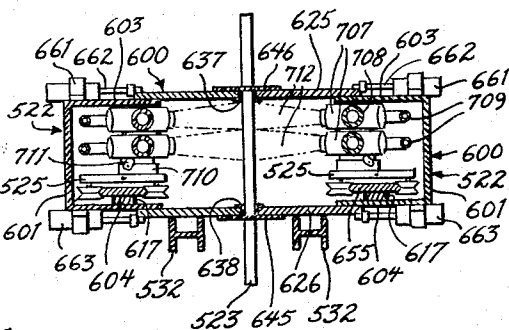
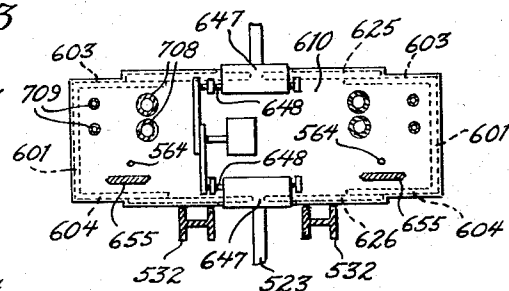
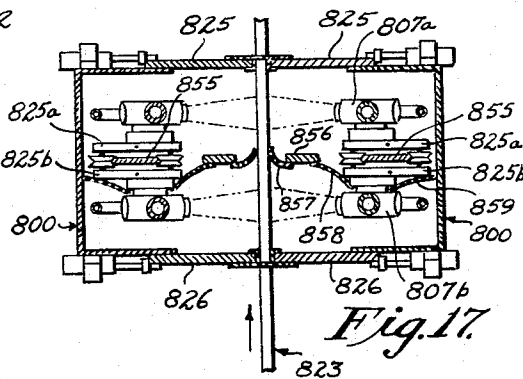


Fig. 14.



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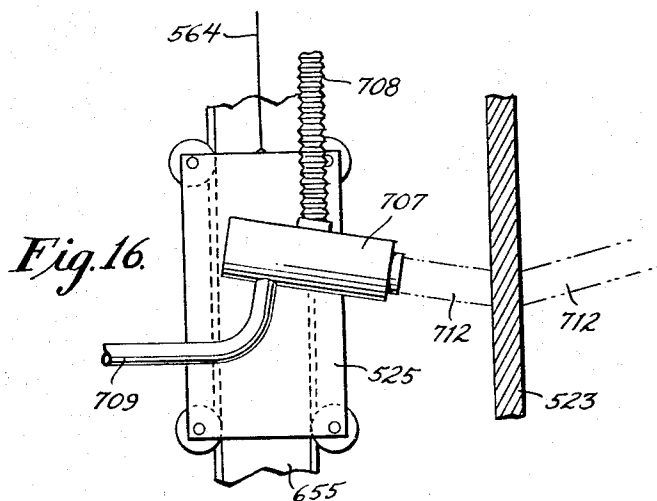
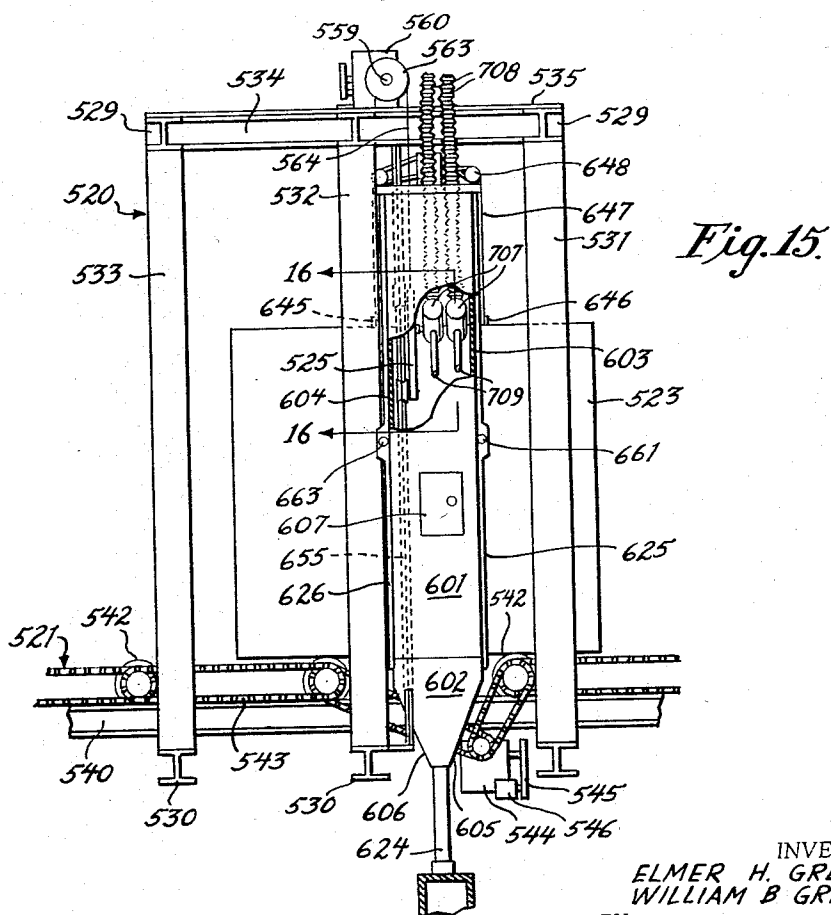
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7 Sheets-Sheet 7



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METHOD FOR SURFACE-FINISHING METALWORK

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15 Claims. (Cl. 51-319)

This invention relates generally to a highly improved method for treating metal, and is especially concerned with surface treatment of metal plate and sheet, but without limitation thereto. The invention is more specifically related to the abrasive surface treatment of metal articles, including polishing thereof.

As is well known to those versed in the art, abrasive surface treatment is compounded with difficulty according to the fineness of surface desired. Heretofore, the production of finer surface finishes has required not only additional operations and materials, but it has been necessary to maintain the different operations and materials effectively separate or spaced, to minimize defective product. This, of course, greatly added to the time, facilities and cost involved in obtaining finer surface finishes.

Accordingly, it is an object of the present invention to provide a surface-finishing method which overcomes the above-mentioned difficulties, permits of substantially continuous and closely associated abrasive-finishing operations to obtain relatively fine surface finishes in a highly automatic manner, and add substantial savings in space, equipment and time.

It is a more particular object of the present invention to provide a highly advantageous method for the surface-finishing of metal articles, which is clean and safe even when employing relatively fine abrasive material, and is uniquely adapted for a wide variety of production operations employing different sizes and types of abrasive, both wet and/or dry.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings, which form a material part of this disclosure.

The invention accordingly consists in the method steps, which will be exemplified in the following description, and of which the scope will be indicated by the appended claims.

In the drawings:

FIGURE 1 is a longitudinal elevational view showing apparatus of the present invention in its operative condition, and partly broken away for clarity of understanding;

FIGURE 2 is a generally horizontal sectional view taken substantially along the line 2-2 of FIGURE 1, also partly broken away for clarity;

FIGURE 3 is a horizontal sectional view taken generally along the line 3-3 of FIGURE 1;

FIGURE 4 is a sectional elevational view taken generally along the line 4-4 of FIGURE 2;

FIGURE 5 is a sectional elevational view taken generally along the line 5-5 of FIGURE 4;

FIGURE 6 is a sectional elevational view taken generally along the line 6-6 of FIGURE 4;

FIGURE 7 is a sectional elevational view taken generally along the line 7-7 of FIGURE 4;

FIGURE 8 is a sectional elevational view taken generally along the line 8-8 of FIGURE 5;

FIGURE 9 is a partial side elevational view showing a slightly modified construction of apparatus in accordance with the teachings of the present invention;

FIGURE 10 is a sectional elevational view taken generally along the line 10-10 of FIGURE 9;

FIGURE 11 is a partial side elevational view showing

2

another slightly modified embodiment of the instant invention;

FIGURE 12 is an end elevational view showing a further slightly modified embodiment of the present invention, with parts broken away for clarity;

FIGURE 13 is a horizontal sectional view taken generally along the line 13-13 of FIGURE 12;

FIGURE 14 is a horizontal sectional view taken generally along the line 14-14 of FIGURE 12;

FIGURE 15 is a sectional view taken generally along the line 15-15 of FIGURE 12;

FIGURE 16 is a partial sectional elevational view taken generally along the line 16-16 of FIGURE 15; and

FIGURE 17 is a horizontal sectional view similar to FIGURE 13, but showing another slightly modified embodiment of the present invention.

Referring now more particularly to the drawings, and specifically to the embodiment of FIGURES 1-8 thereof, an upstanding frame is generally designated 20, within which is located a suitable conveyor means 21 for handling a workpiece or article 22 to be treated. Projection means is shown at 23 and 24 for projecting finishing material against the workpiece 22 being carried by the conveyor or handling means 21. Means for collecting the finishing material after engagement thereof with the workpiece 22 is generally designated 25 and 26; and, carriage means 27 effects movement of the projection means 23 and 24 vertically relative to the workpiece 22.

In FIGURE 2 it will be observed that the frame 20 is symmetrical about the edgewise path of the workpiece 22, and that the projection means 23 and 24 are located symmetrically on opposite sides of the path of work movement. Associated with the collection means 25 of projection means 23 is a finishing-material handling means generally designated 30; while an additional finishing-material handling means 31 is associated with the collection means 26 of the projection means 24.

The frame 20 may include a series or row of generally upstanding I beams or standards 34 along each side of the path of workpiece 22, and a lintel or generally horizontal upper structure 35 which may extend between the upper ends of the standards 34, both along and across the path of work movement. The conveyor means 21 may include a generally horizontal rail or track 36 suitably supported in elevated relation extending along and over the path of plate movement and longitudinally through the frame 20. Thus, the conveyor rail or track 36 may extend longitudinally between the rows of standards 34 and beneath the upper frame structure 35. A pair of conveyor trolleys 37 and 38 may be mounted for movement along the track 36, for this purpose at least one trolley being powered by suitable drive means 39. Suitable releasable holding means or clamps 40 and 41 depend from respective trolleys or carriages 37 and 38 for releasable holding engagement with a plate or other workpiece 22. The workpiece 22 may thus be suspended and conveyed edgewise along its path of movement, say from right to left as seen in FIGURES 1 and 2.

One of the standards 34 on each side of the path of work movement may be provided, say on its outer side with a generally vertically extending plate or track 45 which may have its vertical edges configured for retaining engagement with the wheels 46 of the respective carriage 27. That is, each rail or track 45 may consist of a vertically elongate plate fixedly secured by any suitable means in facing engagement with the outer flange of the adjacent upright member or column 34, having its vertical edges extending beyond the supporting flange. Each carriage 27, see FIGURE 1, may be generally rectangular, having four wheels or rollers 46 at its corners for rolling engagement along the rail to mount the car-

3

riage for vertical or up-and-down movement. Extending coplanar with and horizontally from opposite sides of each carriage 27 are a pair of rigid arms 47 and 48. The arms 47 each extend upstream or rightward toward the inlet end of the apparatus, and the arms 48 each extend downstream or leftward toward the outlet end of the apparatus. Superposed on the upper frame member 35, generally over the carriages 27, is a powered hoist mechanism 50 having laterally outwardly extending rotary drums 51 each wound with a cable 52 depending for connection at its lower end to a respective carriage 27, say at the arm 47. The hoist 50 is operative to rotate the drums 51 in one direction to gravitationally lower the carriages 27 and rotate the drums in the other direction to raise the carriages.

The projection means 23 are substantially identical, so that a description of one will suffice. As best seen in FIGURES 3, 4, 5 and 8, each projection means or head 23 includes a hollow main body 54 having a generally vertical rear wall 55 which is fixed to the adjacent carriage arm 47 to mount the head for vertical movement with the carriage. The body 54 may be generally tubular, of ovaloid cross-sectional configuration and arranged in upwardly and inwardly inclined relation with its inner end open. The collection means 25 may depend from the underside of the body 54, being connected to the interior of the latter by an opening 56 through the underside of the body at the outer region thereof. Located in the open inner end region of the body 54 is a tubular extension 57. The extension 57 may be conformably received in the body 54 and extend obliquely upward and inward toward the work 22, generally coaxially with the body. The outer end of extension 57, received in the body 54, is open for communication with the interior of the body, while the inner or forward end of the extension is closed by a generally vertical closure or plate 58. The extension 57 is slidably telescopically received in the hollow body 54, projecting upward and forward from the upper and forward end of the latter and adjustably positioned relative thereto.

As seen in FIGURE 3, a pair of adjustment screws 60 are disposed longitudinally of the head 23, externally on opposite sides thereof and each rotatably carried by a journal lug or arm 61 projecting from opposite sides of the extension 57, while extending threadedly through a respective lug or arm 62 fixedly projecting from the main body 54. Each screw 60 is provided with a crank or suitable actuating means, as at 63 for telescopically adjusting the extension 57 relative to the body 54. Of course, other suitable adjustment means may be employed for telescopically adjusting the head extension 57 relative to the body 54, as required by the nature of the work 22.

Also provided on the projection head 23, as seen at the right side thereof in FIGURE 3, is suitable sensing means 64, such as an electric switch 64 having an actuating finger 65 adapted to ride on the work, which switch could be a proximity switch, if desired.

The end member or closure 58 is formed with a through aperture or opening 67, see FIGURES 5 and 8, which may be of laterally elongate or ovaloid configuration. Spacedly and conformably received in the opening 67 is a ring or tube 68, which extends both interiorly and exteriorly of the wall 58. The ring 68 is preferably lined with suitable abrasion-resistant rubber, plastic or the like, as at 69, which lining preferably covers the inner end of ring 68, see FIGURE 5 for bearing engagement with the work without scratching and iron pick-up. The lining 69 may also extend beyond the ring 68 without covering the inner ring end. A plurality of resilient elements 70 may be employed to floatingly mount the tube or ring 68 in the end-plate aperture 67. More specifically, the resilient elements 70 may each comprise an axially elongate helical spring or resilient strip having its opposite ends respectively secured to the ring 68

4

and plate 58, with the springs or strips located at circumferentially spaced locations exteriorly about the tube. In this manner, the tube 68 is resiliently yieldable longitudinally, and adapted to be tilted or canted in any desired direction against the resilient restoring forces of the mounting springs 70. Of course, the extension 57, including the floating tube 68, may be moved forward or rearward relative to the main body 54 of the head 23 and adjusted in any selected position of its forward and rearward movement by means of the threaded shafts 60. In certain installations adjustability of the extension 57 relative to the body 54 may be omitted, and the resilient mounting of the ring 68 employed to accommodate for variations in work surfaces.

Each projection means or head 23 further includes one or more projectors 72, which in the illustrated embodiment are shown as nozzles, but may be other suitable means for projecting the desired finishing material. A pair of nozzles 72 are arranged in horizontally spaced parallel relation in each head 23, extending inward through the rear wall 55 in substantial alignment with the ring or tube 68, and having their forward or discharge ends terminating short of the tube. The laterally spaced projectors 72 may be fixedly secured together by any suitable means, such as the brace 73. Projecting laterally outward from one nozzle 72 may be a cup or collar 74 opening toward one side of the body 54. The nozzles 72 extend movably through the rear body wall 55, being connected to the latter by flexible diaphragms or gaskets 75, which construction permits the nozzles to be moved relative to the body while effectively closing the rear wall 55 about the nozzles. If desired, the nozzle hoses may extend through the body 54 and, by their flexibility, permit of nozzle movement without a diaphragm construction, but the hose being sealed directly to the wall 55.

Externally of each head 23, carried on the respective body 54, is a nozzle-oscillation device or jiggle, generally designated 76 serving to jiggle or move the nozzles 72 relative to the body 54, for a purpose appearing presently. Each jiggle mechanism 76 includes a bracket 77 mounted exteriorly on the adjacent body 54 and having an outwardly projecting member or slideway 78. Carried by each bracket 77 may be a motor 79 and an associated speed reducer 80 having a shaft 81 projecting upward through the guideway 78. An eccentric cam 82 may be fixed to the shaft 81 for rotation therewith. Mounted for sliding movement on the guideway 78, between the side wall of body 54 and the eccentric cam 82, is a slide member 83. A rod or plunger 84 extends from the slide member 83 slidably through the adjacent side wall of body 54 and has its inner end received in the collar 74. A setscrew or other suitable securing means 85 may be employed to detachably and adjustably secure the rod 84 to the collar 74. It is by this securement of the collar 74 to the rod 84 that the inclination of the nozzles 72 is determined. Thus, while the nozzles are illustrated as generally horizontal, the connection between collar 74 and rod 84 may be released for rotation of the nozzles, say clockwise as seen in FIGURE 5, to a desired position which may be fixed by resecurement of the holding member or screw 85. As noted hereinbefore, the nozzles 72 are rotatable relative to the rear body wall 55 by the diaphragm construction 75. A coil compression spring 86 may be interposed between the slide member 83 and adjacent side of the body 54 to yieldably and resiliently urge the slide member outward and maintain engagement thereof with the cam 82 upon rotation of the latter. It will now be apparent that rotation of the cam 82 serves to effect generally horizontal oscillatory movement of the slide member 83, which in turn oscillates the nozzles 72 laterally to produce a jiggling motion thereof. This jiggling motion may be accomplished with the nozzles in any vertical angle of adjustment, as described hereinbefore.

The projection means 24 on opposite sides of the path of work movement are each substantially identical, so that a description of one will suffice. Each projection means or head 24 is located adjacent to and downstream of a respective head 23, being carried by respective arms 48. In particular, each head 24 includes a generally tubular, forwardly or inwardly inclined body 90 having a generally vertical rear or outer wall 91, and having its forward or inner end open. The body 90 may incline obliquely upward and inward, as best seen in FIGURE 6, toward the work 22. Conformably received in the open upper end region of the body 90 is a generally tubular extension 92, which is telescopically slidable relative to the body for extension toward and retraction from the work 22. The tubular extension 92 has its rear or lower end open for communication with the interior of the body 90, and has its forward or inner end closed by a generally vertical closure or plate 93. The underside of the body 90, adjacent to its lower or outer end, is provided with an opening 94 for fluid communication with the upper end of collection means 26.

There is advantageously provided adjustment means for adjustably positioning the telescopic extension 92 relative to the body 90. An example of such adjustment means is best seen in FIGURE 3 as including a pair of threaded shafts or screws 95 extending longitudinally along and externally on opposite sides of the projection head 24, each shaft being rotatably carried by a journal lug or arm 96 projecting from the telescopic extension 92. An additional lug or arm 97 projects rigidly from each side of the body 90 in threaded engagement with a respective screw 95; and, suitable actuating means such as cranks or handles 98 are provided on the shafts for selective rotation thereof. By this adjustment means 95-98, it is apparent that the extension 92 is selectively adjustable toward and away from the work 22, as required. Of course, other suitable adjustment means may be employed. Also carried externally of the projection head 94, on the left-hand side of the body 90 as seen in FIGURE 3, is suitable sensing means 100, such as an electric switch, and provided with an actuating finger 101 for engagement with the work. If desired, a proximity switch may be employed for the sensing means 100, which is operative to sense the trailing edge of the work when the switch 64 is no longer operative.

The forward end wall or closure 93 of the extension 92 is formed with a through opening 102, which conformably and spacedly receives a tubular member or ring 103 having its opposite ends extending exteriorly and interiorly of the wall 93. The inner surface of the tube 103 may advantageously be coated with suitable abrasion-resistant material 104, such as rubber or plastic. The material 104 may cover the inner end of ring 103, or extend beyond the inner ring end without covering the latter, to ride on the work with minimum friction, scratching and iron pick-up. A plurality of resilient elements 105 may be employed to floatingly mount the tube 103 in the end-plate aperture 102. Such resilient elements 105 may each comprise an axially elongate helical spring or resilient strip having its opposite ends respectively secured to the tube 103 and plate 93, with the springs or strips located at circumferentially spaced locations exteriorly about the tube. The tube 103 is thereby resiliently yieldable longitudinally, and adapted to be tilted or canted in any desired direction against the resilient restoring forces of the springs 105. Here again, under certain circumstances provision for telescopic adjustment of the extension 92 may be omitted, if the floating action of tube 103 is sufficient to accommodate to the work.

Mounted interiorly in each projection head 24 are one or more projectors, which may comprise nozzles 107 as illustrated, or other suitable projectors. Further, while the illustrated nozzles 107 require separate propellant fluid, nozzles may be employed which do not utilize separate propellant fluid.

The nozzles 107 of each projection head 24 are illustrated as being two in number, disposed generally horizontally and spaced laterally from each other within the projection head. Specifically as illustrated, each nozzle 107 includes a generally horizontal projection tube 108 extending inward through the rear wall 91 generally toward and terminating short of the ring 103. In addition, each nozzle 107 includes a supply tube 109 extending inward through the rear wall 91 beneath and upward toward the tube 108 for connection therewith at a location spaced from the inner or discharge end. The tubes 108 and 109 of each nozzle 107 extend spacedly through the rear body wall 91, and suitable sealing means such as a gasket or diaphragm 110 may be employed to seal the wall 91 and permit of nozzle movement relative to the body 90. The gasket or diaphragm 110 may be fabricated of suitable flexible sheet material, such as rubber, or the like. Here again, the diaphragm may be omitted and a flexible hose extended in sealed relation through the wall 91 to permit of desired nozzle movement.

Rigidly connecting together the nozzles 107 may be a brace or strut 111, and an adjustment collar or sleeve 112, see FIGURE 3, may project laterally from one of the nozzles 107 similar to the collar 74. Externally of the projection head 24, carried by the body 90, may be a nozzle-motion mechanism or jiggle 115, similar to the motion mechanism or jiggle 76. The motion mechanism 115 is best seen in FIGURES 3, 4 and 7, as including a bracket 116 fixed to the body 90 and having a slideway or guide 117 projecting outward from the body. A motor 118 may be carried by the bracket, together with a speed reducer 119 having a rotary shaft 120 upstanding through the slideway 117 and carrying an eccentric cam 121. A slide member or crosshead 122 is slidable back and forth on the guide 117 between the cam 121 and adjacent side of body 90, being maintained in engagement with the cam by a coil compression spring 123 interposed between the slide member and body. Extending from the slide member 122 slidably through and into the body 90 is a rod or plunger 124 which is received in the sleeve 112, see FIGURE 3. The rod 124 is adjustably secured to the sleeve or collar 112 by any suitable securing means, such as a setscrew 125, so that the pair of projectors or nozzles 107 is rigid with the slide member 122. As with the projectors 72, the projectors 107 are angularly adjustable, say about the axis of rod 124 by release of the securing means 125 and resecurement thereof with the projectors rotated to the desired vertical angle. The flexible diaphragms 110 permit of this vertical angular adjustment. Also, the flexible diaphragms 110 permit of lateral oscillation or jiggling movement of the projectors 107 by the jiggle 115, in the same manner as described hereinbefore in connection with the projectors 72 and jiggle 76. While the above-described motion of projectors relative to their enclosures has been described as a jiggling or oscillation, it is understood that any similar movement transverse of the direction of movement of carriages 27, including circular or otherwise, is intended to be comprehended by such terminology.

The collection means 25 depending from each projection head 23 may include a conduit of vertically extensible and retractile construction, say of a plurality of telescopically connected sections 130. Similarly, the collection means 26 associated with each projection head 24 may include a generally vertically depending conduit 131, say of vertically extensible and retractile corrugated hose, or other suitable conduit construction. The conduits or collection means 25 are connected at their lower ends to the materials-handling apparatus 30, while the conduits or collection means 26 are connected at their lower ends to the materials-handling apparatus 31.

More particularly, the lower ends of the conduits 25 are connected by respective materials-receiving boots or ducts 132 and 133 to respective bucket-type elevators 134 and 135. Interiorly of the housing of elevators 134

and 135 may be a bucket chain 149, as shown in FIGURE 1 for conveying material upward away from the adjacent boot. Connected to respective elevators 134 and 135 are pneumatic separators generally designated 136 and 137. While the separators 136 and 137 may be of any suitable type, such as the air separator shown in FIGURE 1, the separator 136 is characterized by separating out reusable coarse particles, while the separator 137 is characterized by separating out reusable fine particles. In particular, the separators 136 and 137 may each be of the type which separates out the larger particles fed thereto by dropping these particles to a lower storage region, the material fed to separator 136 containing larger particles than the material fed to separator 137, as will appear presently. An upper conduit or duct 138 may be connected between the upper ends of elevator 134 and separator 136 for carrying air or fluid and entrained fines to the latter separator. Also a direct conduit 139 is connected between upper regions of the elevator 134 and separator 136 to gravitationally transfer particular material from the elevator to the separator. The conduit 139 discharges obliquely into the separator 136, best seen in FIGURE 1, the reusable coarse particles falling to the lower or storage region 136a of the separator 136, as at 140, the reusable fine particles falling at 141 into a conduit 142 for transmission to the boot 133, and the extremely fine particles or dust 143 passing pneumatically through the conduit 144 to a cyclone separator 145. Beneath the lower storage region 136a may be a pressurized continuous operation blasting machine 136b receiving the reusable coarse particles from the storage region.

A coarse make-up supply vessel is shown at 146 connected by a feed conduit 147 to the separator 136 for discharge to the lower or storage region thereof. A baffle 148 may be provided in the housing of separator 136 to prevent overflow. An air or gas supply, designated 150 in FIGURE 1, is connected by conduit 136c to the blasting machine 136b to pressurize and control the latter. The gas supply 150 is also connected by conduit 151 to a mixer 152 for mixing gas and particulate material from the blasting machine 136b. The particulate material is then delivered through conduit 153 to projector 72, see FIGURE 3. Also, an additional mixer 154 is connected by a conduit 155 to the propellant supply 150, and also connected to blasting machine 136b of separator 136 for mixing particulate material therefrom and transmitting the same through conduit 156 to a corresponding projector opposite to projector 72.

On the opposite side of the work 22, the upper side as seen in FIGURE 2, the housing of elevator 135 is connected at its upper end to the upper end of the separator 137 by a conduit or duct 160. A branch conduit 161 extends from duct 160 to the cyclone separator 145 and may be provided with suitable valve means, such as a damper 162 to by-pass a selected quantity of air or fluid from the elevator 135 directly to the cyclone separator without passing through and adversely affecting the separator 137. In addition, a conduit 163 passes directly from an upper region of the elevator 135 to the separator 137 for gravitationally conducting particles to the latter separator. Located in the conduit 163 may be an additional separator 164 for removing relatively coarse material before entry to the separator 137. The separator 164 may be of the rotating-screen or scalping-wheel type, or other suitable device, and is connected by a conduit 165 to the boot 132 for delivering the relatively coarse material to the latter boot.

The relatively coarse material from boot 133 and elevator 135 having been removed by the separator 164, the separator 137 serves to separate out the reusable fine from the nonreusable fine or fine refuse and dust. The fine refuse may be discarded through conduit 166, and another conduit 167 is connected between the separator

137 and conduit 161 for transferring dust to the latter conduit and cyclone separator 145.

Thus, remaining in the fine separator 137, in the lower or storage region thereof, is reusable fine particulate material; and, a fresh-supply or make-up vessel 168 is connected by a conduit 169 to the separator 137 to replenish the supply of fine material.

A mixer 170 is connected to a continuous operation blasting machine receiving particulate material from the separator 137 and, by a conduit 171 to a propellant supply of air or gas, for mixing the fine finishing material with the gas and transmitting the same through conduit 172 to the leftward projector 72, see FIGURE 3. Similarly, a mixer 173 is connected to the continuous operation blasting machine associated with the separator 137 and a propellant supply of air or gas, as by conduit 174 for propelling fine finishing material through conduit 175 to a projector opposite the leftward projector 72.

The cyclone separator 145 is provided with a lower-end discharge conduit 180, see FIGURE 1, having a one-way valve or flap 181 for removing fine particulate material, and an upper-end discharge conduit 182 for conveying dust to a baghouse 183. A blower or fan 184 is connected by a conduit 185 to the baghouse, being driven by a motor 186. The dust is collected by the baghouse for safe removal through conduit 187 having a one-way valve or flap 188. Fresh or clean air may be discharged from the blower 184.

The materials-handling system 31 includes a receiver or reservoir tank 190 connected to the lower ends of collection conduits 26 for receiving a liquid slurry of finishing material and foreign matter. As used herein, the term "slurry" refers to any mixture of liquid and finishing material regardless of consistency. Also received by the reservoir 190 from the collection means 26 is air employed as propellant in the nozzles 107. Outlet means for the received air is provided in the form of conduits 191 extending from upper opposite regions of the reservoir 190 and merging into conduit 192 for carrying air and entrained matter, including water and dust to a cyclone separator 193, which separates out water and fine abrasive or dust 194 as through one-way valve 189. In addition, a fume collector 195 may be connected by a conduit 196 to the cyclone separator for removing additional dust and mist or water at 197 and discharging clean air from a fan or blower 198 driven by a motor 199.

Interiorly of the receiver 190, in a lower region thereof, is a pump 200 connected by a conduit 201 to a cyclone separator 202. A valved recirculating or by-pass conduit 251 is connected between the conduit 201 and tank 190 to maintain suspension. The separator 202 is associated with a reservoir or tank 203 and discharges thereto reusable liquid slurry containing fine finishing material. The remainder of the material received by separator 202 contains a slurry of reusable extra-fine finishing material, foreign matter, and refuse or nonreusable finishing material. This is passed through conduit 204 to a cyclone separator 205 associated with a reservoir or tank 206. The separator 205 discharges to the tank 206 a slurry of reusable extra-fine finishing material, and discards through conduit 207 waste material, including foreign matter and nonreusable or refuse finishing material.

One or more pumps, as at 208 are associated with the tank 203, say to pump from the lower region thereof outward through conduits 209 to respective opposite projectors 107. A valved by-pass conduit 210 is connected between each conduit 209 and the reservoir 203 for recirculating the fine slurry to maintain suspension in the tank. Interposed in each conduit 209 is a filter or separator 211 for removing coarse abrasive and refuse from the fine slurry being conducted to the projectors.

The tank or reservoir 206 is similarly provided with one or more pumps, as at 215, each connected by a con-

duit 216 to a respective extra-fine-slurry projector 107. A valved by-pass conduit 217 is connected to each conduit 216 and returns to the vessel 206 for achieving recirculation of the extra-fine slurry to maintain the desired suspension. Interposed in each conduit 216 is a separator or filter 218 for removing coarse material before conduction of the extra-fine slurry to its respective projectors.

Connected to the reservoir or tank 203 is a liquid make-up or supply conduit 220 for maintaining sufficient liquid in the reservoir. The liquid-supply conduit may be automatically controlled by a float valve 221, or other suitable control means to automatically maintain the desired liquid level. Also connected to the reservoir 203 is a finishing-material make-up or supply conduit 222 having associated therewith a hydrometer or other suitable control means 223 for sensing the specific gravity or pulp density of the contained slurry. The hydrometer may be operatively associated with a valve 224 to control the admission of fresh or make-up finishing material to maintain the desired pulp density.

Also associated with the reservoir or tank 206 is a liquid-make-up or supply conduit 225 which may be automatically controlled by a float valve 226 or other suitable control means; while a make-up or supply conduit 227 for extra-fine finishing material is connected to the tank 206 and operatively associated with suitable pulp-density sensing means 228, such as a hydrometer, which may be in controlling relation with a valve 229.

In operation, the work 22 which is illustrated as a sheet, is carried edgewise by the conveyor 21, shown as an overhead monorail, longitudinally therealong. The sheet is moved leftward, as seen in FIGURES 1 and 2, the leading or left-hand edge of the sheet engaging the finger 65, see FIGURE 3 to initiate operation of the heads 23 and 24. By suitable control means associated with the conveyor 21, the work 22 may be moved stepwise horizontally and the carriages 27 moved vertically between the steps of work movement. In this way, the projection means or work heads 23 and 24 each scan an entire face of the work. Up-and-down movement of carriages 27 may be controlled by suitably located limit switches, say one of the switches 64 and 100 for limiting upward carriage movement, and say the lower switch 241 on track 45 to limit downward carriage movement. An upper safety switch 240 on track 45 serves as a back-up safety switch. As the carriages 27 move up and down, by the drive means or motor 50 and its sheave 51 and cable 52 connected to the carriages, it is apparent that the conduits 25 necessarily retract and extend, as in a telescopic relationship, while the conduits 26 also retract and extend, but in a collapsing or folding manner. Associated with each of the foldably retractile conduits 26 may be a cable or line 242 carried by the respective carriage arm 48, as in a resiliently retractile reel 243. The cable 242 extends downward from the reel 243 along the conduit 26 and has its lower end secured adjacent to the lower end of the conduit, say to the vessel or tank 190. Thus, the cable is at all times held taut in closely parallel relation with the conduit 26 under all conditions of conduit extension and retraction. Suitable guide members, such as rings 244 may be slidable on the cable 242 and connected to conduit 26 to maintain the latter in generally vertical condition along the cable as the carriage moves up and down.

During the above-described movement of the pressure heads 23 and 24, and workpiece 22, suitable treating material, such as abrasive, is projected from the nozzles or projectors 72 through the sealing rings 68 against the work faces. The rings 68, by their resilient mounting or floating action maintain effective endwise engagement with the adjacent plate faces and accommodate to surface variations of the sheet faces to effectively seal the enclosures 54 and assure return thereto of spent abrasive rebounding from the work. Relatively coarse abrasive is projected from the rightward nozzle 72 on each side of

the work 22, the coarse abrasive passing from the lower or storage region of separator 136 through continuous operation blasting machine 136b, the air-abrasive mixer 152 and conduit or hose 153 to one nozzle 72. The compressed-air supply 150, through conduit 151 serves to propel the abrasive through conduit 153. Also, the air or fluid under pressure from supply tank 150 passes through conduit 155 to air-abrasive mixer 154 to propel coarse abrasive from the continuous operation blasting machine 136b of the separator 136 through conduit 156 to the rightmost projector of rear projection head 23. To make up discarded coarse abrasive, the make-up supply vessel 146 feeds through conduit 147 to the lower or storage region of separator 136 to maintain a predetermined quantity therein.

The fine-abrasive separator 137 is similarly connected in fluid communication with the leftward projector or nozzle 72 on both the front and rear sides of the work path. In particular, an air-abrasive mixer 170 receives abrasive from the continuous operation blasting machine of the fine separator 137 and air or fluid under pressure through conduit 171 to propel the fine abrasive through conduit 172 to the leftward projector or nozzle 72 of the front projector head 23, while an air-abrasive mixer 173 is connected to the continuous operation blasting machine of the fine separator 137 and an air-supply conduit 174 for pneumatically propelling fine abrasive through conduit 175 to the leftward nozzle of the rear projection head 23.

In each projection head 23 all of the rebounding abrasive, both coarse and fine, as well as broken or extra fine and scale or refuse, is received in the housing of the projection head and passes downward through the associated conduit 25. The heavier particles pass downward in the conduits 25 gravitationally, and a slight downward flow of air is maintained sufficient to insure that substantially all of the fine particles also pass downward. This rebounded material falls to the respective boot 132 and 133 where it is raised by the elevators 134 and 135. A slight flow of air is maintained upward in the elevators to insure travel therethrough of substantially all entrained fines.

From the elevator 134, the bulk of the solids is gravitationally discharged through conduit 139 to the separator 136, the entrained fines being carried pneumatically to the separator through overhead conduit 138. In the separator 136, the coarse abrasive falls, at 140, to the bottom of the separator, while the fine material falls, as at 141 into the conduit 142, and the dust is carried at 143, into conduit 144 and through the latter to cyclone 145. Thus, the coarse abrasive is separated out and settles in the bottom of separator 136, while the fine material is carried through conduit 142 to the boot 133 for mixture with all of the material rebounded from the rear face of the work 22. This material in the boot 133 is elevated mechanically in the elevator 135, and also by slight updraft therein sufficient to carry entrained fines, the latter passing through overhead duct 160 to the fine separator 137. The abrasive material mechanically raised in the elevator 135 is discharged through conduit 163 to the fine separator 137. However, in the conduit 136 is located a preseparator of the rotating-screen or scalping-wheel type, as at 164 for removing larger particles and discharging the same to conduit 165 for transfer to boot 132. Thus, the coarse abrasive is screened or otherwise removed and separated from the material collected in boot 133 before the latter is passed to the separator 137. In the fine separator 137, the reusable fine abrasive is separated out and may fall to the bottom, being separated from fine refuse which may be discarded through conduit 166, and dust which may pass through conduit 167 and thence conduit 161 to cyclone 145. In order to maintain sufficient supply of fine abrasive in the separator 137 at all times, the fine-abrasive make-up vessel 168 is connected to the separator 137 through conduit 169. In use, the

11

damper 162 may be adjusted to provide proper air flow in the system and desired velocity in the separator 137. Thus, the damper 162 permits by-passing the separator 137 to carry entrained fines and excess carrier gas or fluid directly to the cyclone 145.

It will now be appreciated that the separation systems associated with separators 136 and 137 are generally connected in parallel with each other, extending between respective boots 132 and 133 to the cyclone 145 and thence to the baghouse 183. However, the systems associated with separators 136 and 137 are respectively cross-connected with each other, the fines separated out by separator 136 passing through conduit 142 to the boot 133 for passage through the fine-separator system, and the coarse removed by the pre-separation step at separator 164 ahead of separator 137 being passed through conduit 165 to the boot 132 for passage through the coarse-separator system.

As best seen in FIGURE 5, each nozzle or projector 72 may be mounted by sleeve 74 on shaft 84 for angular adjustment of the projected abrasive about the axis of the shaft. Thus, when operating conditions require the angle of projection of the abrasive streams may be adjusted out of the generally normal angle illustrated, say to achieve a desired finish or to avoid interference by rebounding particles with the abrasive stream. Also, the oscillation or jiggling mechanism serves to shift the projectors 72 transversely of their vertical travel to minimize and obviate the occurrence of visible stripes formed on the work by the abrasive treatment. This oscillatory operation of the jiggle mechanism 76 both removes sharp lines of demarcation and imperceptibly blends adjacent areas of treatment.

From the rightward or upstream projector 107 of each projection head 24 is projected a slurry of medium-fine abrasive against the respective face of workpiece 22. The leftward or downstream projector or nozzle 107 in each projection head 24 projects a slurry of extra-fine abrasive at the respective workpiece face. This projection of slurries may be effected pneumatically, as by the use of compressed air or the like through conduits 250 connected to the projectors 107 to project a spray of slurry and air. It is appreciated that other types of projection may be employed, some of which will be discussed herein-after.

The separately projected slurries, as projected separately in each projection head 24 by respective nozzles 107, separately impinge upon the work 22 and rebound therefrom inward through the rings 103 for passage downward through the conduits 26. Thus, the rebounded abrasive and liquid, together with air, passes down the conduits 26 to the tank or vessel 190. From an upper region of the vessel 190 the air, with mist and entrained fines is drawn off through branch conduits 191 to conduit 192 to a cyclone 193 and fume collector 195. The collected slurry in the tank 190 is pumped by pump 200 through conduit 201 to the separator 202 which separates out and passes to the tank 203 a slurry of reusable medium-fine abrasive, passing the remainder to conduit 204. The pumps 208 in tank 203 pump the medium-fine abrasive slurry through conduits 209 for return to the projection head 24. In the conduits 209 may be the filters 211 for removing coarse abrasive before it reaches the nozzles; and, recirculation lines 210 having valves therein may be connected between the conduits 209 and vessel 203 to maintain the solids in suspension. A similar, valved recirculation line may be employed between the conduit 201 and tank 190, for the same purpose.

As discussed hereinbefore, the liquid-level and pulp-density devices 221, 223 and 224 serve to add make-up liquid and abrasive to maintain proper level and specific gravity of slurry in the tank 203.

The material discharged from separator 202 through conduit 204 is passed to separator 205 which separates out the reusable extra-fine abrasive slurry, discharging

12

the same to the tank 206, and discarding the remaining refuse material through conduit 207. Proper supply of extra-fine slurry in tank 206 is maintained by the liquid-level maintenance device 226, and pulp-density maintenance means 228, 229.

From the tank 206 the extra-fine abrasive slurry is pumped by pumps 215 through conduits 216 to respective leftward or downstream projectors 107. In each conduit 216 is a filter 218 for removing coarse abrasive, and a valved recirculation line 217 is connected between each conduit 216 and the vessel 215 to maintain the contents of the vessel in suspension.

Thus, it will now be appreciated that the separators 202 and 205 define a series separation system, the former and latter serving to successively separate out from the rebounded slurry the medium-fine abrasive slurry and extra-fine abrasive slurry, respectively.

As with the nozzles or projectors 72, the nozzles or projectors 107 are also preferably mounted, as by sleeve 112 on shaft 124 for angular adjustment about the horizontal axis of the shaft, to thereby permit selection of the angle of projection. Also, the sealing ring 103 accommodates to and maintains effective sealing engagement with the adjacent surface of plate 22 to prevent or minimize escape and assure rebound of the projected material, while slight downdraft is maintained in the conduits 26, as from the cyclone 193 or otherwise, to insure retention in the closed system of entrained fines and mist.

The oscillatory or jiggle mechanism 115 effects relatively rapid transverse movement of projectors or nozzles 107 relative to the vertical movement thereof to obscure or eliminate demarcation between adjacent or successively treated areas of the work.

While the foregoing description of the embodiment of FIGURES 1-8 has been simplified for clarity, it is understood that various changes and additions are considered within the scope of the invention.

Referring now to the embodiment of FIGURES 9 and 10, the present invention is there shown wherein a workpiece is supported on its underside for conveying during treatment.

More particularly, an upstanding frame is generally designated 320, within the lower region of which is located a suitable conveyor 321 for horizontally transporting the work 322 by supporting engagement with the underside thereof.

Projection means 323 and 324 are carried by carriages 327 and provided with collection conduits 325 and 326, all in similar manner to the hereinbefore described projection means 23 and 24, carriages 27 and collection conduits 25 and 26.

The frame 320 is arranged astride the path of conveyor 321 and may include on each side thereof a series or row of generally upstanding I beams or standards 334, and a lintel or generally horizontal upper structure 335 extending between the upper ends of the standards 334. In FIGURE 10 it may be seen that a hoist mechanism 350 is mounted on the upper frame structure 335 and provided on opposite sides with outboard drums 351 each connected by a cable 352 to a respective carriage 327 for raising and lowering the latter.

The conveyor means 321 includes a pair of longitudinally extending, laterally spaced, generally horizontal support members 340 secured by any suitable means between the uprights 334. At longitudinally spaced locations along the support members or beams 340 are provided pairs of upstanding journal pedestals 341, each pair carrying therebetween a rotatable roller 342. Thus, a plurality of rollers 342 are arranged in longitudinally spaced relation between the uprights of frame 320, each roller being journaled for rotation about a horizontally disposed axis extending transversely of the conveyor means. Suitable drive means, say in the form of sprocket-and-chain connections 343 may connect the various rollers 342 to each other, and to a variable-speed transmission 344, for simul-

taneous rotation of the rollers. The variable-speed transmission 344 may be connected through any transmission means 345 to a suitable drive means or motor 346, so that the latter effects simultaneous and equal angular velocities for all the rollers 342, to thereby convey a workpiece or sheet 322 resting on edge on at least two of the conveyor rollers.

As appears in FIGURE 9, the drive sprocket 347 of the transmission 344 is spaced below the horizontally aligned rollers 342, so that chains 348 and 349 connecting the drive sprocket to the adjacent conveyor rollers define a trough permitting full lowering of the projection means 323 to the lower edge of plate 322. Similarly, directly below the projection head 324, and spaced below the horizontally aligned rollers 342, there is mounted an idler sprocket 350 provided with chains 351 and 352 connected in driving relation with adjacent conveyor rollers. The lowered idler sprocket 350 and chains 351 also define a trough permitting full downward movement of the projection head 324 to the lower sheet edge without obstruction.

In order to maintain the workpiece 322 in upright condition resting on and being conveyed by the rollers 342, the uprights 334 may be provided with one or more guide rollers 355 for rolling engagement with the workpiece and to maintain the latter accurately in its upstanding condition between the frame members. The rollers may be advantageously coated with suitable protective material, such as rubber or the like, especially in the fine-finishing of work. Also, the guide rollers may be of an adjustable construction to vary the space therebetween and accommodate for a variety of work.

If desired, the work-carrying conveyor rollers 342 may be provided with means effecting more positive roller engagement with the workpiece.

It will now be appreciated that the nether roller-supported arrangement of FIGURES 9 and 10 is operative in a manner similar to the first-described embodiment, and may be substantially the same as the latter except for the work conveyor 320, the treating-material handling system being omitted from FIGURES 9 and 10 for clarity.

In the embodiment shown in FIGURE 11, the overall treating-material handling system and work-handling system has been omitted, sufficient structure being shown to illustrate the absence of commingling or mixture of different treating materials after impingement upon the work. Thus, a pair of separate projection heads 424a and 424b are carried by a carriage 427 for movement along a track 445. However, the projection heads 424a and 424b are respectively provided with separate collection conduits 426a and 426b. By this construction the rebounded treating material from separate projectors may be separately collected and returned, as through supply lines 409 and 416. Also, separate air-supply lines 450a and 450b may be provided for respective projection heads 424a and 424b.

In the embodiment of FIGURES 12-16 is shown a slightly modified device wherein the treating-material projectors or nozzles are movable relative to the treating-material collection enclosures. In particular, a frame is generally designated 520, and may be similar to the frame 320, having located therein conveyor means 521 which may be similar to the conveyor 321. On opposite sides of the frame 520, see FIGURE 12, are provided treating assemblies 522 for applying treating material to a workpiece 523 carried by the handling means or conveyor 521.

The frame 520 may be symmetrical about the conveyor 521, and the workpiece or sheet 523 may be carried in upstanding relation on the conveyor within the frame, the workpiece being supported at its lower edge by the conveyor. The treating assemblies 522 are located to treat respective faces of the work or sheet 523, and may be substantially identical.

The frame 520 includes a plurality of parallel spaced, crosswise base members 530, which may be embedded

in or otherwise fixedly secured to an appropriate ground or other supporting surface. On each side of the conveyor 521, extending generally upward from a plurality of adjacent base members 530, are a plurality of uprights 531, 532 and 533. The uprights 531, 532 and 533 on each side of the conveyor 521 are in alignment with each other longitudinally of the conveyor, while each pair of identically numbered uprights on opposite sides of the conveyor are in alignment with each other transversely of the conveyor.

Extending across the ends of the uprights 531, 532 and 533 on each side of the conveyor 521 is a top frame member or lintel 534, with the lintels on opposite sides of the conveyor 521 being connected together by transverse members or beams 529. Resting on the members 529 and 534 may be a generally horizontal mounting plate 535 bridging the area over the conveyor 521.

The conveyor 521 may be essentially similar to the conveyor 321 described hereinbefore, including longitudinal support members or beams 540 having mounted thereon a series of rollers 542 arranged in longitudinally spaced relation between the uprights of frame 520 with each roller being journaled for rotation about a horizontally disposed axis extending transversely of the conveyor means. Suitable drive means, such as by sprocket-and-chain connections 543 may positively connect the several rollers 542 to each other and to a variable-speed transmission 544 for simultaneous roller rotation. The transmission 544 is driven through suitable transmission means 545 from a motor 546 to effect simultaneous motion and equal angular velocity of all rollers 542, for conveyance thereby of the workpiece 523 resting in upstanding relation with its lower edge on at least two of the conveyor rollers.

Suitable guide rollers 550 may be provided on the inner sides of uprights 531, 532 and 533 for guiding the work, and may be adjustable as the guide rollers 355. Both the guide rollers 550 and conveyor rollers 542 may be suitably surfaced to obtain necessary frictional contact and protection of the work.

Located on opposite sides of the conveyor 521, preferably directly opposite to each other, are a pair of generally upright or vertically elongate enclosures 600. The enclosures 600 may each be considered part of a respective treating assembly 522, and may be substantially identical to each other, but of opposite hand. Each enclosure 600 includes a generally vertical outer wall 601 in a plane generally parallel to the conveyor 521 and spaced therefrom. Each outer closure wall 601 may extend vertically from the region of conveyor 521 to the region adjacent to and spaced below the beams 529 and 534. Extending from the lower edge of each outer wall 601, declining inward therefrom, is a downwardly narrowing outer-wall extension 602, see FIGURE 15. Extending from opposite sides or vertical edges of each outer enclosure wall 601 are a pair of generally vertical-enclosure side walls 603 and 604. The enclosure side walls are generally vertically coextensive with the adjacent enclosure outer walls 601, and extend in facing spaced parallelism with each other inward toward the path of movement of work 523. As best seen in FIGURE 13, the enclosure side walls 603 and 604 terminate at their inner edges spaced from the work 523. The lower inner regions of the enclosure side walls 603 and 604, respectively designated 605 and 606, may decline obliquely toward each other along opposite side edges of the outer-wall extension 602, and taper toward their lower ends. The enclosures 600, as thus far described, are suitably fixed in stationary relation, and are advantageously provided with access doors, as at 607 in FIGURE 15, for convenience in operation and maintenance.

A generally horizontal upper end plate 610 extends across the upper ends of both enclosures 600, bridging the space over conveyor 521, and may be fixedly secured

by any suitable means to the upper regions of enclosure walls 601, 603 and 604, bridging the space therebetween. Beneath the path of work 523 there are provided a pair of downwardly and outwardly inclined lower walls 611, each tapering downwardly and extending between the inner edges of walls 605 and 606 of a respective enclosure 600. Thus, each enclosure includes walls 602, 605, 606 and 611 which combine to define a funnel-like lower-end region of the respective enclosure for gravitationally collecting treating material, as will appear more fully hereinafter. In addition, the enclosures 600 may have their lower regions connected together and closed by a connection wall, obscured in the drawings. It will be observed, as in FIGURE 15, that the enclosures 600 are arranged at a location along the conveyor 521 to permit their lower-end connection without interference of the conveyor, and their upper-end connection by cover plate 610 without interference of the frame structure 520.

Outward of the uprights 531-533, and adjacent to the upright 532, there may be fixed a generally vertically extending track or rail 655 on each side of the frame. Each track or rail 655 may have its lower and upper ends welded or otherwise fixed to a base member 530 and an upper transverse member 529. As best seen in FIGURES 12, 13, 14 and 15, each rail or track 655 extends vertically through a respective enclosure 600 along an adjacent enclosure wall 604. The rails or tracks 655 may lie in the same vertical plane extending transversely of the conveyor 521, and have their lower and upper ends projecting beyond the lower and upper ends of the respective enclosures 600, for securement to the beams 529 and 530. Further, each vertical track or rail 655 may be welded or otherwise fixedly secured to the lower and upper enclosure walls 606 and 610, as well as being fixed to the enclosure side walls 604, as by braces 617. In this manner, the enclosure 600 may be fixedly secured in stationary relation with respect to the frame 520.

Rollably mounted on each rail or track 655, for vertical movement therealong, is a carriage 525. Mounted on the plate 535 may be a motor or other suitable drive means 562 in driving relation with a variable-speed transmission 560 having a pair of output shafts 559. The shafts 559 each carry a drum 563 having coiled thereabout a cable 564 depending through the cover member 610 into respective enclosures 600 and there connected to respective carriages 525 for raising and lowering the latter on the tracks 655.

Mounted on each of the carriages 525, for vertical movement therewith, are a pair of side-by-side projectors or nozzles 707 for projecting treating material against the adjacent surface of the work 523. The projectors 707 may be of any suitable construction, as mentioned hereinbefore in connection with the projectors 72 and 107, and for purposes of illustration are shown as each having associated therewith an extensible hose 708 for supplying treating material, and a flexible hose 709, say for supplying propellant, such as air. The hoses or conduits 708 and 709 may pass outward through the upper end of the enclosure 600 for connection to suitable supply means, while permitting unobstructed vertical movement of the carriages 525 and projectors 707 relative to and within the enclosures. In order to obtain the hereinbefore described oscillatory or jiggling action, each pair of projectors 707 may be mounted on its adjacent carriage 525 by telescopic or other suitable mounting means, as at 710, which is provided with a rotary eccentric 711 for effecting the desired oscillatory movement.

The projectors 707 emit streams or sprays of treating material generally toward each other, as indicated at 712, the enclosures 600 being open or facing toward each other on opposite sides of the path of work 523. In order to prevent the escape of treating material from the enclosures 600, each is provided on opposite sides with a pair of generally vertically extending, facing spaced closure plates or shutters 625 and 626. That is, extend-

ing vertically along each enclosure wall 603, and inward therefrom toward the path of work 523, is a closure or shutter 625, while a similar closure or shutter 626 extends vertically along each enclosure wall 604 and inward therefrom toward the work being treated. The closures or shutters 625 are preferably substantially coplanar, in a vertical plane transverse of the conveyor 521; and, the closures or shutters 626 are also preferably coplanar in a vertical plane transverse of the conveyor. The shutters 625 may be located closely outward of respective walls 603, and the shutters 626 closely outward of respective walls 604. Each shutter 626 is preferably mounted at its lower and upper ends by channel-like guideways, as at 635 and 636, see FIGURE 12, fixedly secured to the adjacent wall 604. The shutters 625 may be similarly mounted, for sliding movement toward and away from the work 523.

Thus, the closures or shutters 625 and 626 extend vertically substantially between the upper ends of the enclosures 600 and to just slightly below the upper sides of conveyor rollers 542. Also, the inner edges of the shutters 625 and 626 may be provided with resilient seals or gaskets 637 and 638 for sealing engagement with the work 523. A lower-edge seal 641 may be separate from and extend along the lower edges of shutters 626 and therebetween, beneath the work 523 and in sealing engagement with the lower edge thereof, see FIGURE 12. The lower-edge seal 641 may be of any suitable resilient material, such as rubber or the like; and, a similar lower-edge seal may be provided along the lower edges of shutters 625.

In order to close the space between the upper edge of workpiece 523 and the enclosures 600, additional closure means is provided at opposite sides of the closures, designated 645 and 646. The closure means 645 and 646 may be substantially identical and each includes a flexible strip or screen, as at 647 having its upper-end region coiled about a roller 648 mounted on the upper side of cover 610. The free end of strip 647 may be weighted and depends vertically exteriorly and in covering relation with respect to the shutters 626. In particular, the free lower end of strip 647 depends to the upper edge of workpiece 523 and is vertically extensible and retractile for engagement with workpieces of different height. The closure 646 operates in substantially identical manner with respect to shutters 625, and both closure 645 and 646 overlap the adjacent shutters to accommodate workpieces of different thickness.

The shutters 625 and 626 are slidable inward toward and outward away from the path of work movement, as may be required to accommodate workpieces of different thickness. Further, shutter-actuating means such as fluid-operated cylinders 661 may be mounted on enclosure walls 603 and provided with piston rods 662 connected to adjacent shutters 625 for shifting the latter toward and away from each other and maintaining the shutters in sealing relation with a workpiece being treated. Similar cylinder assemblies 663 may be mounted on the enclosure walls 604 and connected by piston rods 664 to shutters 626 for maintaining the latter in sealing relation with workpieces of different thickness.

In operation, the workpiece 523 is moved in its upstanding condition, horizontally edgewise by the conveyor 521 through and between the enclosures 600, the latter effectively sealing about the workpiece to define a single enclosed chamber with the workpiece passing there-through. The workpiece may be moved intermittently, and the projectors 707 moved vertically between horizontal steps of work movement, projecting treating material against opposite faces of the workpiece along vertical areas thereof. Suitable apparatus for handling the treating material is connected to the projectors 707, as well as the enclosures 600, such as the apparatus described in connection with FIGURES 1-8. Toward this end, the treating material rebounded from the work 523 is commingled in the enclosure 600 and gravitationally falls

therein to the lower enclosure regions, which are connected by outlet conduits 624 to suitable treating-material handling apparatus.

The remaining embodiment of FIGURE 17 is similar to that of FIGURES 12-16, but illustrates movement of the projector means relative to and within a fixed enclosure, wherein the rebounded treating material from different projectors is maintained separate.

For example, a pair of enclosures are generally designated 800, and similar to the enclosures 600, having adjustable shutters 825 and 826, and otherwise adapted to effectively seal against a workpiece 823 passing between and being treated within the enclosures. Provided within each enclosure 800 is a fixed, vertically extending rail or track 855. However, the track 855 in each enclosure 800 is arranged medially therein to carry a pair of carriages 825a and 825b on opposite sides of the track. Thus, a pair of carriages 825a and 825b are mounted on opposite sides of each track or rail 855 and movable up and down therealong within each enclosure 800. Carried by each carriage 825a and 825b is a respective projector 807a and 807b, both facing toward the path of work movement.

In each enclosure 800, proximate to the respective track or rail 855, may extend a vertical support or bar 856 fixedly secured in position within and extending vertically the entire length of the respective enclosure. Each bar 856 is located in spaced relation between the adjacent track or rail 855 and the path of workpiece 823. Secured along each support or bar 856, the entire vertical extent of the enclosure 800 is a seal or resiliently flexible lip 857 extending toward the path of work movement, and an additional seal or resiliently flexible lip 858 extending away from the workpiece toward the outer side of the respective enclosure. An additional resiliently flexible seal or lip vertically coextensive with the outer enclosure wall and extending inward therefrom is designated 859. The lips 858 and 859 are in sealing engagement with each other and resiliently deflectible or deformable about one of the carriages 825b to permit vertical movement thereof while the lips remain sealed. Also, the lip 857 engages and seals against the work 823. Hence, it will now be understood that the lips 857, 858 and 859 serve to subdivide each enclosure 800 into a pair of vertical, side-by-side compartments or chambers, each of which houses a respective projector 807a and 807b, the lips 858 and 859 parting to let the carriage 825b pass, but sealing against each other above and below the carriage. Thus, the streams of treating material from the respective projectors 807a and 807b may be kept separate and separately processed without commingling, if desired.

It is, of course, obvious that the separate projection means at successive locations along the path of work movement may be operated independently of each other to achieve a wide variety of advantageous results. For example, opposite sides of a single workpiece may be differently finished, say by projecting only fine abrasive against one plate side and only coarse abrasive against the other plate side. Further, different surface areas of a single plate may be differently finished, as by projecting only coarse abrasive against one surface area and only fine abrasive against another surface area. Similarly, successive plates may be differently finished, as by projecting one type of abrasive against one plate, and projecting another type of abrasive against the next plate. Additional variations in practice of the instant invention may occur to those skilled in the art, and are intended to be comprehended herein.

From the foregoing, it is seen that the present invention provides a method for surface-finishing metalwork which fully accomplishes its intended objects and is well adapted to meet practical conditions of manufacture, installation and operation.

Although the present invention has been described in some detail by way of illustration and example for pur-

poses of clarity of understanding, it is understood that certain changes and modifications may be made within the spirit of the invention and scope of the appended claims.

What is claimed is:

1. In the method of surface-finishing metalwork, the steps which comprise: projecting a first slurry of liquid and finishing material transversely toward the work for impingement thereon, gravitationally collecting the first slurry, separately projecting a second slurry of liquid and a finishing material different from said first-mentioned finishing material transversely toward the work for impingement thereon, gravitationally collecting said second slurry with said first-mentioned slurry, separating the collected first and second finishing materials from each other, and separately returning said first and second finishing materials for repeated projection with liquid.

2. In the method of surface-finishing metalwork, the steps which comprise: moving the work along a path, projecting a first particulate finishing material at a first location transversely toward the path for impingement against the work, projecting a second particulate finishing material at a second location transversely toward the path for impingement against the work, collecting together said first and second finishing materials after impingement, separating the reusable first and second particulate finishing materials of the collected material, and returning the reusable first and second particulate finishing materials to respective first and second locations for repeated impingement.

3. The method according to claim 2, said first and second particulate finishing materials being of different sizes, and said reusable first and second particulate finishing materials being separated out according to size.

4. The method according to claim 2, said first and second particulate finishing materials each comprising liquid and solids, said separating including separating the solids of the respective first and second finishing materials from each other.

5. The method according to claim 4, further characterized in projecting said first and second particulate finishing materials by propellant gas, and removing the propellant gas prior to said collection.

6. The method according to claim 2, said separating comprising successively removing each of said reusable first and second finishing materials from the collected material.

7. The method according to claim 6, said first and second finishing materials comprising liquids and solids.

8. The method according to claim 2, said separating comprising continuously removing from each of first and second separate quantities of said collected material a respective one of said first and second reusable finishing materials, and combining a remainder of said first separate quantity with said second separate quantity for removal from the remainder of said second reusable finishing material.

9. The method according to claim 8, said first and second finishing materials consisting essentially of solids.

10. The method according to claim 9, wherein said first and second reusable finishing materials are respectively fine and coarse solids, withdrawing substantially all coarse solids from said first separate quantity before removing the reusable fine solids, and combining said withdrawn coarse solids with said second separate quantity before removal of the reusable coarse solids.

11. The method according to claim 2, said first and second particulate finishing materials being solid, said collecting including collecting of refuse together with said first and second finishing materials, and said separating including separating of refuse from the collected material.

12. In the method of differently surface finishing respective metalwork areas, the steps which comprise: moving work along a path, projecting a first particulate finishing material transversely toward the path for impingement

19

against one surface area of work, projecting a second particulate finishing material transversely toward the path for impingement against another surface area of work, collecting together said first and second finishing materials after impingement, separating the reusable first and second particulate finishing materials of the collected material, and returning the reusable first and second particulate finishing materials for repeated impingement.

13. The method according to claim 12, said first and second particulate finishing materials each comprising liquid and solids, said separating including separating the solids of the respective first and second finishing materials from each other.

14. The method according to claim 13, further characterized in projecting said first and second particulate finishing materials by propellant gas, and removing the propellant gas prior to said collection.

15. The method according to claim 12, said separating comprising continuously removing from each of said first and second separate quantities of said collected material a respective one of said first and second reusable finishing

20

materials, and combining a remainder of said first separate quantity with said second separate quantity for removal from the remainder of said second reusable finishing material.

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