March 25, 1969 E. H. GREENBERG ET AL 3,434,241

APPARATUS FOR SURFACE-FINISHING METALWORK

Filed Nov. 3, 1966 Sheet 1 of 8

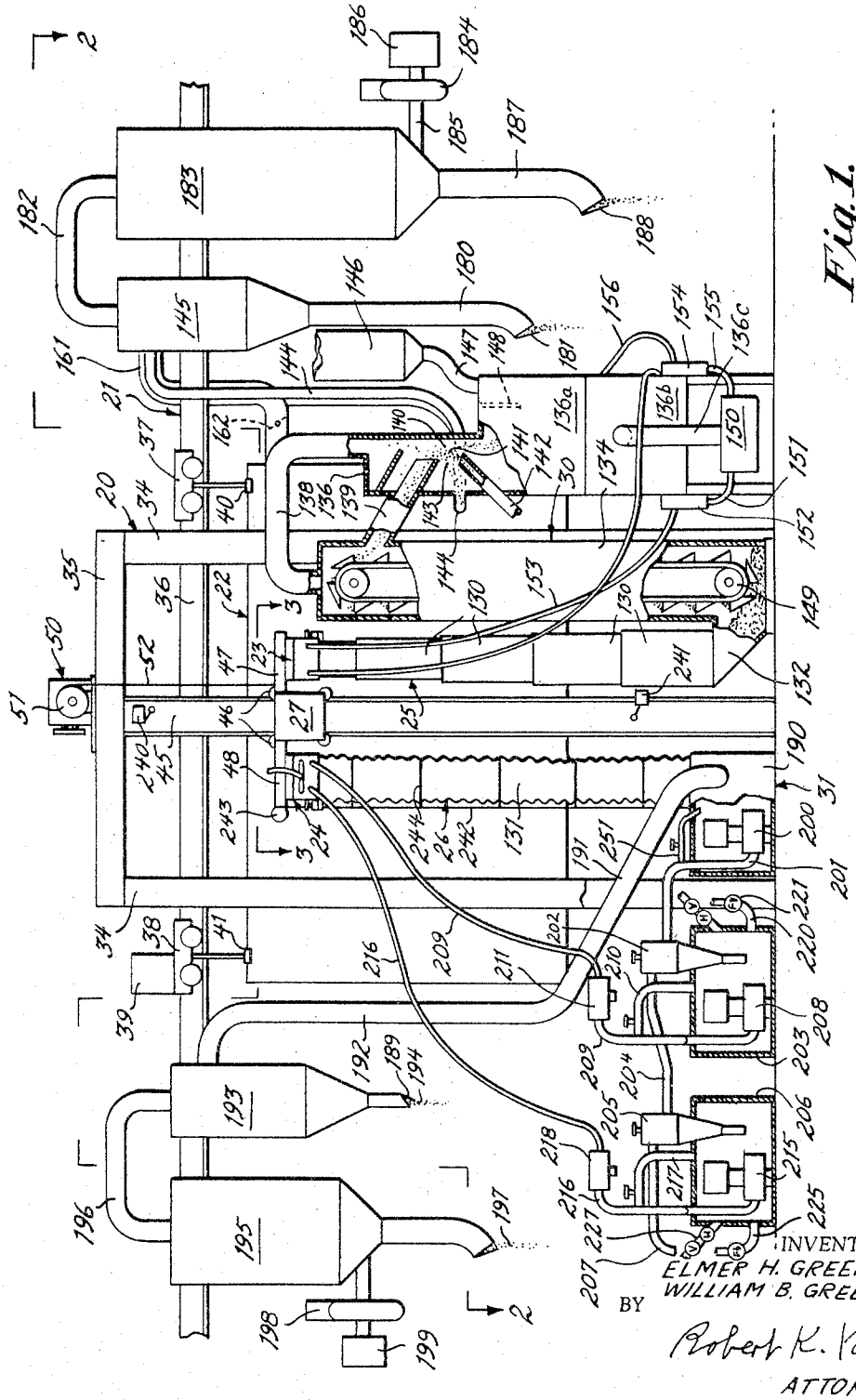


Fig. 1.

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APPARATUS FOR SURFACE-FINISHING METALWORK

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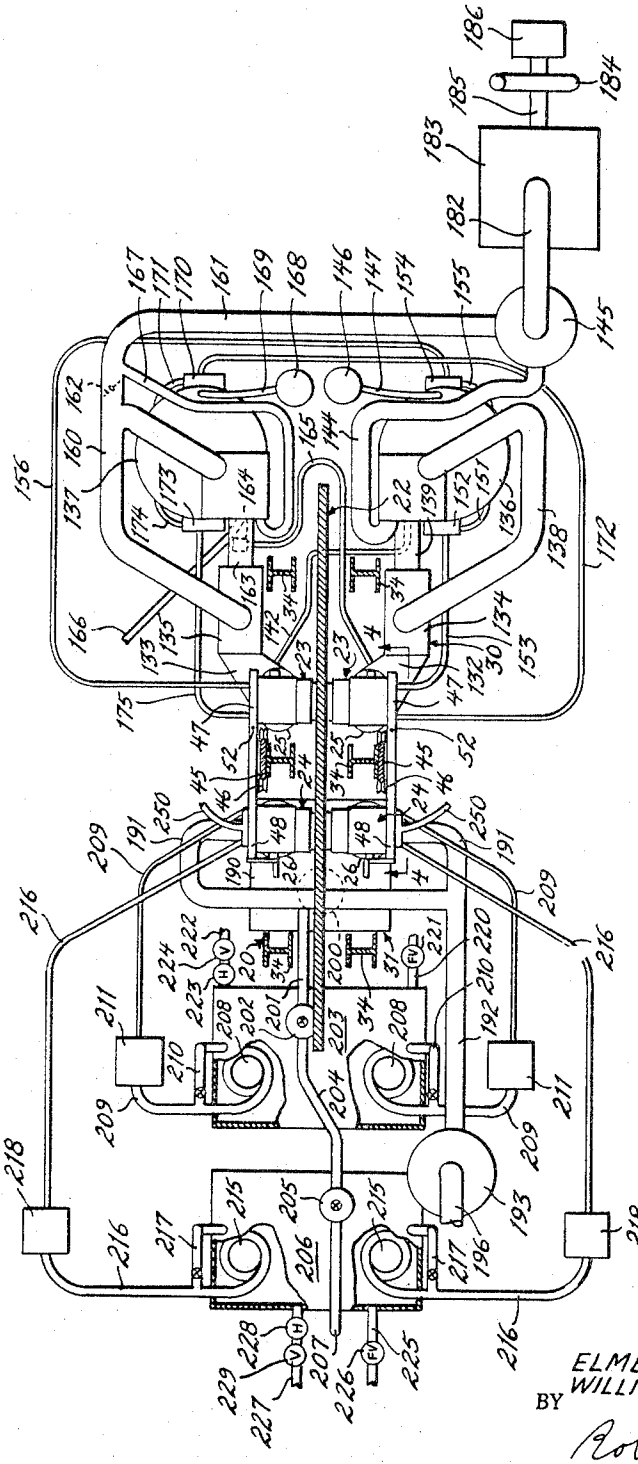


Fig. 2

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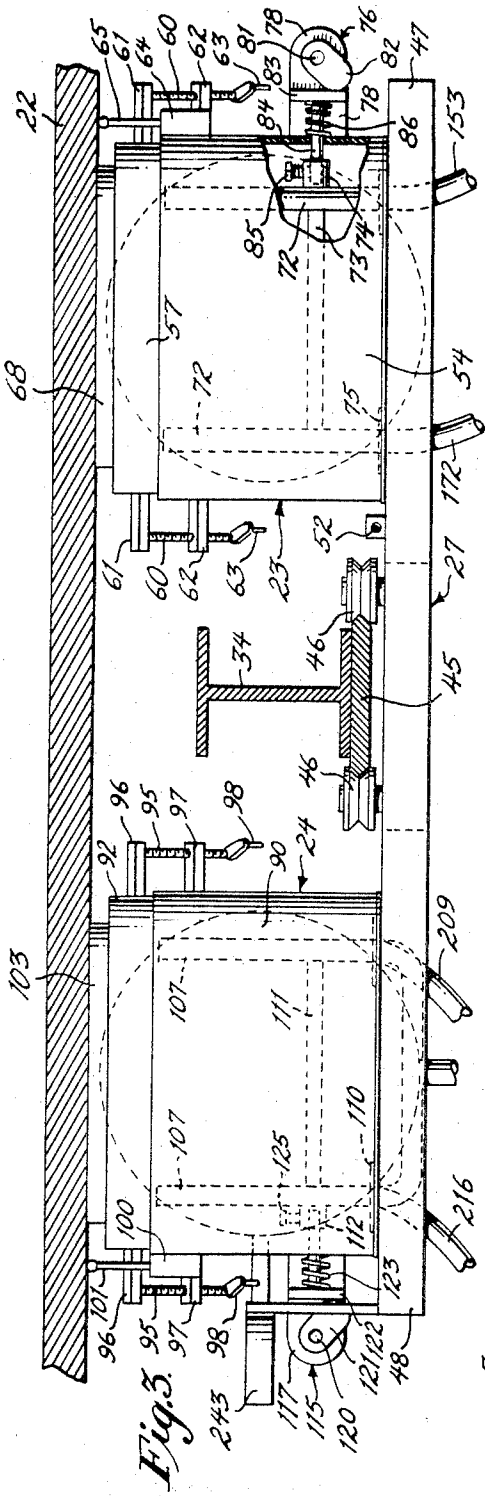


Fig. 5.

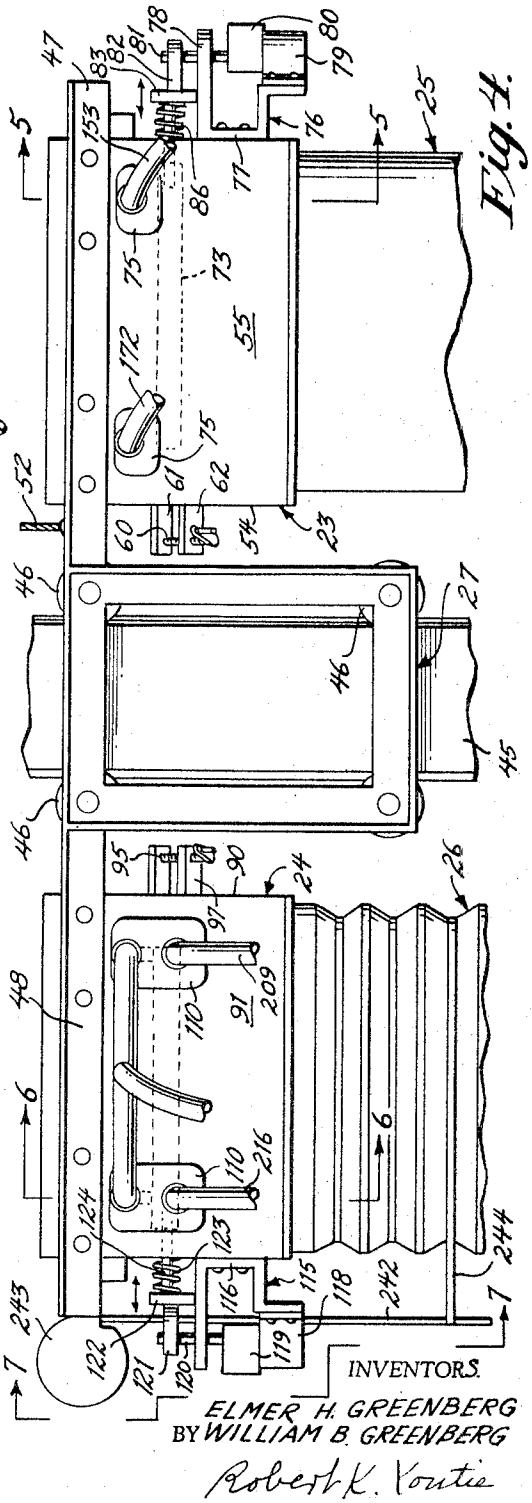


Fig. 4.

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APPARATUS FOR SURFACE-FINISHING METALWORK

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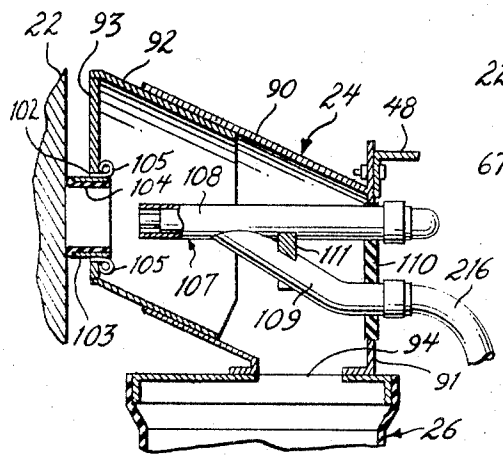


Fig. 6.

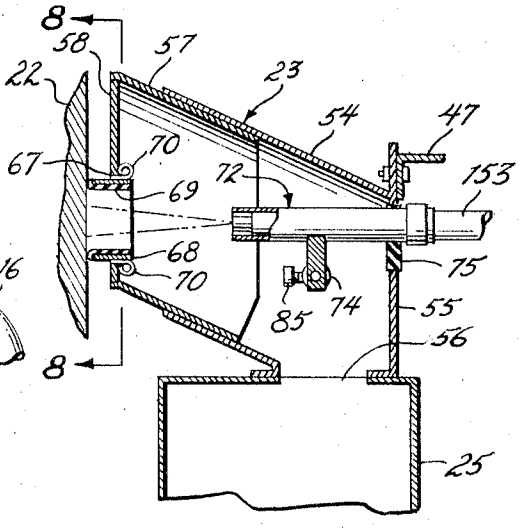


Fig. 5.

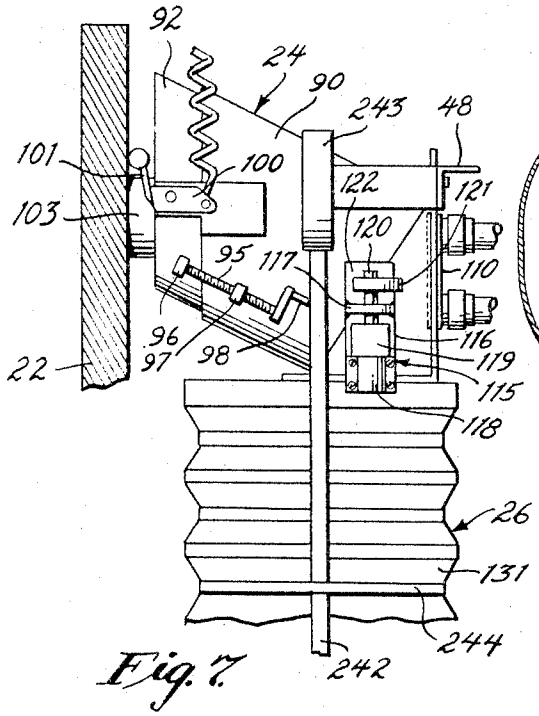


Fig. 7.

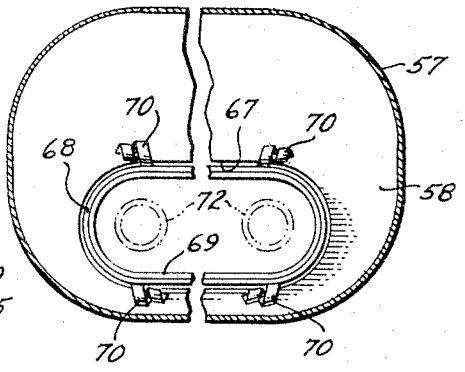


Fig. 8.

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APPARATUS FOR SURFACE-FINISHING METALWORK

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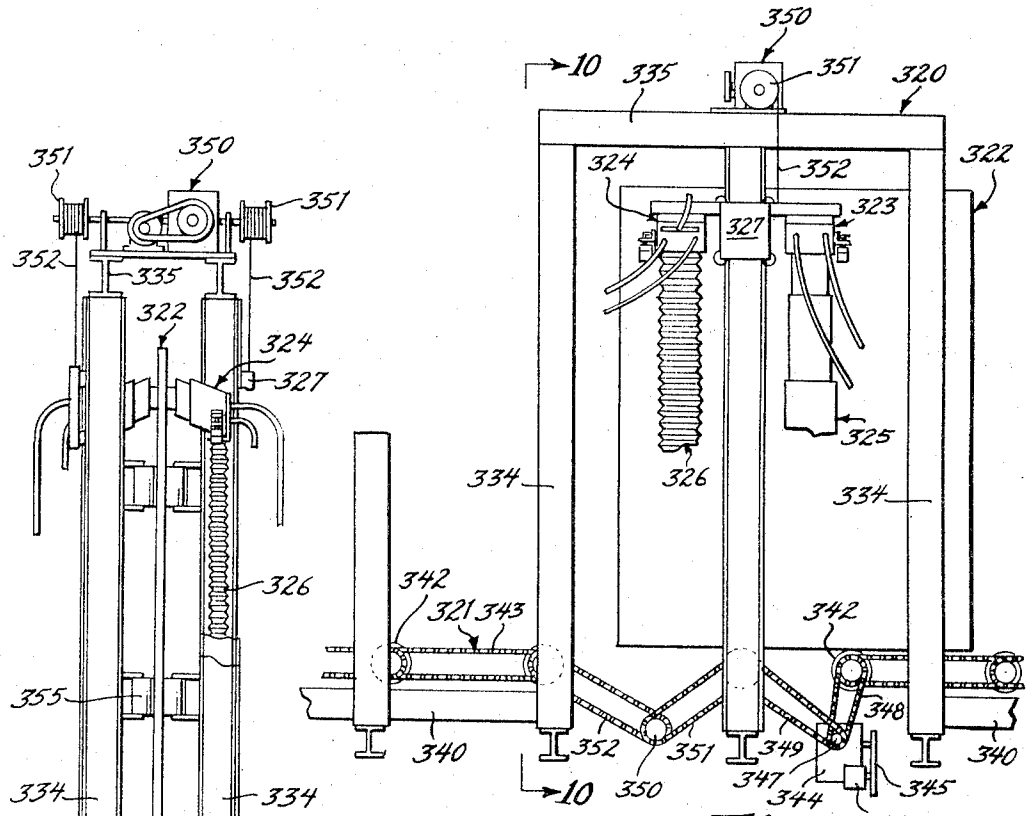


Fig. 9.

Fig. 10.

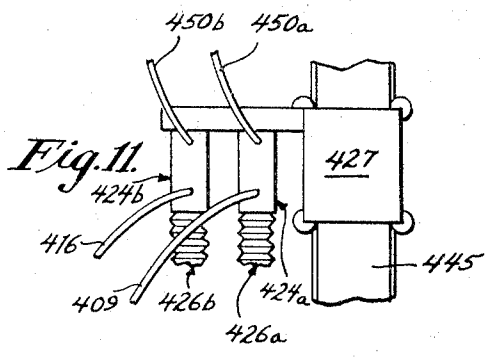


Fig. 11.

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Fig. 12.

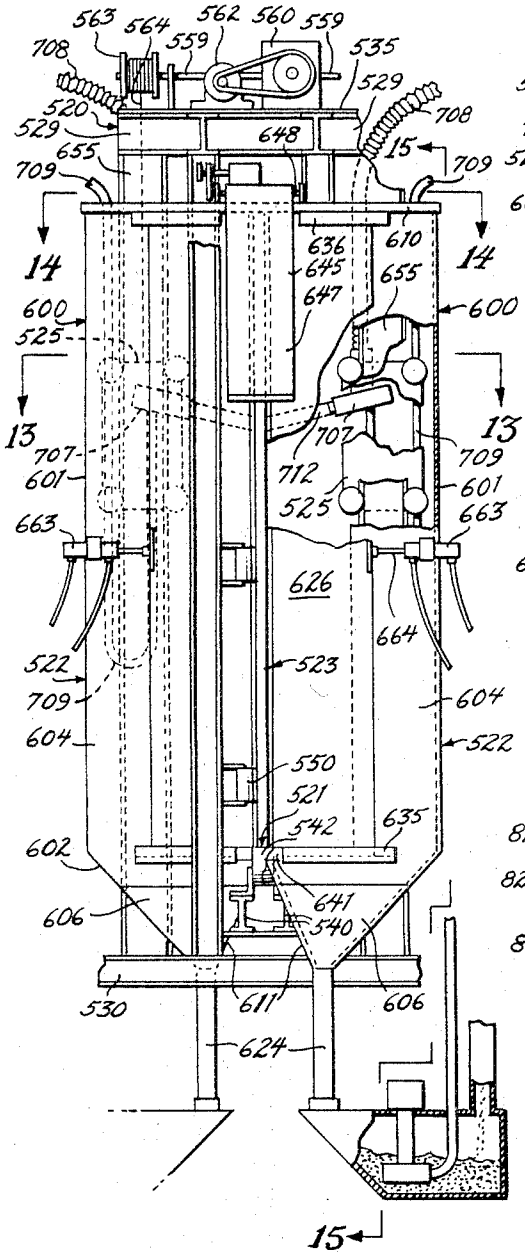


Fig. 13.

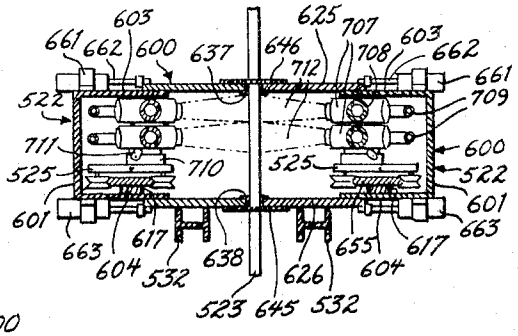
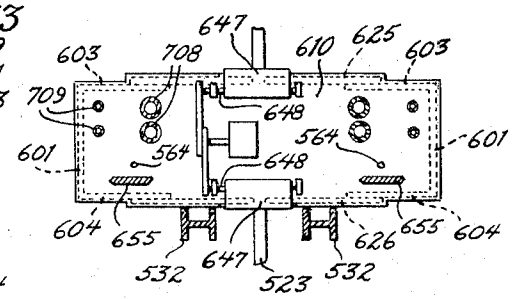


Fig. 14.



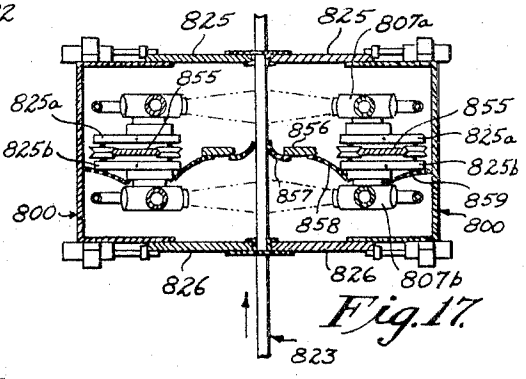


Fig. 17.

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APPARATUS FOR SURFACE-FINISHING METALWORK

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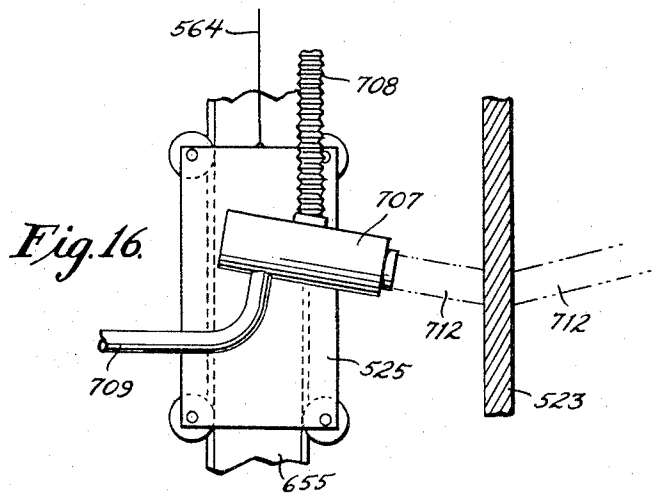


Fig. 16.

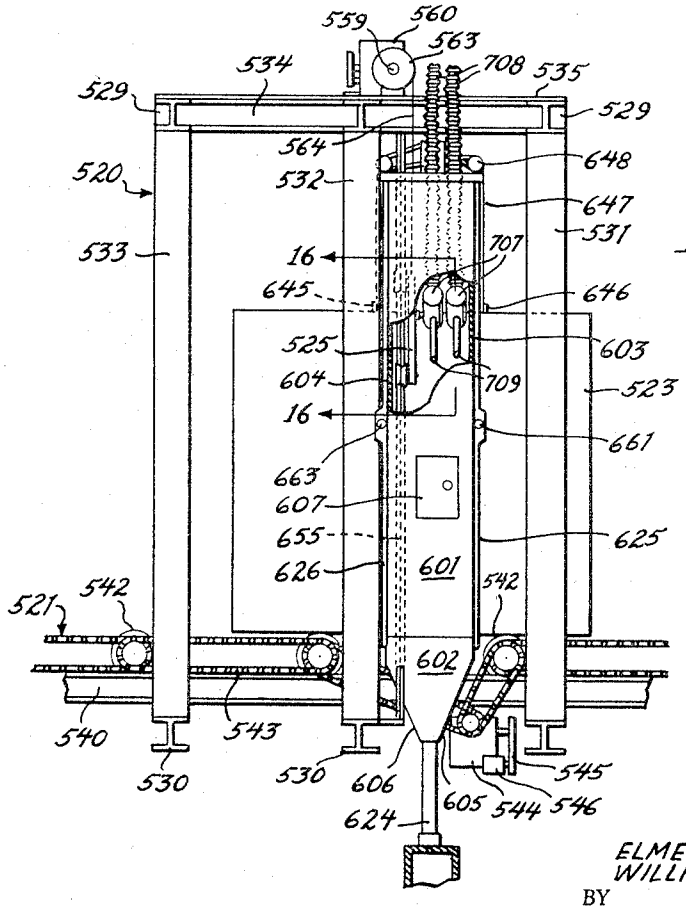


Fig. 15.

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APPARATUS FOR SURFACE-FINISHING METALWORK

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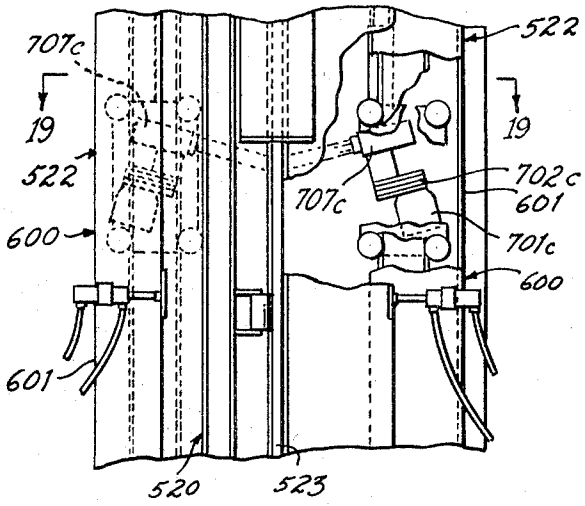


Fig. 18.

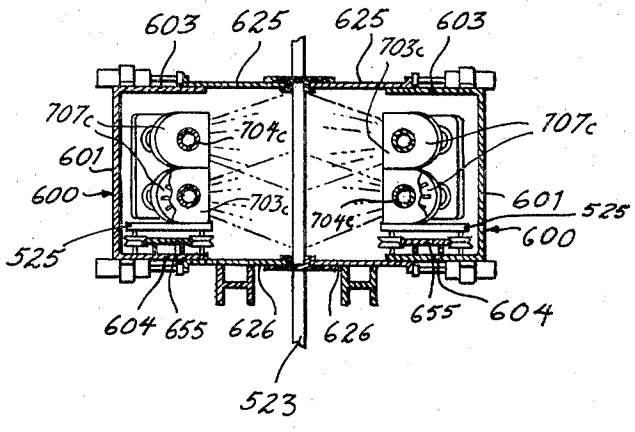


Fig. 19.

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3,434,241

APPARATUS FOR SURFACE-FINISHING METALWORK

Elmer H. Greenberg, Philadelphia, Pa., and William B. Greenberg, 1510 Brinton Park Drive, Wynnewood, Pa. 19096; said Elmer H. Greenberg assignor to said William B. Greenberg

Continuation-in-part of application Ser. No. 314,725, Oct. 8, 1963. This application Nov. 3, 1966, Ser. No. 591,757

Int. Cl. B24c 3/00

U.S. Cl. 51—14 12 Claims

ABSTRACT OF THE DISCLOSURE

A work conveyor with means for projecting different finishing materials against the work at successive locations along the path of work movement and means for collecting together the different finishing materials, separating the different finishing materials from each other, and returning the finishing materials for repeated projection.

This application is a continuation-in-part of our copending patent application Ser. No. 314,725, filed Oct. 8, 1963, now Patent No. 3,283,154, dated Nov. 8, 1966.

This invention relates generally to a highly improved apparatus for treating metal, and is especially concerned with surface treatment of metal plate and sheet, but without limitation thereto. The invention is more specifically relaed 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 apparatus 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 apparatus 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 features of construction, and combinations and arrangements of elements, 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 partially 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 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;

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

FIGURE 18 is a partial end elevational view, partly broken away, similar to FIGURE 12, but illustrating a slightly modified embodiment of the instant invention; and

FIGURE 19 is a horizontal sectional view taken generally along the line 19—19 of FIGURE 18.

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 collective 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 carriage 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 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 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 thru 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 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 embodiments of FIGURES 1–17 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 jiggler, generally designated 76 serving to jiggle or move the nozzles 72 relative to the body 54, for a purpose appearing presently. Each jiggler 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 guide way 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, 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 thru 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 the tube 103 is sufficient to accommodate 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 propellent fluid, nozzles may be employed which do not utilize separate propellent 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 jiggler 115, similar to the motion mechanism or jiggler 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 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 jiggler **115**, in the same manner as described hereinbefore in connection with the projectors **72** and jiggler **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 extensile 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 extensile 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 mean **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 each elevator **134** and **135** may be a bucket chain **149** 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 **136***a* 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 **136***a* may be a pressurized continuous operation blasting machine **136***b* 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 **136***c* to the blasting machine **136***b* 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 **136***b*. 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 propellent supply **150**, and also connected to blasting machine **136***b* 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 lefthand 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 conduits **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 mater. 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 conduit **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 **206** 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 **136*b***, 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 **136*b*** 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 the 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 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 preseparation 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 oscillating 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 jiggler 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 hereinafter.

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 conduits **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 discharge from separator **202** through conduit **204** is passed to separator **205** which separates out the reusable extra-fine abrasive slurry, discharging 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 jiggler 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.

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 strcture **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 con-

nected 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 simultaneous 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 serrations, frictional peripheral surfaces, or other 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 over-all 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 **424***a* and **424***b* are carried by a carriage **427** for movement along a track **445**. However, the projection heads **424***a* and **424***b* are respectively provided with separate collection conduits **426***a* and **426***b*. 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 **450***a* and **450***b* may be provided for respective projection heads **424***a* and **424***b*.

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 simutlaneous 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 suitable 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 funnellike 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 enclosures **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, extending 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 channellike 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 include 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 extensile 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 therethrough. The workpiece may be moved intermittently, and the projectors **707** moved vertically between horizontal steps of work movement, projecting treating material against oppositive 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 enclosures **600** and gravitationally falls therein to the lower enclosure regions, which are connected by outlet conduits **624** to suitable treating-material handling apparatus.

The 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 **825***a* and **825***b* on opposite sides of the track. Thus, a pair of carriages **825***a* and **825***b* 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 **825***a* and **825***b* is a respective projector **807***a* and **807***b*, 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 deflectable or deformable about one of the carriages **825***b* 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 **807***a* and **807***b*, the lips **858** and **859** parting to let the carriage **825***b* pass, but sealing against each other above and below the carriage. Thus, the streams of treating material from the respective projectors **807***a* and **807***b* may be kept separate and separately processed without commingling, if desired.

The remaining embodiment of FIGURES 18 and 19 is similar to that of FIGURES 12–16, but illustrates the use of projection means in the form of rotary, centrifugal wheels. There may be a frame **520** provided on opposite sides with treating assemblies **522** for applying treating material to a workpiece **523** carried by suitable conveyor means in upstanding relation through the workpiece. The treating assemblies **522** are located on opposite sides of the path of workpiece **523** for treating respective faces thereof, and may be substantially identical.

Each treating assembly **522** may include a generally upright or vertically elongate enclosure **600**, which enclosures may be essentially similar to the correspondingly numbered enclosures of the embodiment of FIGURES 12–15. Thus, each enclosure **600** may have an upright outer wall **601**, and a pair of side walls **603** and **604**, see FIGURE 19. The enclosures **600** may have their upper and lower ends constructed in substantially the same manner as those of FIGURE 12, and may each further include adjustably movable closure plates or shutters **625** and **626** similar to those of corresponding number in FIGURES 12 and 13.

Interiorly of each enclosure **600** there may be fixed an upright track or rail **655** carrying a carriage **525** for up-and-down movement along the respective track. Suitable drive means are provided for effecting vertical movement of the carriages **525**, as in a previously described embodiment.

Mounted on each of the carriages **525**, for vertical movement therewith, are a pair of side-by-side projectors or centrifugal throwing wheels **707***c*. Associated with each throwing wheel **707***c* is a drive motor **701***c* for driving the respective wheel, and suitable power-transmission means **702***c* for connecting the wheel in driven relation with the motor. The centrifugal wheels are each enclosed in a housing **703***c* which opens toward the workpiece **523** for directing treating material from the wheels to the work.

A feed conduit **704***c* may be connected to each wheel housing **703***c*, say to the upper side thereof for gravitationally feeding treating material centrally to the associated throwing wheel, for centrifugal impelling of the material by the wheel. The feeding conduits **704***c* may be telescopic, or otherwise extensile and retractile for accommodating up-and-down movement of the carriages **525**.

As in the previously described embodiments, the adjacent pairs of material-projection means, or wheels **707***c* may project different treating materials, which are commingled in collection and processed in the manner described hereinbefore for return to respective wheels.

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 the 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 an apparatus 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 purposes 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. Apparatus for surface-finishing of a metal piece of work, said apparatus comprising conveyor means for conveying a piece of work along a path, plural projection

means at successive locations along said path for separately projecting different finishing materials against the work, collection means for collecting together the different finishing materials and foreign matter after impingement of the finishing materials against the work, separation means connected to said collection means for separating the collected different finishing materials from each other, and plural return means connected between said separation means and respective projection means for returning the different finishing materials to their respective projection means.

2. Apparatus according to claim 1, said separation means comprising a plurality of separators connected in series for successively removing said different finishing materials from the collected material, said return means being connected between respective separators and their associated projection means.

3. Apparatus according to claim 1, said separation means comprising a pair of separators connected in parallel between said collection and return means, and crossover feed means connected between said separators for feeding refuse from each separator to the inlet of the other separator.

4. Apparatus according to claim 3, one of said separators comprising means for separating reusable coarse solids from a remainder of fine and extra-fine solids, and the other separator comprising means for separating reusable fine solids from a remainder of coarse and extra-fine solids.

5. Apparatus according to claim 4, said other separator comprising a coarse-solids removal stage, and an extra-fine-solids removal stage.

6. Apparatus according to claim 1, said plural projection means comprising plural fluid-pressure nozzles for projecting particulate finishing material.

7. Apparatus according to claim 1, said plural projection means comprising plural fluid-pressure nozzles for projecting particulate finishing material in liquid suspension, and said separation means comprising separators for separating solids in liquid suspension.

8. A surface-finishing apparatus comprising an enclosure located for communication with a surface to be finished, projection means associated with said enclosure for projecting finishing material from said enclosure against the surface to be finished for rebound of the finishing material into said enclosure, motive means for effecting relative movement between the projection means and the surface to be finished, and oscillatory means for moving the projection means transversely of said relative movement, said enclosure comprising a hood mounted for movement with said projection means relative to said surface.

9. A surface-finishing apparatus according to claim 8, said projection means being mounted for said transverse movement relative to said hood.

10. A surface-finishing apparatus comprising an enclosure located for communication with a surface to be finished, projection means associated with said enclosure for projecting finishing material from said enclosure against the surface to be finished for rebound of the finishing material into said enclosure, motive means for effecting relative movement between the projection means and the surface to be finished, and oscillatory means for moving the projection means transversely of said relative movement, said enclosure comprising a fixed cabinet, and said projection means being mounted in said cabinet for movement therein by said motive means.

11. Apparatus for surface-finishing metalwork, said apparatus comprising projection means for projecting a slurry of liquid and solid finishing material against the work, collection means for collecting the slurry and foreign matter after impingement against the work, separation means connected to said collection means for separating a slurry of reusable finishing material from the collected material, specific-gravity-sensing means for sensing the specific gravity of the separated slurry, feed means for adding liquid and finishing material to the separated slurry to adjust the specific gravity thereof, and return means connected between said separation means and projecting means for returning the adjusted slurry to said projection means.

12. Apparatus according to claim 11, in combination with volume-sensing means for sensing the volume of separated slurry, said feed means further serving for adjustment of the volume of separated slurry.

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