March 14, 1944. D. C. TURNBULL 2,344,476

ABRADING APPARATUS

Filed Dec. 31, 1941 7 Sheets-Sheet 1

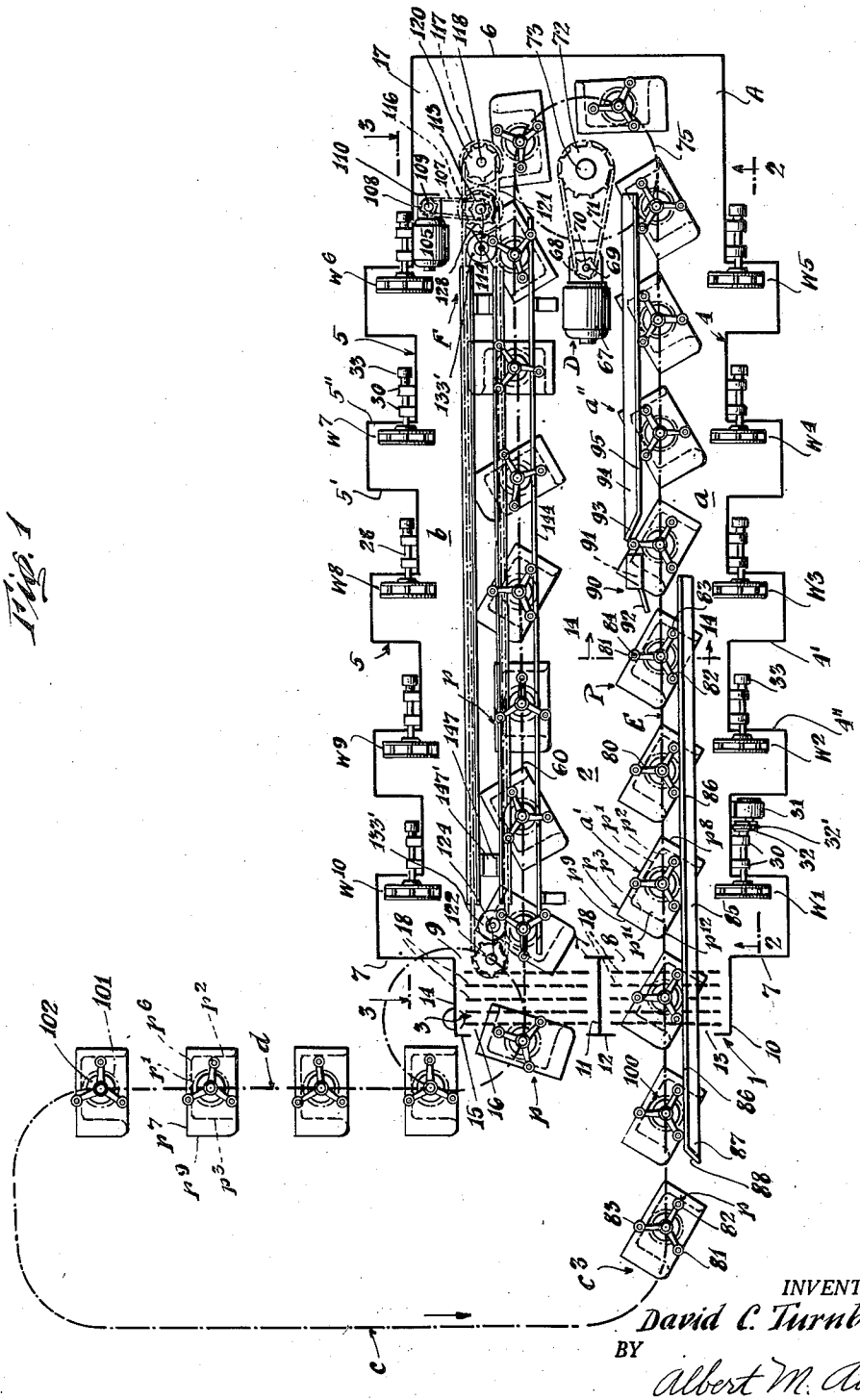


Fig. 1

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March 14, 1944. D. C. TURNBULL 2,344,476

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Filed Dec. 31, 1941 7 Sheets-Sheet 2

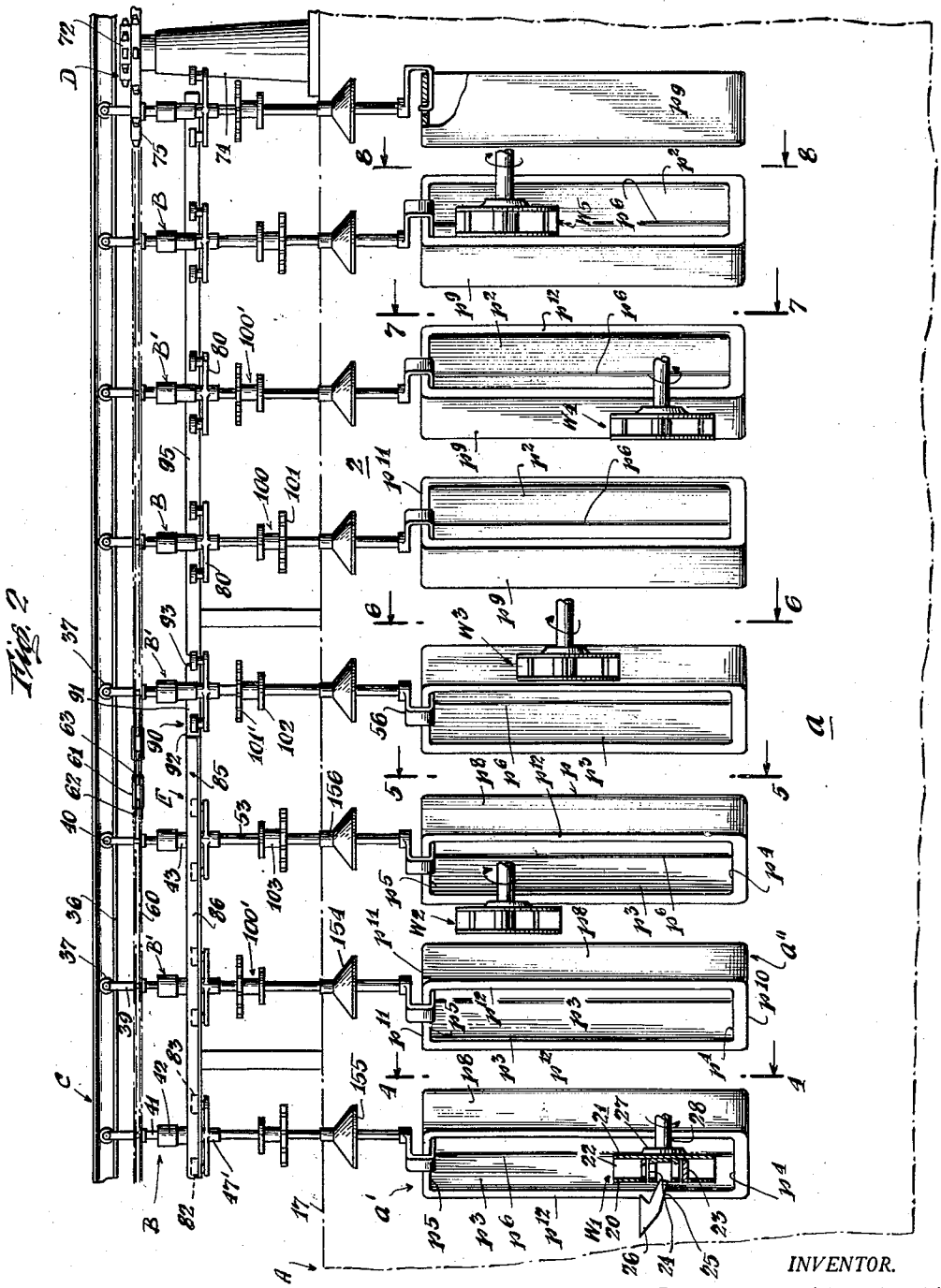


Fig. 2

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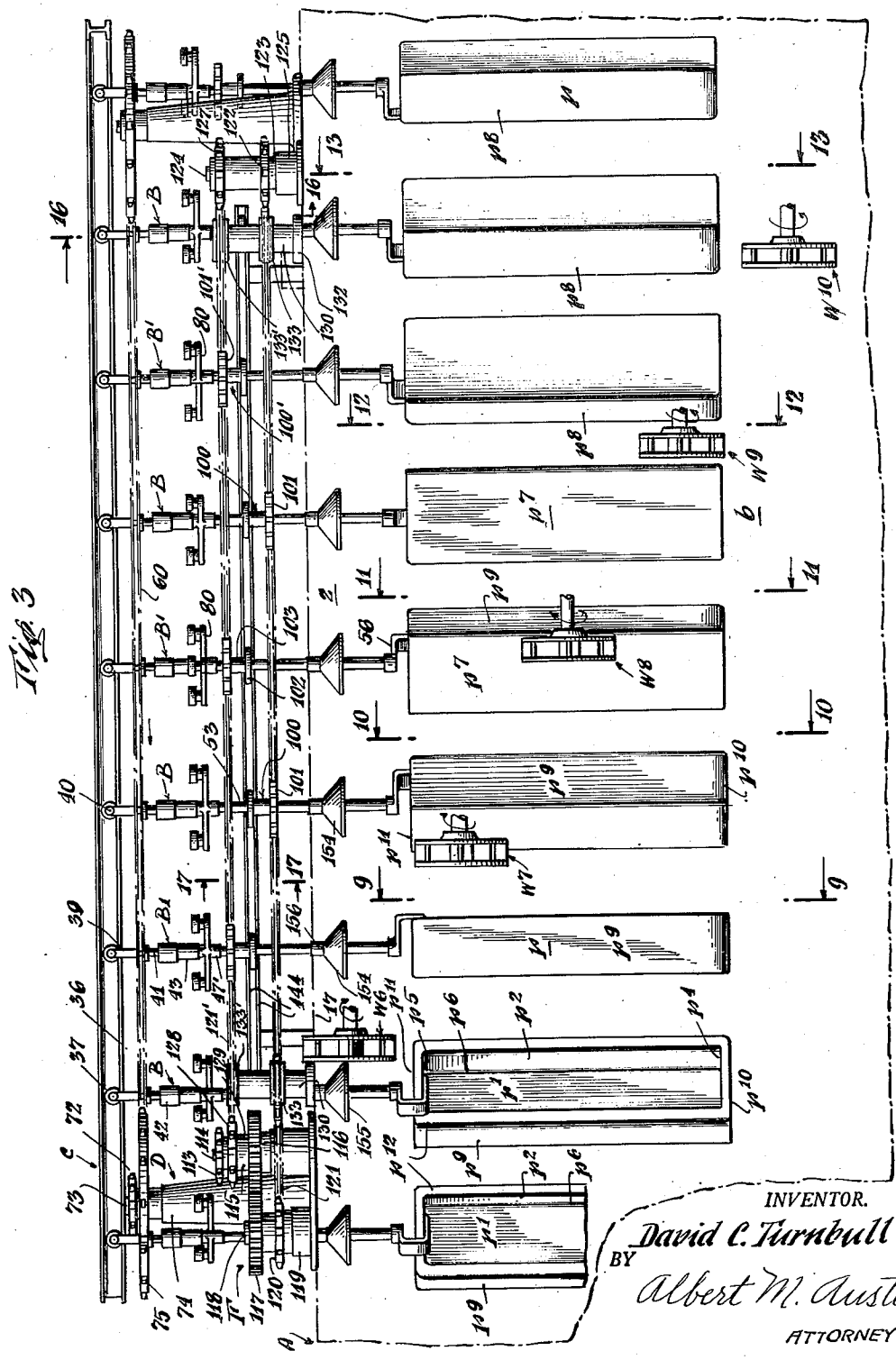
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ABRADING APPARATUS

Filed Dec. 31, 1941 7 Sheets-Sheet 3

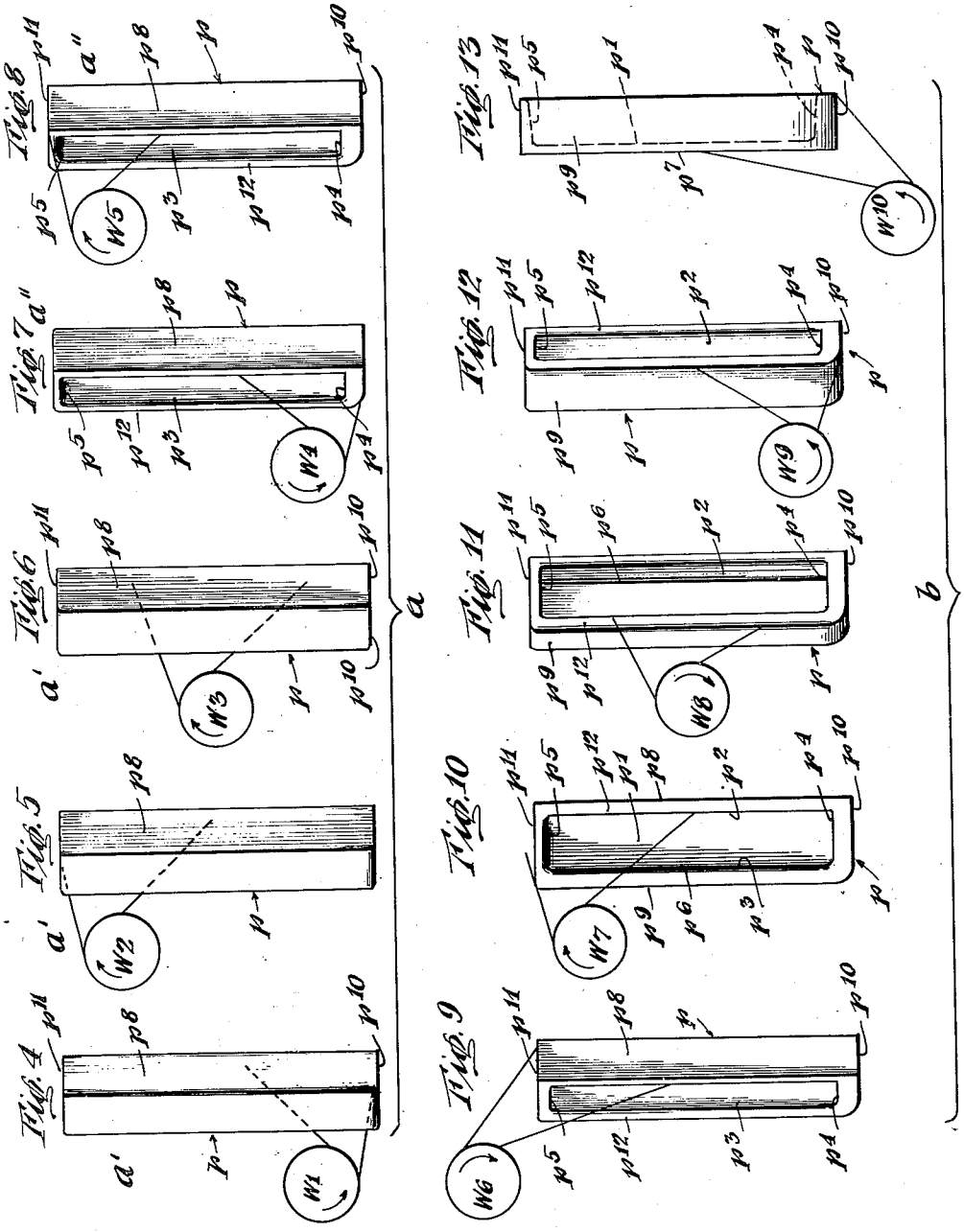


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March 14, 1944. D. C. TURNBULL 2,344,476

ABRADING APPARATUS

Filed Dec. 31, 1941 7 Sheets-Sheet 5

Fig. 14

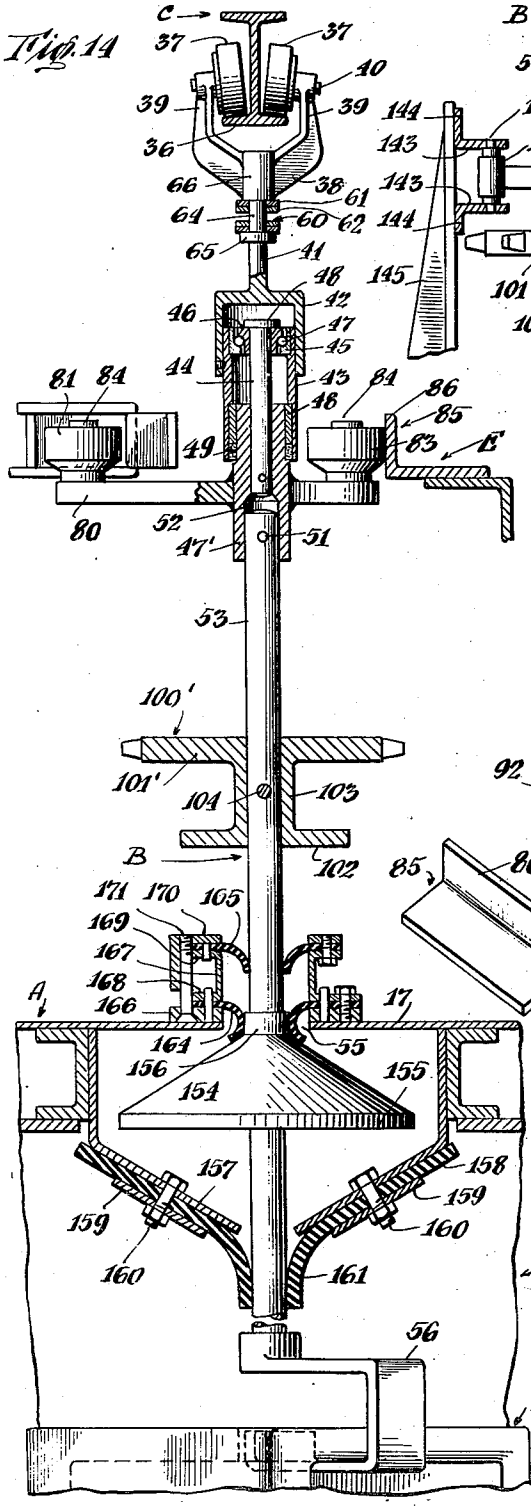


Fig. 17

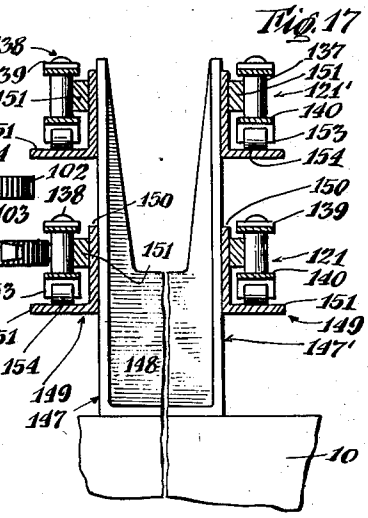
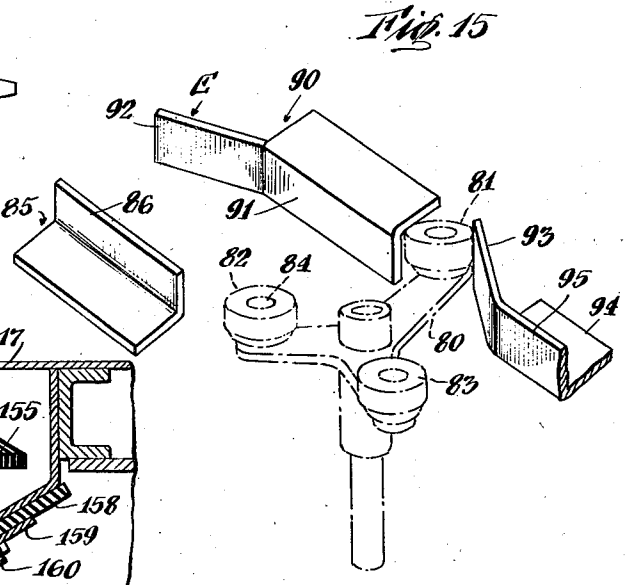


Fig. 15



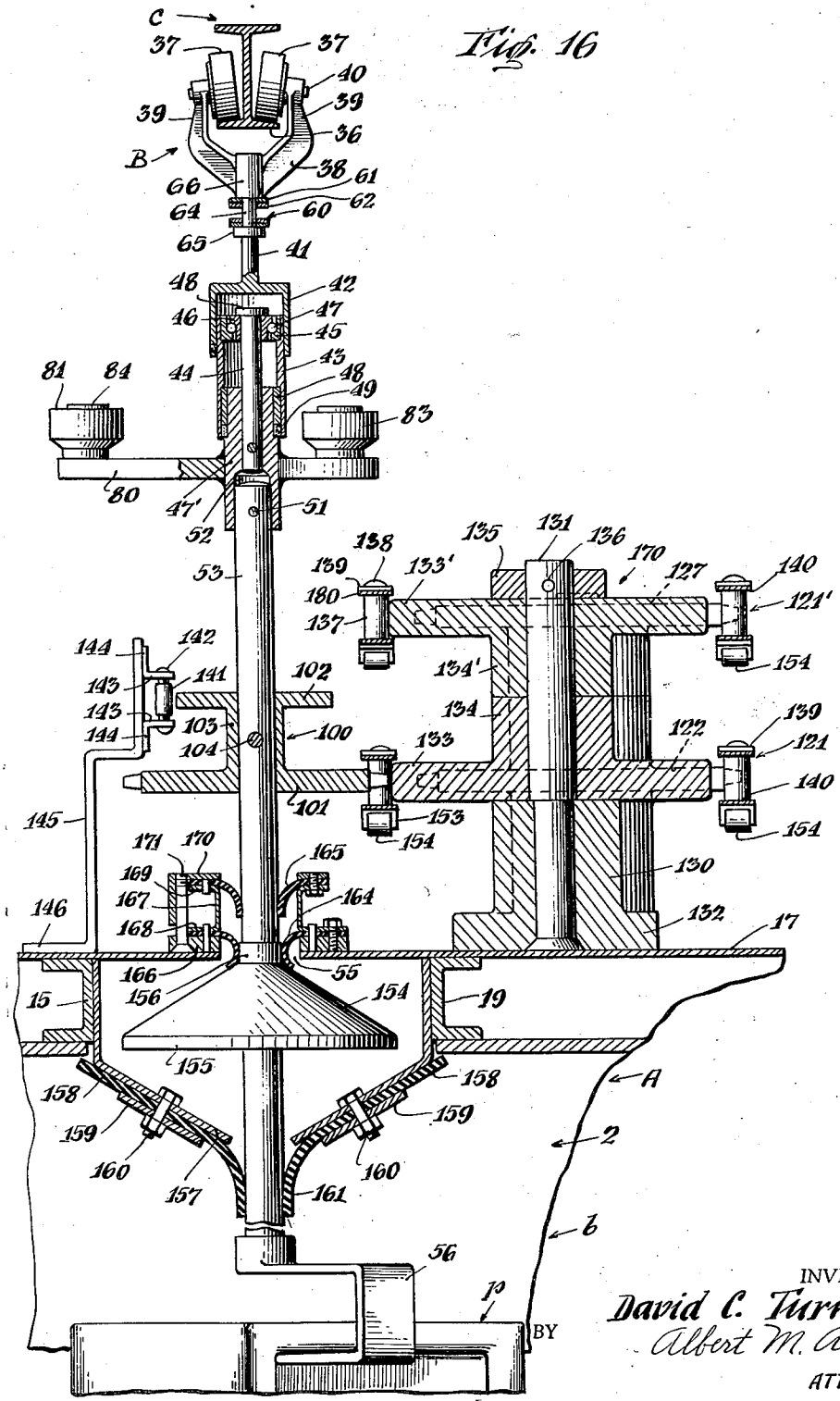
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ABRADING APPARATUS

Filed Dec. 31, 1941 7 Sheets-Sheet 6

Fig. 16

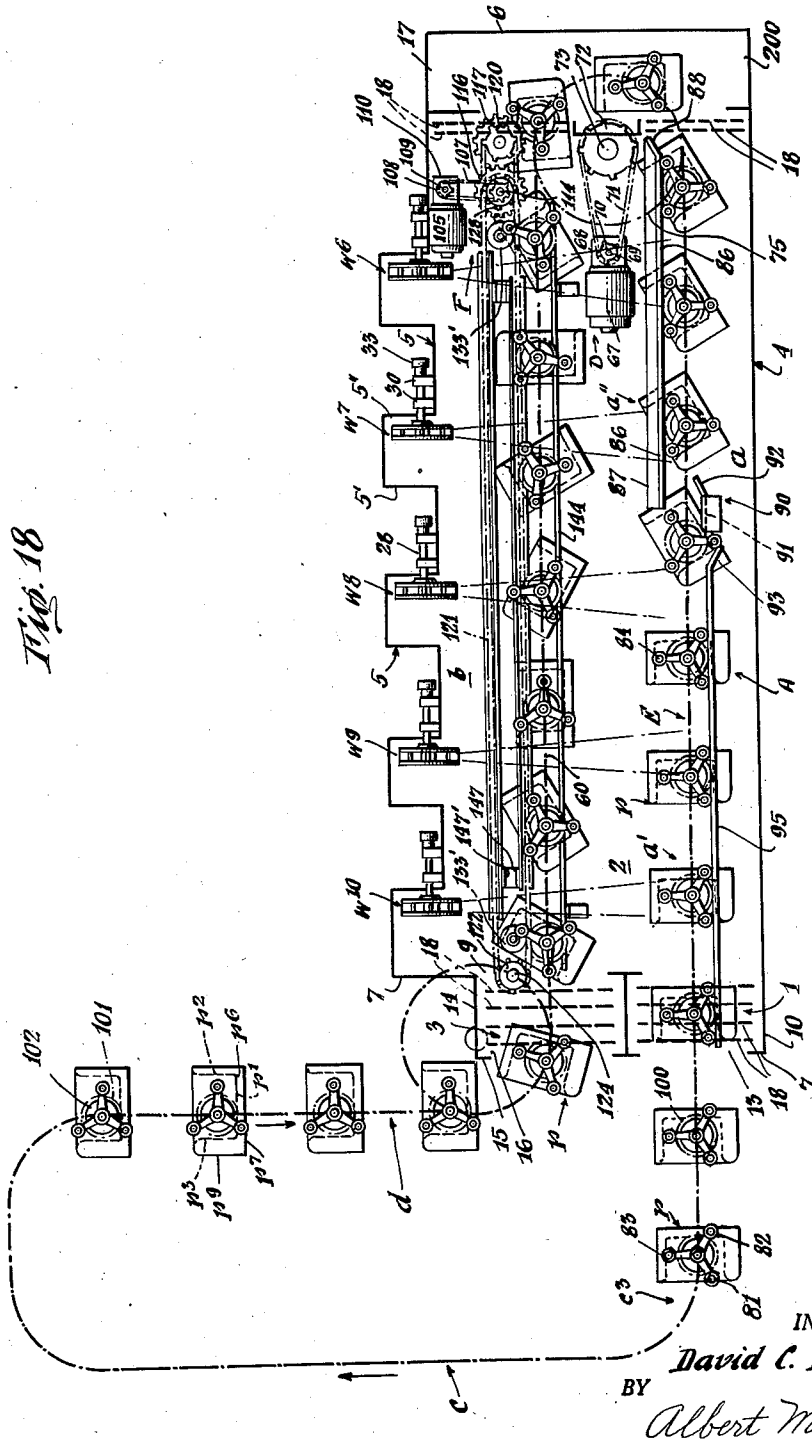


March 14, 1944. D. C. TURNBULL 2,344,476

ABRADING APPARATUS

Filed Dec. 31, 1941 7 Sheets-Sheet 7

Fig. 18



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UNITED STATES PATENT OFFICE

2,344,476

ABRADING APPARATUS

David C. Turnbull, Mishawaka, Ind., assignor to The American Foundry Equipment Company, Mishawaka, Ind., a corporation of Delaware

Application December 31, 1941, Serial No. 425,083

14 Claims. (Cl. 51—9)

This invention relates to abrading apparatus, and more particularly to blast cleaning apparatus wherein the work pieces are suspended on hangers and conveyed through any desired number of abrasive streams fired from centrifugal abrasive projectors.

Certain metal workpieces require complete and thorough cleaning and removal of scale, encrusted sand, and rough metal from certain areas thereof, while other areas which are to be positioned against a floor or wall, for example, require less thorough blast cleaning. This is particularly true of such metal ware as cast iron bathtubs, sinks and the like, whose exposed surfaces are to be coated with a porcelain enamel which must be perfectly smooth. This requires that the hollow interior surfaces as well as one or both exterior side wall surfaces and one or both exterior end wall surfaces be thoroughly cleaned so as not only to remove scale and encrusted sand but also to smooth out rough metal projections to provide a base surface to which the porcelain enamel will tenaciously adhere. The outside surface of the bottom wall of tubs and sinks, for example, need not be as thoroughly blast cleaned since these surfaces are in contact with the floor or walls of the room and are not exposed.

Since the blast cleaning operation adds to the cost of manufacture in proportion to the extent of the blast cleaning performed, it is desirable to keep blast cleaning costs to a minimum and not unnecessarily blast clean surfaces which will not be exposed or do not require extensive blast cleaning but to concentrate the cleaning operation on the surfaces which are exposed and which are to receive the porcelain enamel or other coating, so that a high grade product can be produced which is eminently satisfactory for use and lasting in service.

High speed low cost cleaning can best be attained by the use of centrifugal blasting wheels having means associated therewith for accurately controlling the direction of fire of the abrasive blast, as illustrated in Peik Pat. No. 1,953,566. Such abrasive throwing wheels are capable of throwing many hundreds of pounds of abrasive per minute at high abrading velocity with the projected stream fired in a predetermined direction and within a predetermined limited blasting zone. However, due to the weight and speed of rotation of such blasting wheels, it is generally most convenient to maintain the wheels in relatively stationary position and manipulate the workpieces in each of the blast streams.

An object of this invention is to provide improved blasting apparatus for conveying the workpieces into and through the blasting streams of a plurality of abrasive blasting wheels and for manipulating the workpieces in said streams in a manner to thoroughly clean and polish such areas as required through cleaning and to rough clean such areas as require only superficial cleaning.

Another object of this invention is to provide improved blasting apparatus whereby the major portion of the abrasive projected from the centrifugal blasting wheels is employed in cleaning such surfaces of the workpieces as require thorough and complete cleaning.

Another object of this invention is to provide improved blasting apparatus whereby the exposed surfaces of bathtubs, sinks, and like hollow metal may be thoroughly blast cleaned, whereby a tenacious bond between the enamel coating and metal can be effected and a smooth finish produced and whereby the non-exposed or concealed surfaces may be subjected to only rough cleaning.

A further object of this invention is to provide improved blasting apparatus which is substantially automatic, foolproof, smooth and efficient in operation, sturdy and lasting in construction, simple in design, and which permits higher production speed at relatively lower costs than apparatus of this type heretofore provided.

Other objects will become apparent as the disclosure proceeds.

Various other features and advantages of the invention will be apparent from the following particular description and from an inspection of the accompanying drawings.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 is a top plan view of my improved blast cleaning apparatus illustrating the manner in which hollow metal ware such as bathtubs are subjected to thorough blast cleaning on the exposed surfaces thereof and to minor blast clean-

ing on the non-exposed surfaces which require only superficial blast cleaning;

Fig. 2 is an enlarged elevational view of that part of the blast cleaning apparatus embodying one cleaning zone where thorough cleaning of certain exposed surfaces is effected as it appears when viewed along line 2—2 of Fig. 1;

Fig. 3 is an enlarged elevational view of that part of the blast cleaning apparatus embodying another cleaning zone where the certain exposed exterior surfaces are thoroughly cleaned and where certain unexposed surfaces are superficially cleaned as it appears when viewed along line 3—3 of Fig. 1;

Figs. 4 to 8, inclusive, are diagrammatic illustrations of the blast cleaning operation carried out in the blasting zone as illustrated in Fig. 2; Fig. 3 showing the operation as it appears when viewed along line 4—4 of Fig. 2; Fig. 5 showing the operation as it appears when viewed along line 5—5 of Fig. 2; Fig. 6 showing the operation as it appears when viewed along line 6—6 of Fig. 2; Fig. 7 showing the operation as it appears when viewed along line 7—7 of Fig. 2; and Fig. 8 showing the operation as it appears when viewed along line 8—8 of Fig. 2;

Figs. 9 to 13, inclusive, are diagrammatic illustrations of the blast cleaning operation carried on in the other blasting zone as illustrated in Fig. 3; Fig. 9 showing the operation as it appears when viewed along line 9—9 of Fig. 3; Fig. 10 showing the operation as it appears when viewed along line 10—10 of Fig. 3; Fig. 11 showing the operation as it appears when viewed along line 11—11 of Fig. 3; Fig. 12 showing the operation as it appears when viewed along line 12—12 of Fig. 3; and Fig. 13 showing the operation as it appears when viewed along line 13—13 of Fig. 3;

Fig. 14 is an enlarged vertical cross-sectional view through one of the work-supporting hangers and the mechanism for guiding the hangers and suspended workpieces through the first blasting zone as the same appears when looking along line 14—14 of Fig. 1;

Fig. 15 is a fragmentary top view of the mechanism for guiding the hangers through the blasting zone shown in Fig. 2;

Fig. 16 is an enlarged vertical cross-sectional view through one of the work-supporting hangers and adjacent spinner chain-guiding and bulging devices, as the same appears when looking along line 16—16 of Fig. 3;

Fig. 17 is an enlarged fragmentary vertical cross-sectional view showing a portion of a work-supporting hanger and adjacent spinner chain-guiding and supporting devices as the same appear when viewed along line 17—17 of Fig. 3; and

Fig. 18 is a top plan view of the apparatus which is designed to carry the ware or articles to be cleaned through the cabinet in a direction opposite to that illustrated in Fig. 1 and in which only one set of centrifugal blasting wheels are employed.

Similar reference characters refer to similar parts throughout the several views of the drawings and the specification.

Referring to the drawings, the blasting apparatus comprises generally a blast cabinet A into which the workpieces *p* are conveyed by workpiece suspension hangers B and B' which are adapted to roll along a circuitous track C. The surfaces of the workpieces *p* are blasted with abrasive during their travel through the cabinet A, by a plurality of centrifugal abrasive throwing wheels which operate to project controlled streams of abrasive against the surface of the workpieces. The workpiece-supporting hangers B and B' are continuously advanced through one blasting zone *a* and another blasting zone *b* by means of hanger-advancing mechanism D. The hangers and their supported workpieces are retained in a definite position during the initial stages of their advance through the blasting zone *a* and are then swung through a small arc during the second stage of their advance through the blasting zone *a* by hanger-guiding and manipulating mechanism E. Mechanism F is provided for also rotating the workpiece-supporting hangers and the suspended workpieces during their travel through blasting zone *b* where the workpieces are subjected to further cleaning action.

As shown more particularly in Fig. 1, the blast cabinet A comprises generally an entrance vestibule section 1, a blast section 2 which contains blasting zones *a* and *b*, and an exit vestibule section 3. The entrance and exit vestibule sections provide hallways through which the work-supporting hangers move when entering and leaving the main blast section 2 disposed therebetween. Main blasting section 2 may be generally rectangular in outline having a relatively long front side wall 4 upon which the abrasive throwing wheels firing abrasive into the first blasting zone *a* are supported, and a rear side wall 5 which supports the blasting wheels firing abrasive into the second blasting zone *b*. The cabinet may be closed at one end by an end will 6 and the other end wall 7 may be provided with an entrance opening 8 through which the workpieces enter and an exit opening 9 through which the workpieces leave the main blasting section 2 of the cabinet. The entrance vestibule 1 provides a hallway through which the workpieces *p* enter the blasting section 2 through the entrance opening 8, the entrance vestibule 1 having enclosing side walls 10 and 11 and an entrance wall 12 having an entrance opening 13. The exit vestibule 3 is likewise defined by side walls 11 and 14 and entrance wall 15 having an exit opening 16.

The top of the entire cabinet A may be covered and enclosed by a top wall 17 which closes the top of the entrance vestibule 1, the main blasting section 2 and exit vestibule 3. The enclosing walls of the cabinet are braced and supported by suitable framing members so arranged and constructed as to rigidly support all the walls of the cabinet and the various operating mechanisms thereto attached. A plurality of rubber curtains or flaps 18 may be suspended in the entrance vestibule 1 and exit vestibule 3 to prevent the escape of abrasive from the main blasting section 2 through the entrance and exit vestibules. Suitable abrasive hoppers and abrasive cycling mechanism (not shown) may be incorporated with the cabinet for cycling the abrasive from and to the various abrasive throwing wheels and for removing foreign matter and broken abrasive and dust from the abrasive cycled to the abrasive throwing wheels.

The conveyor track C may be of any desired length to convey the workpieces from a loading zone *c* through the first blasting zone *a*, through the second blasting zone *b*, and out of the cabinet to an unloading zone *d*. That part of the track which supports the hangers in their travel through the primary blasting zone *a* and secondary blasting zone *b* is positioned above the top wall 17 of the cabinet, as illustrated more particularly in Figs. 2, 3, 14 and 16. That part of the track C which extends along the loading zone

c and that part of the track which extends along the unloading zone d may be positioned beyond the cabinet but nevertheless lead to and away from the cabinet, so that the workpieces can be conveniently transported from and transported to other locations in the plant where other operations on the workpieces have been or will be performed.

This invention is particularly directed to a combination of centrifugal blasting wheels and work-supporting hangers having associated therewith mechanism for retaining those areas of the workpieces which are to be thoroughly cleaned directly in the path of the centrifugally projected streams during their travel through one cleaning zone a so as to thoroughly clean and prepare such areas for enameling or subsequent treatment, and to rotate the workpieces in other centrifugally projected streams projected at zone b so as to treat other surfaces to a lesser degree or to such degree as such other surfaces require. To more clearly illustrate this invention, the drawings illustrate a series of bathtubs undergoing blast cleaning treatment, but it will be understood that other hollow ware and numerous other articles requiring the surfaces thereof to be treated in varying degrees by the abrasive blast may be cleaned by apparatus constructed in accordance with the principles of this invention.

Bathtub workpieces p, shown in the drawings for purposes of illustration, require that the interior bottom surface p^1, the interior side wall surfaces p^2 and p^3, the interior end wall surfaces p^4 and p^5, the top edge surfaces p^{12}, the interior corners p^6, and one or both exposed exterior side wall surfaces p^8 and p^9 and one or both exposed exterior end wall surfaces p^{10} and p^{11}, be thoroughly and completely blast cleaned so that not only all scale and encrusted sand are removed but, in addition, these surfaces should be smoothed down and peened to the point where the porcelain enamel coating later applied will not only present a smooth and finished surface but will be tenaciously bonded to the metal. Thorough cleaning of these surfaces is effected in the blasting zone a by a plurality of abrasive throwing wheels W^1, W^2, W^3, W^4 and W^5, which are so arranged that the abrasive streams projected therefrom effectively attack the interior surfaces p^1, p^2, p^3, p^4, p^5 and p^6, and the top edge surface p^{12}, and the exterior side wall surfaces p^8 and p^9. Mechanism is provided for guiding and presenting these surfaces to the full force of the abrasive blasts projected into blasting zone a. This mechanism includes parts which are fixed to each of the hangers and parts which are independently supported.

In the other blasting zone b a plurality of abrasive throwing wheels W^6, W^7, W^8, W^9 and W^{10} are provided which are so arranged as to project their streams of abrasive against all exterior surfaces as well as the interior surfaces of the workpieces as they travel therethrough. This is effected by the provision of mechanism F for rotating the workpieces suspended by the hangers during their travel through the blasting zone b so as to finally clean, polish and peen the interior surfaces p^1, p^2, p^3, p^4, p^5 and p^6, the top edge p^{12} and exterior side wall surfaces p^8 and p^9 previously subjected to the abrasive blast in zone a, and in addition to thoroughly clean, polish and peen the exterior end wall surfaces p^{10} and p^{11} and to clean the exterior bottom wall surface p^7 sufficiently to remove encrusted sand and scale.

In order that the workpieces p may be arranged as close together as possible and thereby utilize the projected abrasive streams to the maximum in cleaning the workpieces p, the hangers and the workpieces suspended therefrom are positioned relatively close together. It is obvious that the workpieces may be suspended in closer relationship if all alternate workpieces moving through blasting zone b are rotated in one direction and all intermediate workpieces moving through blasting zone b are rotated in the opposite direction. This invention, therefore, further comprehends improved mechanism for rotating all the alternate hangers B while moving through blasting zone b in one direction and for rotating all the intermediate hangers B' moving through blasting zone b in the opposite direction.

Any desired number of abrasive throwing wheels may be provided as may be necessary or desirable to effectively clean the surfaces of the workpieces p under treatment at the desired production speeds. While I have illustrated in Figs. 1, 2 and 3 five abrasive throwing wheels for projecting abrasive into the one treating zone a and five wheels for projecting abrasive into the other treating zone b, it will be appreciated that this invention is in no wise limited to the use of only such number of abrasive throwing wheels but any desired number thereof may be provided. The abrasive throwing wheels preferably used are control cage and impeller type wheels, such as disclosed in Peik Pat. No. 1,953,566 having certain refinements in design as illustrated in Unger Pat. 2,162,139.

Each wheel comprises generally a pair of side wall forming discs 20 and 21 having channel-shaped abrasive throwing blades 22 mounted therebetween, which extend inwardly short of the axis of rotation of the wheel to provide a central space. A tubular control cage 23 extends into the central space of the wheel and is normally stationary during operation of the wheel but is so mounted that it may be adjusted to place the discharge outlet in the cage in any desired clock-dial position to regulate the direction of fire of the abrasive stream projected therefrom. The wheel is equipped with a vaned impeller 24 positioned within the control cage 23 and fixed to the rear side wall disc 21 of the wheel to rotate with the blades 22 thereof. Abrasive is supplied to the interior of the impeller by means of a feed spout 25 having a funnel formation 26 at the upper end thereof.

Each wheel W may be positioned entirely within the blasting section 2 of the cabinet and has a hub 27 secured to the rear side wall disc 21 thereof. The wheel shaft 28 fixed to the hub 27 is preferably positioned on the outside of the cabinet and is rotatably mounted in suitable spaced bearings 30 which may be secured to the adjacent side wall of the cabinet. The wheel shaft 28 is driven by a motor 31 having a drive pulley 32 over which V-belts 32' are trained, the V-belts 32' also being trained around the pulley 33 secured to the end of the wheel shaft 28.

The front side wall 4 and rear side wall 5 of the cabinet may both be recessed in the manner illustrated in Fig. 1 so as to provide an offset side wall portion 4' and 5' respectively upon which the motors 31 and bearings 30 are mounted, and an end wall portion 4'' and 5'' respectively having an opening therein through which a portion of the hub 27 of the wheel projects. In this arrangement the driving motors 31, V-belts 32', wheel

shafting 28 and shaft bearings 30 are fully protected from flying abrasive, while the abrasive throwing wheels are free to operate within the blasting section 2 of the cabinet.

It will also be noted, by referring more particularly to Fig. 1, that the rear side wall 5 of the blasting section 2 of the cabinet 1 is spaced a substantial distance from the blasting position of the wheels mounted on the front wall 4, and front side wall 4 is spaced a substantial distance from the blasting position of the wheels mounted on the rear side wall 5. In this construction of the cabinet the cabinet side walls 4 and 5 of the blasting section 2 of the cabinet are spaced sufficiently far apart so that any abrasive which may fail to strike the workpieces *p* advancing through the blasting zones has lost its abrading force before reaching the opposite side wall.

Both the alternate and intermediate work-supporting carriers B and B', as illustrated more particularly in Figs. 2, 3, 14 and 16 are generally similar in construction, each comprising a pair of rollers 37 which roll on the flanges 36 of the I-beam shaped track C. The rollers 37 are secured to the arms 39 of the U-shaped yoke 38, each arm carrying a stub shaft 40 on which the rollers 37 are journalled. Each yoke 38 is provided with a downwardly extending leg 41 which terminates in a cup-shaped receiver 42. A tubular sleeve 43 has the upper end thereof projecting into the cup 42 and is firmly secured to the cylindrical wall of the cup. A spindle 44 is rotatably mounted within the sleeve 43 on a thrust bearing comprising a bearing part 45 fixed to the upper end of the sleeve 43 and a bearing part 46 fixed to the upper end of the spindle 44, the bearing parts 45 and 46 having a raceway therebetween for ball bearings 47. The spindle 44 may be provided with a flattened head 48 which rests on the bearing part 46.

Both the alternate and intermediate hangers B and B' are each provided with a work-supporting spindle 53 which is connected to the carriage spindle 44. The spindle 44 is secured to a heavy collar member 47' which is provided with a bearing collar 48 secured to the upper end thereof and which is positioned adjacent a bearing collar 49 secured to the lower end of the sleeve 43, thus permitting the heavy collar member 47' and spindle 44 to freely rotate within the sleeve 43. The upper end of the work-supporting spindle 53 is removably secured within a socket 52 of collar member 47' by means of a suitable key 51. The spindles 53 are of sufficient length to extend through a slot 55 in the top wall 17 of the cabinet, the slot 55 being directly below the track C. The lower end of each hanger spindle 53 is provided with a hook element 56 to which the workpiece *p* may be conveniently attached. Each of the work-supporting spindles 53 and the workpiece which it supports may be rotated from the thrust bearing contained within the stationary sleeve 43 of the hanger carriage.

All the hangers B and B' are connected together by means of a continuous conveyor chain 60 which is positioned directly beneath the track C. The conveyor chain 60 may be in the form of a heavy link chain comprising paired links 61 connected to intermediate links 62 by heavy studs 63. The leg portion 41 of each hanger bracket 38 is provided with a reduced neck portion 64 which extends through aligned apertures in the paired links 61 so that the paired links 61 seat between an enlarged collar portion 65 and an enlarged head portion 66 provided on each leg 41. Thus connected, the work-supporting hangers B and B' can be arranged in uniform spaced relationship with the rollers 37 thereof free to roll on the flanges 36 of the track C.

The work-supporting hangers are caused to travel along the track C by driving mechanism D which engages the conveyor chain 60, and comprises a conveyor driving motor 67 mounted on the top wall 17 of the cabinet and having a driving connection with a speed reducer 68. The drive shaft 69 of the speed reducer 68 carries a sprocket 70 which carries a drive chain 71. Drive chain 71 is trained around a sprocket 72 fixed to a stub shaft 73 rotatably mounted in a bearing collar 74 fixed to the top wall 17 of the cabinet. Stub shaft 73 carries a large sprocket wheel 75 which meshes with the conveyor chain 60. Driving motor 67 thus operates to continuously advance the workpieces *p* suspended from hangers B and B' through the blasting zones *a* and *b* within the cabinet.

In order that the interior surfaces and certain exterior surfaces of the workpiece *p* which require thorough cleaning be adequately blast treated in blasting zone *a*, mechanism is provided for guiding the workpieces through the first stage *a'* of blasting zone *a* while held in one position as shown in Fig. 1, and through the second stage *a''* of blasting zone *a* while held in a somewhat different position. This mechanism comprises a device associated with all of the hangers B and B', as illustrated more particularly in Figs. 1, 2, 14, 15 and 16, which includes three equally spaced guide rollers 81, 82 and 83, each supported upon an arm 80 fixed to the heavy collar member 47' which serves as a hub therefor. Each of the rollers 81, 82 and 83 is rotatably mounted upon a bearing stud 84 fixed to the end of each arm 80. The arms 80 rotate with their associated hanger spindle 44 and work-supporting spindle 53.

A guide track 85 of considerable length extends along the path of travel of the work-supporting hangers and guides them while passing through the first stage *a'* of the first blasting zone *a*. The guide track 85 may comprise an angle-shaped member having a vertical guide wall 86 along which two of the guide rollers associated with each hanger may roll. The guide track 85 may be supported on the top wall 17 of the cabinet or it may be suitably suspended from the ceiling of the plant in which the cabinet is installed so that its supports do not interfere with the normal advance travel of the hanger. It will be noted that a part 87 of guide track 85 projects some distance beyond the front entrance wall 12 of the entrance vestibule 1 and its leading end is provided with a cam wall 88 to permit unobstructed engagement of two of the guide rollers with the vertical guide wall 86 of the guide track 85.

The hanger hook 56 from which the workpiece *p* is suspended is so constructed as to firmly grip the workpiece and prevent the workpiece from swinging or rotating on the hanger hook 56. When a suspended workpiece *p* is ready to enter the cabinet, a workman guides the workpiece so that two of the hanger guide rollers 81 and 82 roll into contact with the vertical guide wall 86 of the track 85. The workpieces *p* are then advanced through the entrance vestibule 1 and through stage *a'* of blasting zone *a* while held in the position illustrated in Fig. 1. During

advance movement of the suspended workpieces p along the guide track **85**, the workpieces do not rock or rotate but have a continuous advancing movement only as they are subjected to the abrasive blasts from the abrasive throwing wheels W^1, W^2, and W^3.

When the workpiece has reached the end of its travel along guide rail **85** and when it has completely or partially passed through the abrasive stream projected by the abrasive throwing wheel W^3, guide roller **83** passes onto a switch track **90** which may be in the form of an angle bar and which has a vertical guide wall **91**. The vertical guide wall **91** has a curved end portion **92** to permit free and unobstructed rolling movement of the guide roller **83** in contact with the vertical wall **91**. The work-supporting hanger continues its advance along switch track **91**, which may be suitably suspended from the ceiling of the plant, until the other two guide rollers **82** and **81** have cleared the guide track **85**, as indicated more particularly in Fig. 1.

When this occurs, guide roller **83** moves into contact with the cam portion **93** of a second guide rail **94** which may have an angular cross-section and which may be suspended from the ceiling of the plant in which the cabinet is installed. The second guide rail **94** has a vertical guide wall **95** which joins cam guide wall **93**. Cam guide wall **93** engages the outer periphery of guide roller **83** and leads it into contact with the inside face of guide wall **95**. Since the hanger is continuously advanced by the conveyor chain **60** driven by motor **67**, the work-supporting spindle **53** and its suspended workpiece p is rotated, as roller **83** moves over cam guide wall **93**, in an arc of from 60° to 90° and this operation swings guide roller **82** into contact with the inside face of guide wall **95** of the second guide rail **94**. When thus rotated, the workpieces p will assume the position illustrated in Fig. 1 and they are advanced in this position as they travel through the blasting streams projected from the abrasive throwing wheels W^4 and W^5 in the second stage a'' of the first blasting zone a.

By referring more particularly to Fig. 2 and Figs. 4 to 8, inclusive, it will be noted that the workpieces p as thus guided and directed will directly present all of their interior surfaces and certain of their exterior surfaces to the blasting streams projected by the wheels positioned along the first blasting zone a. As shown in Figs. 2 and 4, for example, the abrasive throwing wheel W^1, rotating counterclockwise, will project its stream so as to clean the lower portions of exterior side wall surface p^8, interior side wall surface p^3, interior bottom wall surface p^1, interior end wall surface p^4, adjacent corner surfaces p^6 and the lower half of the edge surfaces p^{12}.

As the workpieces continuously advance, the abrasive throwing wheel W^2 rotating clockwise as illustrated in Figs. 2 and 5 will blast clean the upper portions of exterior side wall surface p^8, interior side wall surface p^3, interior bottom wall surface p^1, interior end wall surface p^5, adjacent corner surfaces p^6 and the upper parts of the edge portions p^{12}.

As the workpieces continue their advances, the abrasive throwing wheel W^3 rotating clockwise as illustrated in Figs. 2 and 6 will blast clean the center portions of exterior side wall surface p^8, interior side wall surface p^3, interior bottom wall surface p^1, adjacent corner surfaces p^6 and the center parts of the edge portions p^{12}.

As the workpieces p continue their advance, it will be noted that they are rotated through an angle of from 60° to 90° which is effected by the spur track **90**, and cam wall **93** and guide wall **95** of the second guide track **94** over which guide rollers **83** and **82** roll. The workpieces p will then travel through the blast stream projected from abrasive throwing wheel W^4, rotating counterclockwise as illustrated in Figs. 2 and 7, which operates to clean the lower portion of interior side wall surface p^3, interior bottom wall surface p^1, interior end wall surface p^4, adjacent corner surfaces p^8, the lower portion of edge parts p^{12}, and the lower portion of exterior side wall surface p^9.

As the workpieces continue their advance, the abrasive stream fired by the abrasive throwing wheel W^5 rotating clockwise as illustrated in Figs. 2 and 8 operates to blast clean the upper portion of interior side wall surface p^2, interior bottom wall surface p^1, interior end wall surface p^5, the upper portion of the edge parts p^{12}, and, finally, the upper portion of the exterior side wall surface p^9.

It will thus be noted that during the continuous passage of the workpieces through blasting zone a, the entire exterior side wall surfaces p^8 and p^9, the entire interior end wall surfaces p^4 and p^5, the entire interior side wall surfaces p^2 and p^3, all interior corner portions p^6, and all exterior edge portions p^{12} have been directly exposed to the full force of the abrasive streams projected from the abrasive throwing wheels W^1, W^2, W^3, W^4 and W^5. These surfaces have by this treatment been all substantially thoroughly blast cleaned during their passage through blasting zone a. The hangers and their suspended workpieces then pass out of the blasting zone a, move around the main chain driving sprocket **75**, and into the second blasting zone b.

In the second blasting zone b the workpieces are rotated a number of times through a complete 360° rotation during their continuance travel through the second blasting zone b. Improved mechanism is provided for uniformly rotating all the workpiece-supporting spindles, all alternate work-supporting hangers B having their spindles **53** rotated in one direction and the spindles **53** of all intermediate work-supporting hangers B' being rotated in the opposite direction. Highly effective and efficient mechanism F is provided for effecting this rotation.

My improved spinner mechanism includes a sprocket member **100** attached to each spindle **53** of the alternate work-supporting hangers B. Each sprocket member **100** has a collar portion **103** which is fixedly secured to the hanger spindle **53** by a suitable key or set screw **104**, shown in Figs. 14 and 15. Sprocket member **100** has a sprocket wheel **101** formed integral therewith and an integral spacing disc **102** positioned above the sprocket wheel **101**. The spindles **53** of each intermediate hanger B' also carries a sprocket member **100'** similar to the alternate sprocket members **100** except that the sprocket wheel **101'** of the intermediate sprocket member **100'** is arranged above its associated spacing disc **102**. As heretofore brought out, each hanger spindle **53** rotates in the bearing positioned within the fixed sleeve **43** of the hanger. The alternate sprocket members **100** provide means for rotating the spindles **53** of alternate hangers B in one direction while the sprocket members **100'** provide means for rotating the spindles **53** of the intermediate hangers B' in the opposite direction.

All of the spindle driving sprocket members 100 and 100' are rotated during their passage through the blasting zone *b* by a continuously driven motor 105 which drives reduction gearing 110. A drive chain 107 is trained around a sprocket 108 attached to the shaft 109 of the reduction gearing 110, as illustrated more particularly in Fig. 1. The drive chain 107 is also trained around sprocket 113 fixed to a stub shaft 114 adjacent the path of travel of the work-supporting hangers when moving through the blasting zone *b*. The stub shaft 114 rotates in a bearing collar 115 suitably secured to the top wall 17 of the cabinet. Stub shaft 114 has fixed thereto a gear 116 which meshes with a gear 117 fixed to an adjacent stub shaft 118 rotatably mounted in a bearing collar 119 supported on the top wall 17 of the cabinet. Stub shaft 118 has a sprocket 120 fixed thereto and carries one end of a continuous spinner chain 121 designed to mesh with the sprocket 101 of sprocket members 100 attached to the spindles 53 of alternate work-supporting hangers B. The other end of the continuous spinner chain 121 is trained around a sprocket 122 fixed to a hub 123 which rotates on a stationary stub shaft 124 fixed to a socket 125 supported upon the top wall 17 of the cabinet.

The intermediate sprocket members 100' attached to the spindles 53 of intermediate work-supporting hangers B' are rotated by a spinner chain 121' positioned directly above the spinner chain 121. One end of the continuous spinner chain 121' is trained around a sprocket 127 fixed to the driven stub shaft 124. The other end of the continuous spinner chain 121' is supported upon a sprocket 128 fixed to a hub 129 which freely rotates on the fixed stub shaft 124.

With the driving arrangement as above provided, it will be appreciated that spinner drive chain 121 travels in one direction, as indicated in Fig. 3, to rotate the alternate sprocket members 100 fixed to alternate spindles 53 in one direction, while spinner chain 121' travels in the opposite direction to rotate the intermediate sprocket members 120' and associated intermediate hanger spindles 53 in the opposite direction, thus permitting the work-supporting hangers B and B' to be arranged so that a minimum of space or clearance is provided between the workpieces *p* suspended therefrom.

To insure positive driving engagement between spinner chain 121 and sprocket members 100 and positive driving engagement between spinner chain 121' and intermediate sprocket members 100' during passage of the workpieces through blasting zone *b*. I have provided chain backing means which is simple in construction and highly efficient. As illustrated more particularly in Figs. 1, 3 and 16, a pair of chain backing pedestals 130 are provided which rest upon the top wall 17 of the cabinet, and are positioned between the inner and outer runs of the spinner chains 121 and 121'. Each backing pedestal 130 comprises a stub shaft 131 whose lower end is fixed to a base 132 rigidly supported on the top wall 17 of the cabinet. A heavy chain-contact disc 133 is provided with a hub portion 134 which is free to idle on stub shaft 131 and is positioned between the inner and outer runs of spinner chain 121 with its periphery positioned to bulge the inner sprocket-engaging run of the chain 121. A second contact disc 133' having a hub portion 134' is free to idle on the upper end of fixed stub shaft 131 and is positioned between the inner and outer runs of spinner chain 121' and arranged to bulge the inner sprocket-engaging run of the chain 121'. The contact discs 133 and 133' may be removably mounted on the stub shaft 131 by means of a collar 135 removably secured to the upper end of stub shaft 131 by a removable key or set screw 136.

To reduce friction and permit the spinner chains 121 and 121' to smoothly roll over or with the peripheries of the respective contact discs 133 and 133', the spinner chains 121 and 121' are provided with roller sleeves 137 which are free to roll on the pins 138 which connect the paired outer links 139 to the paired inner links 140 of the chain. The chain roller sleeves 137 roll over or with the peripheries of the respective free rotating contact discs 133 and 133' substantially without friction and serve to bulge the inner runs of the chains 121 and 121' so that they positively engage spinner sprockets 101 and 101' respectively.

It will also be noted that the chain-engaging peripheries of the contact discs 133 and 133' bulge the driving run of the spinner chains 121 and 121' to the point where the spinner sprockets 101 and 101' will not interfere with the rotative movement of the chain-supporting sprockets 120, 122, 127 and 128. The spinner sprockets 101 and 101' will engage the driving run of the spinner chains 121 and 121' respectively at a point somewhere between the idling sprockets 122 and 128 and the adjacent pedestal 130, and the spinner sprockets 101 and 101' will disengage themselves from the driving run of the spinner chains 121 and 121' respectively somewhere between the other pedestal 130 and the driving sprockets 120 and 127. Thus the spinner sprockets 101 and 101' freely move into and out of engagement with the spinner driving chain 101 and 101' to rotate all of the work-supporting spindles 53 during their advance through the blasting zone *b*.

To further insure positive driving engagement between the spinner chains 121 and 121' with the alternate and intermediate spindle sprocket members 101 and 101' during advance of their suspended workpieces in through blasting zone *b*, the hanger spindles 53 are retained in non-swaying position and so held that their respective spinner sprockets 101 and 101' are in positive driving contact with the respective spinner chains 121 and 121'. This is effected by the spacing disc 102 on each of the spindle sprocket members 101 and 101' whose peripheries are arranged to roll over a series of closely spaced rollers 141. It will be noted that the backing discs 102 of both the alternate sprocket members 101 and intermediate sprocket members 101' travel in substantially the same horizontal plane and along a substantially straight line, so that the closely spaced contact rollers 141 may also be mounted along a straight horizontal line. Each contact roller 141 is free to rotate on a pin 142 fixed at each end to the horizontal legs 143 of a pair of spaced angle bars 144.

The angle bars 144 may be secured to a plurality of spaced brackets 145 having their foot portions 146 secured to the top wall 17 of the cabinet, as illustrated more particularly in Figs. 1 and 15. The spaced angle bars 144, having the closely spaced contact rollers 141 rotatably mounted therebetween, may extend the full distance be-

tween the ends of the spinner chains so that each hanger spindle 53 is prevented from swinging on the track C as it advances through the blasting zone *b*.

Means are also provided for supporting relatively long inner and outer runs of the spinner chains 121 and 121'. As shown more particularly in Figs. 1 and 17, a pair of spaced brackets 147 to support the inner runs and a pair of spaced brackets 147' to support the outer runs of spinner chains 121 and 121' are provided which are positioned between chain pedestals 130 and rest upon the top wall 17 of the cabinet. The brackets 147 and 147' may be cast in one piece and are each provided with a vertical wall 148 adjacent the respective inner and outer runs of the spinner chains 121 and 121'. Each pair of brackets 147 and 147' support a pair of angle bars 149, the vertical leg 150 of which is secured to the wall 148 of the paired brackets with the other leg 151 projecting horizontally therefrom. The vertical leg 150 of each angle bar 149 is provided with a bar-shaped track 151 along which the chain rollers 137 are adapted to roll. It will be noted that each of the chain pins 138 is provided with a U-shaped yoke 153 at the lower end thereof on which a roller 154 is rotatably mounted. The chain rollers 154 are arranged to roll on the horizontally extended leg 151 of the angle bar 149. The upper angle bar 149 is arranged to support and guide the spinner chain 121' while the lower angle bar 149 is arranged to support and guide the other spinner chain 121.

It will thus be noted that the chain-guiding bars 149 provide a firm support for the relatively long inner and outer runs of the spinner chains 121 and 121' so as to insure positive driving engagement with the spindle sprockets 100 and 100'. The chains advance substantially without friction along the angle bars 149 by reason of the rollers 154 and 137 provided on the spinner chains. It will also be noted that the backing discs 133 and 133' bulge the inner runs of the spinner chains 121 and 121', so that the spinner sprockets 100 and 100' will not interfere with the rotating movement of the chain-supporting sprockets 120, 122, 127 and 128, but will engage the inner runs of the respective spinner chains 121 and 121' somewhere between the sprockets 122 and 128 and the adjacent pedestal 130 and will disengage themselves from the inner runs of the spinner chains 121 and 121' somewhere between the other pedestal 130 and sprockets 120 and 127. Thus the alternate spindle sprockets 100 freely move into and out of engagement with their spinner driving chain 121 to rotate all of the alternate hangers B during their advance along the blasting zone *b* of the cabinet, while intermediate spindle sprockets 100' freely move into and out of engagement with their spinner driving chain 121' during advance movement of the intermediate oppositely rotating hangers B during their advance movement along the blasting zone *b*.

As the workpieces suspended on the respective alternate and intermediate hangers B and B' advance through the blasting zone *b* in the direction of the arrow, as shown in Figs. 1, 3 and 9, they first move into and through the blasting stream projected by abrasive throwing wheel W^6 rotating clockwise, as indicated in Figs. 3 and 8. The abrasive throwing wheel W^6 is positioned slightly above the path of travel of the workpieces *p* and its control cage is so adjusted as to project its abrasive stream onto the exterior end wall surface p^{11} of the workpiece as the workpiece rotates. Substantially all of the abrasive stream fired by the abrasive throwing wheel W^6 is projected against only the exterior end wall surface p^{11}, which advances and rotates directly in the path of the abrasive blast, and thus any desired cleaning effect may be attained. For example, exterior end wall surface p^{11} may be thoroughly cleaned, polished and peened for receiving the porcelain enamel coating, by feeding a relatively large volume of abrasive through the wheel but if the exterior end wall surface p^{11} requires only superficial cleaning to remove the encrusted sand and scale, such cleaning can be effected by feeding a lesser volume of abrasive to the wheel W^6.

As the workpieces continue their rotational advance through blasting zone *b* they move into, through and out of the blasting stream projected by abrasive throwing wheel W^7, as illustrated in Figs. 1, 3 and 10. Abrasive throwing wheel W^7 rotating clockwise is so positioned and its control cage so adjusted that it projects its polishing and peening abrasive stream against the upper portion of interior side wall surfaces p^2 and p^3, interior bottom wall surface p^1, interior end wall surface p^5, adjacent corner surfaces p^6, adjacent edge surfaces p^{12}, and the upper portion of exterior side wall surfaces p^8 and p^9, all of which surfaces have been previously abraded while passing through the blasting zone *a*. Abrasive throwing wheel W^7 also superficially cleans the upper portion of the exterior bottom wall surface p^7.

During the further continued rotational advance of the workpieces through blasting zone *b*, the center portion thereof enters and passes through the blasting stream projected by abrasive throwing wheel W^8 rotating clockwise, as indicated in Figs. 3 and 11. The abrasive throwing wheel W^8 is so positioned and its control cage so adjusted as to finally polish and peen the previously abraded center portion of the interior side wall surfaces p^2 and p^3, interior bottom wall surface p^1, adjacent corner surfaces p^6, adjacent edge surfaces p^{12}, and exterior side wall surfaces p^8 and p^9, and to superficially abrade the center portion of the exterior bottom wall surface p^7.

During further continued rotational advance of the workpieces in blasting zone *b*, the workpieces enter and pass through the abrasive blasting stream projected by abrasive throwing wheel W^9 rotating counterclockwise, as indicated in Figs. 3 and 12. The abrasive throwing wheel W^9 is so positioned and its control cage so adjusted as to fire its polishing and peening abrasive stream against the lower portion of previously abraded interior side wall surfaces p^2 and p^3, interior bottom wall surface p^1, interior end wall surface p^4, adjacent corner surfaces p^6, adjacent edge surfaces p^{12} and the lower portion of exterior side wall surfaces p^8 and p^9. Abrasive throwing wheel W^9 also superficially cleans the lower portion of the exterior bottom wall surface p^7.

The workpieces continue their rotational advance through the blasting stream projected by the abrasive throwing wheel W^{10} rotating counterclockwise, as indicated in Figs. 3 and 13, which is positioned below the path of travel of the workpieces *p* and has its control cage so adjusted as to clean the exterior end wall surface p^{10} of the workpiece. By controlling the volume of the abrasive feed to the abrasive throwing wheel W^{10}, the exterior end wall surface p^{10} may be thoroughly cleaned, polished and peened during its rotational advance through the abrasive stream

projected by abrasive throwing wheel W^{10}, or exterior end wall surface p^{10} may be only superficially cleaned by reducing the volume of abrasive feed to the wheel W^{10}.

The workpiece-supporting hangers then move out of engagement with the spinner chains 121 and 121' and move through the exit vestibule 3 and onto that section of the track which leads to the unloading zone *d* or to other zones in the plant where other operations may be performed on the workpieces while still suspended from the hangers.

It will now be appreciated that during the passage of the workpieces through the blasting zone *b* where they are rotated during their advance, abrasive throwing wheel W^6 and abrasive throwing wheel W^{10} may be supplied with a relatively large volume of abrasive to thoroughly clean, polish and peen the exterior end wall surfaces p^{11} and p^{10} of the advancing workpieces, or they may be supplied with a lesser volume of abrasive to only superficially clean the exterior end wall surfaces p^{11} and p^{10} respectively. Thus by regulating the volume of abrasive feed to the wheels W^6 and W^{10}, any desired degree of cleaning of the exterior end wall surfaces p^{11} and p^{10} may be effected.

It will further be noted that abrasive throwing wheels W^7, W^8 and W^9 operate to polish and peen the previously abraded interior side wall surfaces p^2 and p^3, interior end wall surfaces p^5 and p^4, interior bottom wall surface p^1, adjacent corner surfaces p^6, adjacent edge surfaces p^{12}, and also to polish and peen the previously abraded exterior side wall surfaces p^8 and p^9 during advance of the workpieces through the streams projected by abrasive throwing wheels W^7, W^8 and W^9. These surfaces can thus be placed in excellent condition to tenaciously retain porcelain enamel or other coating, which can be smoothly applied to give the surfaces a fine finish. The encrusted sand and scale is also removed from the exterior bottom wall surface p^7 during passage of each workpiece through the blasting streams projected by the abrasive throwing wheels W^7, W^8 and W^9.

It will be further appreciated that the abrasive fed to the abrasive throwing wheels W^1, W^2, W^3, W^4 and W^5 in the first blasting zone *a* may be of such character as to effect maximum cleaning of the surfaces abraded in this blasting zone, and for this purpose cracked steel grit or other sharp cutting abrasive may be selected in accordance with the character of the cleaning required. These wheels may readily be supplied with the selected character of abrasive by a separate abrasive-cycling system. The abrasive throwing wheels W^7, W^8 and W^9, which are to polish and peen the surfaces which are to receive porcelain enamel or other finish coating, may be supplied with another type of abrasive through a separate abrasive-cycling system, which abrasive may comprise round steel shot of selected sizes or such other abrasive material best designed to give these surfaces the desired surface finish. If exterior end wall surfaces p^{11} and p^{10} are to be only superficially cleaned the wheels W^6 and W^{10} may be connected to the same abrasive-cycling system which supplies abrasive to the abrasive throwing wheels positioned in the first blasting zone *a*, or they may be supplied from the same abrasive-cycling system and with the same character of abrasive as is supplied to abrasive throwing wheels W^7, W^8 and W^9, or a special character of abrasive may be supplied to abrasive throwing wheels W^6 and W^{10} by a separate abrasive-cycling system. It will thus be appreciated that the abrasive throwing wheels may be supplied with any character of abrasive desired, fed to the wheels in any desired volume, and thrown at any desired velocity, and that any desired number of abrasive throwing wheels may be employed dependent upon the shape of the workpieces, the character of the surfaces, and the character of the surface finish and production speeds desired.

The entrance opening 13 of the entrance vestibule 1 and the exit opening 16 of the exit vestibule are each closed by a pair of doors which may be made of either flexible rubber or steel. Each of the hangers is provided with a cone-shaper member 154 which is fixed to the rotatable spindle 53 of each of the hangers B and B'. Each cone-shaped shield 154 is of such diameter and so arranged that the peripheral portion 155 thereof will engage the paired doors during advance movement of the hangers to swing the doors open so that the workpieces *p* need not strike the doors.

The cone-shaped shields 154 have their reduced ends 156 arranged to extend into the slot 55 in the top wall 17 of the cabinet, as illustrated more particularly in Fig. 16, so as to partially close the slot and prevent abrasive from escaping from the cabinet and damaging the mechanism mounted on the top wall of the cabinet. To further prevent the escape of abrasive through the slot 55 in the top wall of the cabinet, a pair of downwardly inclined baffle plates 157 are provided whose upper ends are secured to the framing 19 which extends along and on each side of the slot 55. A flexible rubber baffle 158 is secured to each of the downwardly inclined baffle plates 157 as by means of a clamping plate 159 and bolt 160. A downwardly inclined end portion 161 of each flexible baffle 158 is free to flex around the hanger spindles 53 as they move therebetween.

Abrasive sealing means is also provided above the path of travel of the cone-shaped shields 154, as illustrated more particularly in Fig. 16. This further sealing means comprises a pair of lower flexible rubber flaps 164 and a pair of upper flexible rubber flaps 165. Each of the lower flaps 164 rests on a bar 166 seated on the top wall 17 of the cabinet closely adjacent to the slot 55. A U-shaped spacing member 167 has the lower leg 168 thereof resting on one of the bars 166 with the lower flaps 164 clamped therebetween. The upper flaps 165 rest on the upper leg 169 of the U-shaped member 167 and is held in place by a clamping bar or member 170 held in place by screws 171.

By this novel sealing arrangement a triple seal is provided along the path of travel of the spinner spindles 53 which positively prevents any escape of abrasive from within the cabinet through the slot 55 in the top wall of the cabinet. The flexible flaps 158 provide an initial seal within the cabinet. The cone-shaped shields 154 fixed to each of the spinner spindles 53 provide a further and secondary seal. Finally the paired flexible flaps 164 and 165 provide a tertiary seal which absolutely prevents any dust or other particles that may have escaped through the flexible baffle 158 and the cone-shaped shields 154 from escaping into the atmosphere.

My improved blasting apparatus permits convenient loading of the workpieces *p* on the alternate hangers B and intermediate hangers B' dur-

ing their travel along the loading zone c^3. The hangers B and B' with their suspended workpieces closely adjacent one another are guided so that the guide rollers 82 and 81 associated with each work-supporting hanger moves into contact with the vertical guide wall 86 of guide rail 85 prior to their entrance into the entrance vestibule 1. The workpieces continue their advance into stage a' of the blasting zone a while held in the position indicated in Figs. 1 and 2, in which position the blasting wheels W^1, W^2 and W^3 effectively clean the exterior side wall surface p^8, interior side wall surface p^3, interior bottom wall surface p^1, interior end wall surfaces p^5, adjacent interior corner surfaces p^6 and adjacent edge surfaces p^{12}.

During further continued advance of the workpieces into stage a'' of blasting zone a, the spur track 90 and cam track portion 93 operate to swing the suspended workpieces through an arc of from 60° to 90° until the guide rollers 82 and 83 associated with each hanger move into contact with the vertical guide wall 95 of the second guide rail 94. When thus positioned the workpieces present interior side wall surface p^2, interior bottom wall surface p^1, interior end wall surface p^4, adjacent interior corner surfaces p^6, adjacent edge surfaces p^{12}, and the exterior side wall surface p^9 to the abrasive streams projected by abrasive throwing wheels W^4 and W^5, which operate to clean and thoroughly remove encrusted sand and scale from these surfaces.

The workpiece-supporting hangers then move around the large conveyor chain advancing sprocket 75 and into the second blasting zone b where spinner chain 121 engages spinner sprockets 101 of the alternate work-supporting hangers B and spinner chain 121' engages spinner sprockets 101' of the intermediate work-supporting hangers B' to rotate the workpieces through several complete revolutions during their passage through the blasting zone b. During their passage through blasting zone b abrasive throwing wheel W^6 operates to clean the exterior end wall surface p^{11} to the desired degree, abrasive throwing wheels W^7, W^8 and W^9 operate to peen and polish the previously blasted interior side wall surfaces p^2 and p^3, interior bottom wall surface p^1, interior end walls surfaces p^4 and p^5, interior corner surfaces p^6, and exterior edge surfaces p^{12}, and in additional superficially abrade and clean the exterior bottom wall surface p^7. During continued rotational advance through the blasting zone b, abrasive throwing wheel W^{10} cleans exterior end wall surface p^{10} to the desired degree.

It will be noted that the workpieces p traveling through blasting zone b travel in the opposite direction from but parallel to and only a short distance from the path of travel of the workpieces advancing through blasting zone a. Thus any abrasive projected by abrasive throwing wheels W^1, W^2, W^3, W^4 and W^5 in the first blasting zone which fails to strike the closely positioned workpieces p in the first blasting zone a will substantially all strike the workpieces immediately to the rear passing through the second blasting zone b. In the same manner any abrasive projected by the abrasive throwing wheels W^6, W^7, W^8, W^9 and W^{10}, which fails to strike the workpieces passing through the second blasting zone b will substantially all strike the workpieces immediately to the rear thereof passing through blasting zone a. Thus, by spacing the work-supporting hangers B and B' and their suspended workpieces relatively close together and arranging the path of travel of the workpieces through blasting zones a and b relatively close together, substantially all of the abrasive fired from all the wheels is employed to perform useful abrading action with resulting high cleaning efficiency.

The spinner-rotating mechanism is so constructed and arranged as to effectively engage the spinner sprockets 100 and 100' substantially without shock or strain to the parts. The hangers B and B' are prevented from undesirable swinging movement during their travel through the blasting zone a by the guide tracks 85 and 94 and cooperating spur track 90, and are prevented from undesirable swinging movement in blasting zone b by contact disc 102, contact rollers 141, contact discs 133 and 133' and guide rails 150 and 150'.

The conveyor-advancing mechanism is so arranged and constructed that the workpieces may be completely advanced through blasting zones a and b in the blast section 2 of the cabinet without delay or stoppage of continuous production. Since the spinner speed reducer is completely independent of the hanger-advancing speed reducer 68, each may be adjusted to the desired operating speed independently of the other.

In event the hollow metal ware or articles to be cleaned do not require final polishing or finishing in the blasting zone b, it will be appreciated that the centrifugal blasting wheels W^6, W^7, W^8, W^9 and W^{10}, as shown in Fig. 1, may be eliminated from the apparatus or not operated. The metal ware passing through the silenced zone b would still be impinged during their rotative movement by some stray or rebounding abrasive from blasting zone a thrown by the abrasive throwing wheels W^1, W^2, W^3, W^4 and W^5.

It will be also appreciated that the articles may be first conducted into the blasting zone b, as shown in Fig. 18, by driving the conveyor chain in the direction of the arrow there shown. In such event the rotating articles first pass through blasting zone b and are impinged by the abrasive blast from the successive abrasive throwing wheels W^{10}, W^9, W^8, W^7 and W^6. A vestibule 200 is positioned adjacent the end wall 6 of the cabinet, as shown in Fig. 18, wherein a workman may be stationed to guide the workpieces in their movement into the blasting zone a and to place the guide rollers 81 and 82 into contact with the track 86. The apparatus shown in Fig. 18 may be provided with blasting wheels W^5, W^4, W^3, W^2 and W^1, as shown in Fig. 1, so as to clean such surfaces of the workpieces as require thorough cleaning, as above described. In event it is unnecessary to treat the workpieces with the abrasive throwing wheels W^5, W^4, W^3, W^2 and W^1 in the arrangement illustrated in Fig. 18, these wheels may be silenced or eliminated from the apparatus as illustrated in Fig. 18. In event the blasting zone a is not employed, the workpieces may be so arranged, as shown in Fig. 18, that their interior surfaces face the centrifugal blasting wheels W^6, W^7, W^8, W^9 and W^{10} so as to be impinged by stray or rebounding abrasive fired by these wheels.

It will therefore be appreciated that this invention comprehends the employment of two blasting zones a and b, with the workpieces moving first through either blasting zone a or blasting zone b and also comprehends an apparatus wherein only blasting zone a or blasting zone b is employed, as the cleaning problem may require.

While certain novel features of the invention have been disclosed and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be

made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In blast cleaning apparatus, a track, a carriage suspended from, and movable along, said track, a work-supporting spindle rotatably supported by said carriage, an odd number of equally spaced radially extending guide arms fixed to said spindle, a guide roller rotatably mounted on each of said arms, a substantially straight guide track extending along one side of the path of advance of said carriage adapted to provide a guide for a pair of adjoining rollers and preventing lateral movement of said spindle, a substantially straight guide track extending beyond and along the other side of the path of advance of said carriage adapted to provide a guide for another pair of adjoining rollers, and a stationary member positioned between the adjacent ends of said guide tracks for engaging the roller on one of said guide arms to rotate said spindle through a predetermined arc of less than 360°.

2. In blast cleaning apparatus, a track, a work-supporting carriage suspended from, and movable along, said track, a work-supporting spindle rotatably supported from said carriage, an odd number of equally spaced radially extending guide arms fixed to said spindle, a guide roller rotatably mounted on each of said arms adjacent the outer end thereof, a substantially straight guide track extending along one side of the path of advance of said spindle adapted to provide a guide for two of said rollers during the advance of said spindle for a predetermined distance and to prevent lateral movement of said spindle, a substantially straight guide track extending along the other side of the path of advance of said spindle and beyond said first guide track adapted to provide a guide for two of said rollers when said spindle has been rotated through a predetermined arc, and a stationary member positioned between the adjacent ends of said guide tracks for engaging the roller on one of said guide arms to rotate said spindle and the workpiece supported thereon through said predetermined arc.

3. In blast cleaning apparatus, a track, a work-supporting carriage movable along said track, a work-supporting spindle rotatably supported from said carriage, three equally spaced radially extending guide arms fixed to said spindle, a guide roller rotatably mounted on each of said arms adjacent the outer end thereof, a guide track extending along one side of the path of advance of said carriage adapted to provide a guide for two of said rollers during the advance of said spindle for a predetermined distance, a guide track extending along the other side of the path of advance of said spindle and beyond said first guide track adapted to provide a guide for two of said rollers when said spindle has been rotated through an arc of 60° to 90°, and means positioned between the adjacent ends of said guide tracks for rotating said spindle and the workpiece supported thereon through said arc.

4. In blast cleaning apparatus, a track, a work-supporting carriage movable along said track, a work-supporting spindle rotatably suspended from said carriage, means for advancing said carriage and work-supporting spindle along a predetermined blasting zone, three equally spaced radially extending guide arms fixed to said spindle, a guide roller rotatably mounted on each of said arms adjacent the outer end thereof, a guide track extending along one side of the path of advance of said spindle adapted to provide a guide for two of said rollers during the advance of said spindle for a predetermined distance along said blasting zone, a guide track extending along the other side of the path of advance of said spindle and beyond said first guide track adapted to provide a guide for two of said rollers when said spindle has been rotated through a predetermined arc, and a spur track positioned between the adjacent ends of said guide tracks for engaging one of said rollers and automatically rotating said spindle through said predetermined arc during the advance of said carriage from said first to said second guide track.

5. In blast cleaning apparatus, a track, a work-supporting carrige movable along said track, a tubular sleeve fixed to said carriage, a thrust bearing positioned within said sleeve, a work-supporting spindle rotatably supported in said thrust bearing, means for advancing said carriage and work-supporting spindle along a predetermined blasting zone, an odd number of equally spaced radially extending guide arms fixed to said spindle, a guide roller rotatably mounted on each of said arms adjacent the outer end thereof, a guide track extending along one side of the path of advance of said carriage adapted to provide a guide for two of said rollers during the advance of said carriage for a predetermined distance along said blasting zone, a guide track extending along the other side of the path of advance of said carriage and beyond said first guide track adapted to provide a guide for two of said rollers when said spindle has been rotated through a predetermined arc, and a switch track positioned between the adjacent ends of said guide track for engaging one of said rollers and automatically rotating said spindle through said predetermined arc during the advance of said carriage from said first to said second guide track.

6. In blast cleaning apparatus, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path, a work-supporting spindle rotatably suspended from each of said carriers, three equally spaced radially extending guide arms fixed to each of said spindles, a guide roller rotatably mounted on each of said arms, a relatively straight guide member extending along one side of the path of advance of said spindles providing a guide for two of said rollers during advance of said spindles a predetermined distance, a relatively straight guide member extending along the other side of the path of advance of said spindles and beyond said first guide member adapted to provide a guide for two of said rollers when said spindles have been rotated through a predetermined arc, and means positioned between the adjacent ends of said guide member for rotating said spindles through said predetermined arc during advance thereof from said first to said second guide member.

7. In blast cleaning apparatus, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path, a work-supporting spindle rotatably suspended from each of said carriers, three equally spaced radially extending guide arms fixed to each of said spindles, a guide roller rotatably mounted on each of said arms, a relatively straight guide track extending along one side of the path of advance of said spindles providing a guide for two of said rollers during advance of said spin-

dles a predetermined distance, a relatively straight guide track extending along the other side of the path of advance of said spindles and beyond said first guide track adapted to provide a guide for two of said rollers when said spindles have been rotated through a predetermined arc, a spur track positioned between the adjacent ends of said guide tracks for engaging one of said rollers of each spindle and rotating said spindles through said predetermined arc during advance thereof from said first to said second guide track, and means beyond said guide tracks for rotating alternate spindles in one direction and intermediate spindles in the opposite direction during their continued advance.

8. In blast cleaning apparatus, a cabinet having a first and a second blasting zone, centrifugal abrasive projectors for projecting streams of abrasive into each of said blasting zones, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path through said blasting zones, a work-supporting spindle rotatably suspended from each of said carriers, cooperating means including a plurality of guide rollers mounted on arms on each of said spindles, two straight stationary guide members engaging two of said guide rollers to retain said spindles against rotation during a predetermined advance movement thereof along one stage of said first blasting zone, a stationary member arranged between the end of one and the beginning of the other straight guide member and in the path of one of said rollers to engage said roller and rotate said spindle through a predetermined arc of 60° to 90° whereafter said spindles are retained against further rotation during their advance along the second stage of said first blasting zone by engagement of rollers by the second guide member, and means for rotating alternate spindles in one direction and intermediate spindles in the opposite direction during their advance along said second blasting zone.

9. In blast cleaning apparatus, a cabinet having two blasting zones, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path through said blasting zones, a first series of centrifugal abrasive projectors arranged to project a plurality of abrasive streams into said first blasting zone whereby to blast the surfaces of the workpieces requiring thorough cleaning and a second series of centrifugal abrasive projectors arranged to blast all surfaces of said workpieces in said second blasting zone, a work-supporting spindle rotatably suspended from each of said carriers, means operative to retain said spindles against rotation during a predetermined advance movement thereof along said first blasting zone, to thereafter rotate said spindles through a predetermined arc of less than 360° while in said first blasting zone and thereafter to retain said spindles against further rotation during their further advance movement along said first blasting zone, said operative means including a plurality of arms secured to each of said spindles and a guide roller rotatably mounted on each of said arms, two substantially straight tracks arranged in series along the path of said spindles to provide a guide for any pair of rollers on two adjacent arms, and a stationary member arranged between the end of one and the beginning of the other track for engaging one of said rollers to impart a rotation to said spindle, and means for rotating alternate spindles in one direction and intermediate spindles in the opposite direction during advance movement of the spindles along said second blasting zone.

10. In blast cleaning apparatus, a cabinet having two blasting zones, abrasive projectors for projecting streams of abrasive into each of said blasting zones, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path through said blasting zones, a work-supporting spindle rotatably suspended from each of said carriers, means operative to retain said spindles against rotation during a predetermined advance movement thereof along said first blasting zone, to thereafter rotate said spindles through a predetermined arc of less than 360° while in said first blasting zone and thereafter to retain said spindles against further rotation during their further advance movement along said first blasting zone, said operative means including a plurality of arms secured to each of said spindles and a guide roller rotatably mounted on each of said arms, two substantially straight tracks arranged in series along the path of said spindles to provide a guide for any pair of rollers on two adjacent arms, and a stationary member arranged between the end of one and the beginning of the other track for engaging one of said rollers to impart a rotation to said spindle, a spinner sprocket fixed to each of said spindles, and means for rotating the sprockets of alternate spindles in one direction and the sprockets of intermediate spindles in the opposite direction during advance movement of the spindles along said second blasting zone.

11. In blast cleaning apparatus, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path through a blasting zone, a work-supporting spindle rotatably suspended from each of said carriers, a spinner sprocket fixed to each of said spindles, a continuous drive chain having an outer run and an inner run in driving engagement with the sprockets of alternate spindles, a continuous drive chain having an outer run and an inner run in driving engagement with the sprockets of intermediate spindles, means for driving one of said chains in one direction and the other chain in the opposite direction to rotate alternate spindles in one direction and intermediate spindles in the opposite direction, and means including freely rotating contact discs arranged between the inner and outer runs of said drive chains and having their peripheries positioned to bulge the inner sprocket engaging runs of said chains to facilitate engagement between said spinner sprockets and said chains.

12. In blast cleaning apparatus, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path through a blasting zone, a work-supporting spindle rotatably suspended from each of said carriers, a spinner sprocket fixed to each of said spindles, a continuous drive chain having an outer run and an inner run in driving engagement with the sprockets of alternate spindles, a continuous drive chain having an outer run and an inner run in driving engagement with the sprockets of intermediate spindles, means for driving one of said spinner chains in one direction and the other said spinner chain in the opposite direction to rotate alternate spindles in one direction and intermediate spindles in the opposite direction, and a pair of chain backing members positioned between the ends and between the runs

of said drive chains, each of said chain backing members including a pair of freely rotating contact discs arranged between the inner and outer runs of said drive chains and having their peripheries positioned to bulge the sprocket engaging runs of said spinner chains to facilitate engagement and disengagement of said spinner sprockets with their respective drive chains.

13. In blast cleaning apparatus, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path through a blast cleaning zone, a work-supporting spindle rotatably suspended from each of said carriers, a sprocket fixed to each of said spindles, a drive chain for rotating the sprockets of alternate spindles in one direction, a drive chain for rotating the sprockets of intermediate spindles in the opposite direction, a contact disc eccentrically fixed to each of said spindles adjacent said sprocket, a guide member positioned along the path of travel of said contact discs opposite to the sprocket engaging runs of said drive chains, and a plurality of rollers rotatably supported by said guide member against which the peripheries of said contact discs may roll during advance movement of said spindles to retain said spindle sprockets in driving engagement with the sprocket engaging runs of said drive chains.

14. In blast cleaning apparatus, a plurality of work-supporting carriers, means for transporting said carriers along a predetermined path through a blast cleaning zone, a work-supporting spindle rotatably suspended from each of said carriers, a sprocket fixed to each of said spindles, a drive chain for rotating the sprockets of alternate spindles in one direction, a drive chain for rotating the sprockets of intermediate spindles in the opposite direction, a contact disc eccentrically fixed to each of said spindles adjacent said sprocket, a guide member positioned along the path of travel of said contact discs opposite to the sprocket engaging runs of said drive chains, a plurality of rollers rotatably supported by said guide member against which the peripheries of said contact discs may roll during advance movement of said spindles to retain said spindle sprockets in driving engagement with the sprocket engaging runs of said drive chains, and means including guide bars extending along the runs of said drive chains to guide and support said chains.

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