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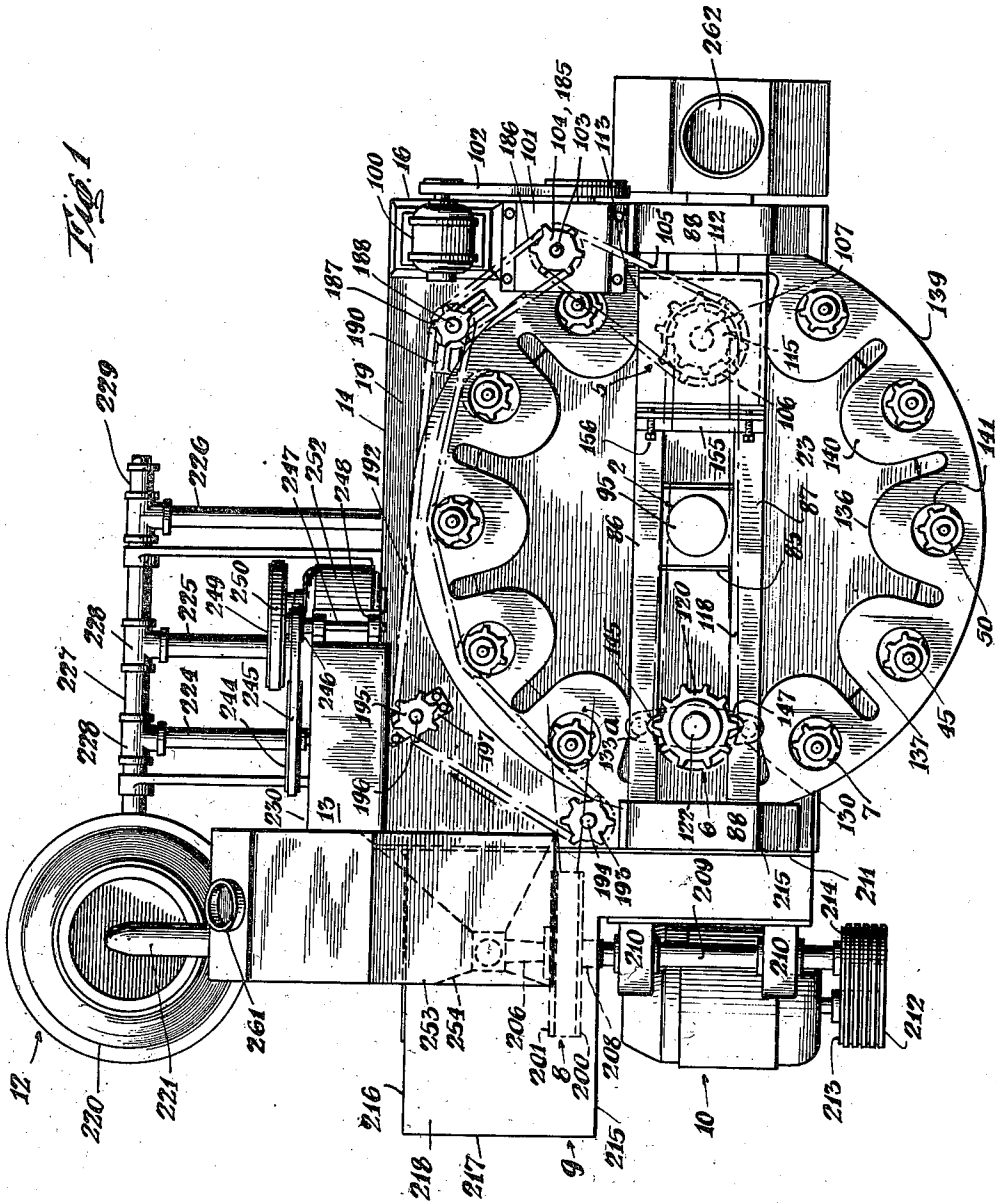
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**2,310,488**

# BLAST CLEANING APPARATUS

Filed March 20, 1941

6 Sheets-Sheet 1



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BLAST CLEANING APPARATUS

Filed March 20, 1941

6 Sheets-Sheet 2

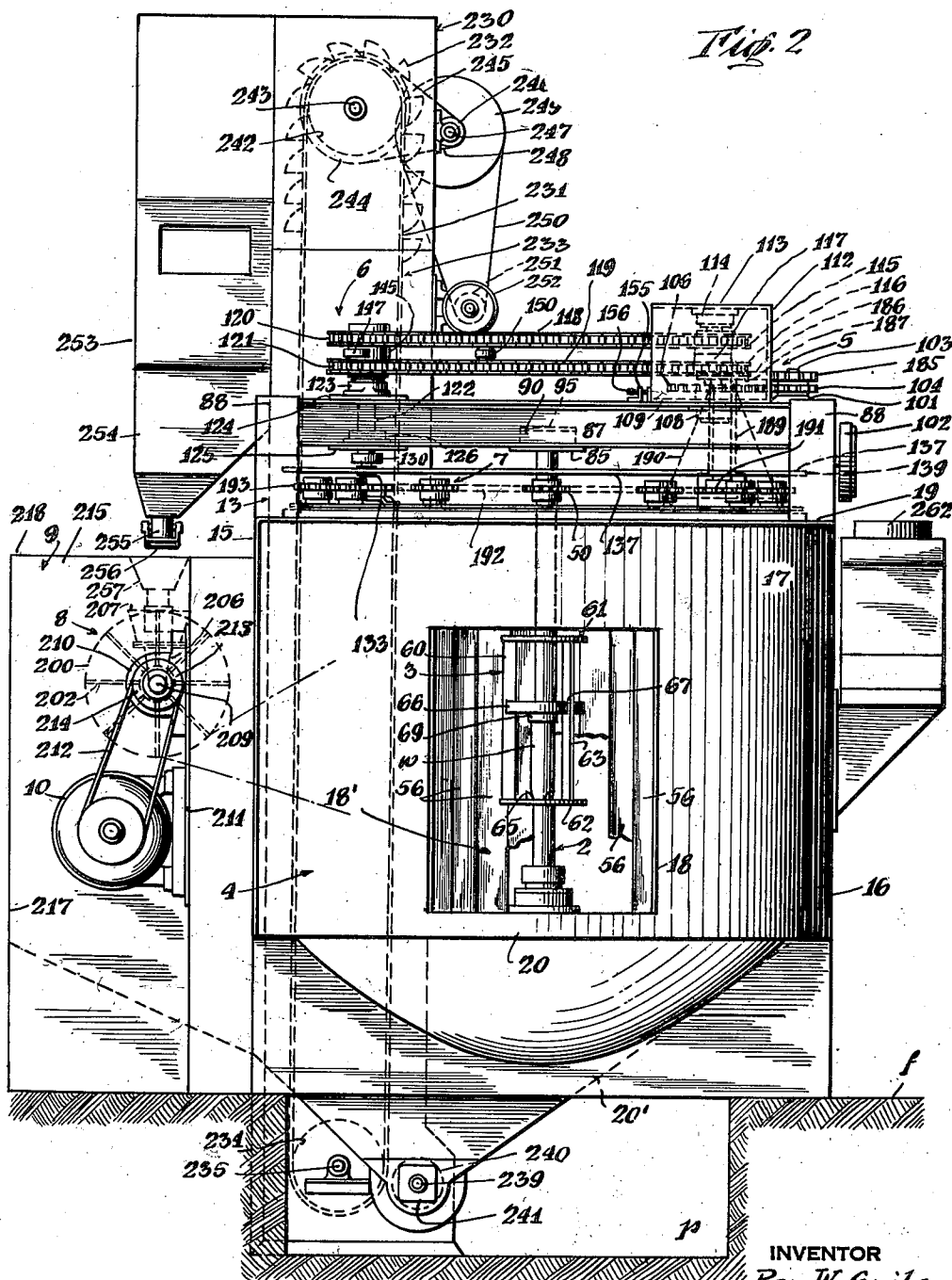


Fig. 2

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## BLAST CLEANING APPARATUS

6 Sheets--Sheet 3



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BLAST CLEANING APPARATUS

Filed March 20, 1941

6 Sheets-Sheet 4

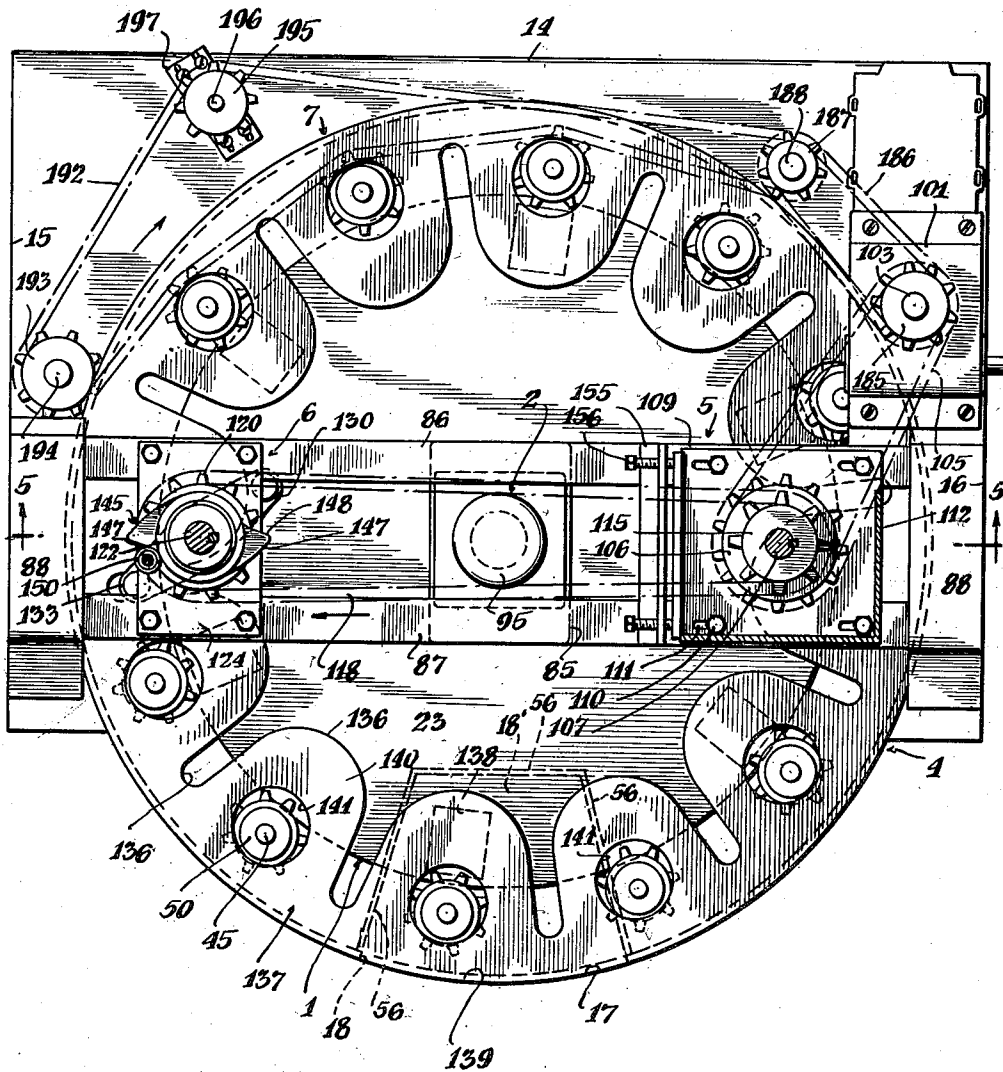


Fig. 4

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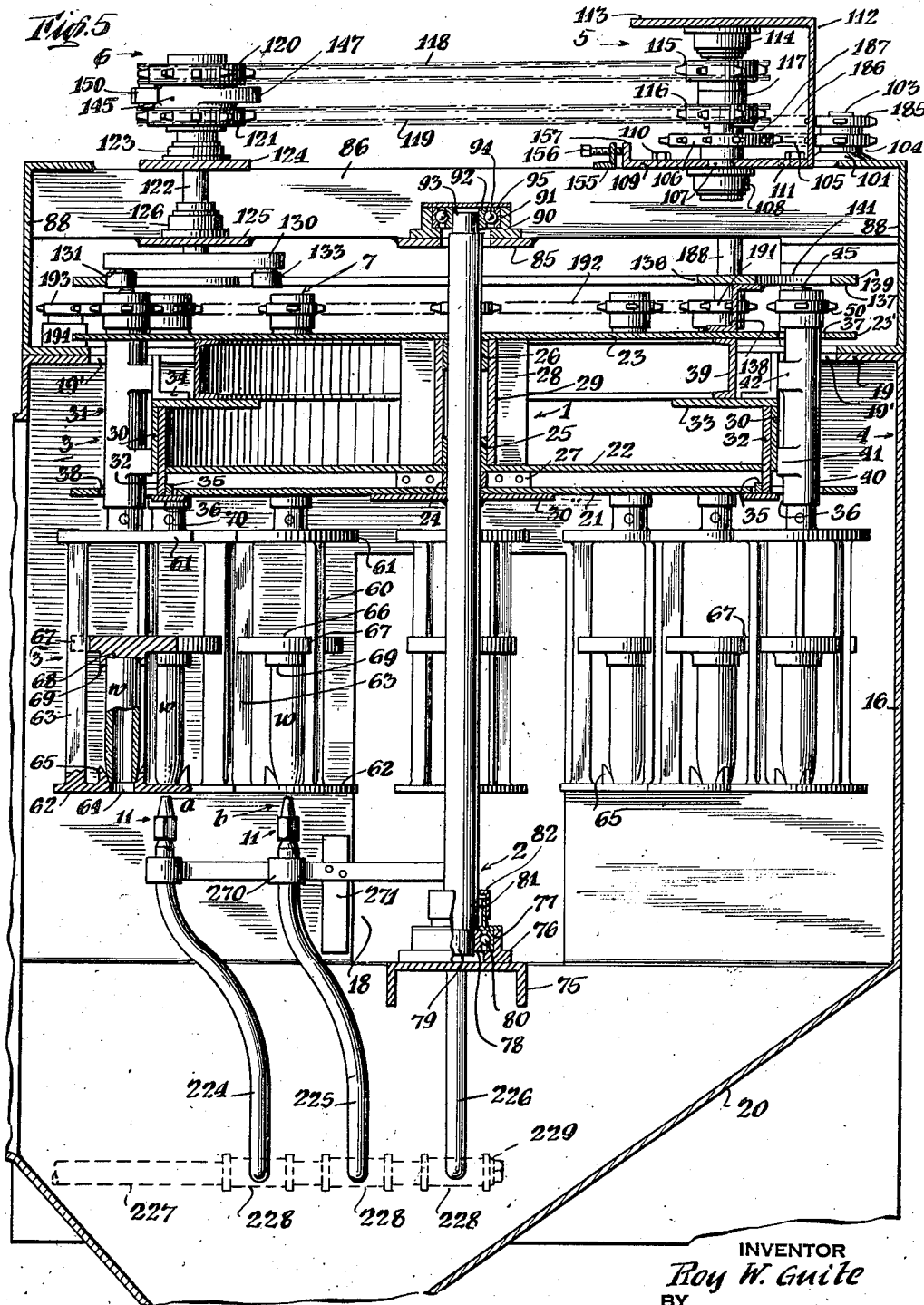
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## BLAST CLEANING APPARATUS

Filed March 20, 1941

6 Sheets-Sheet 5



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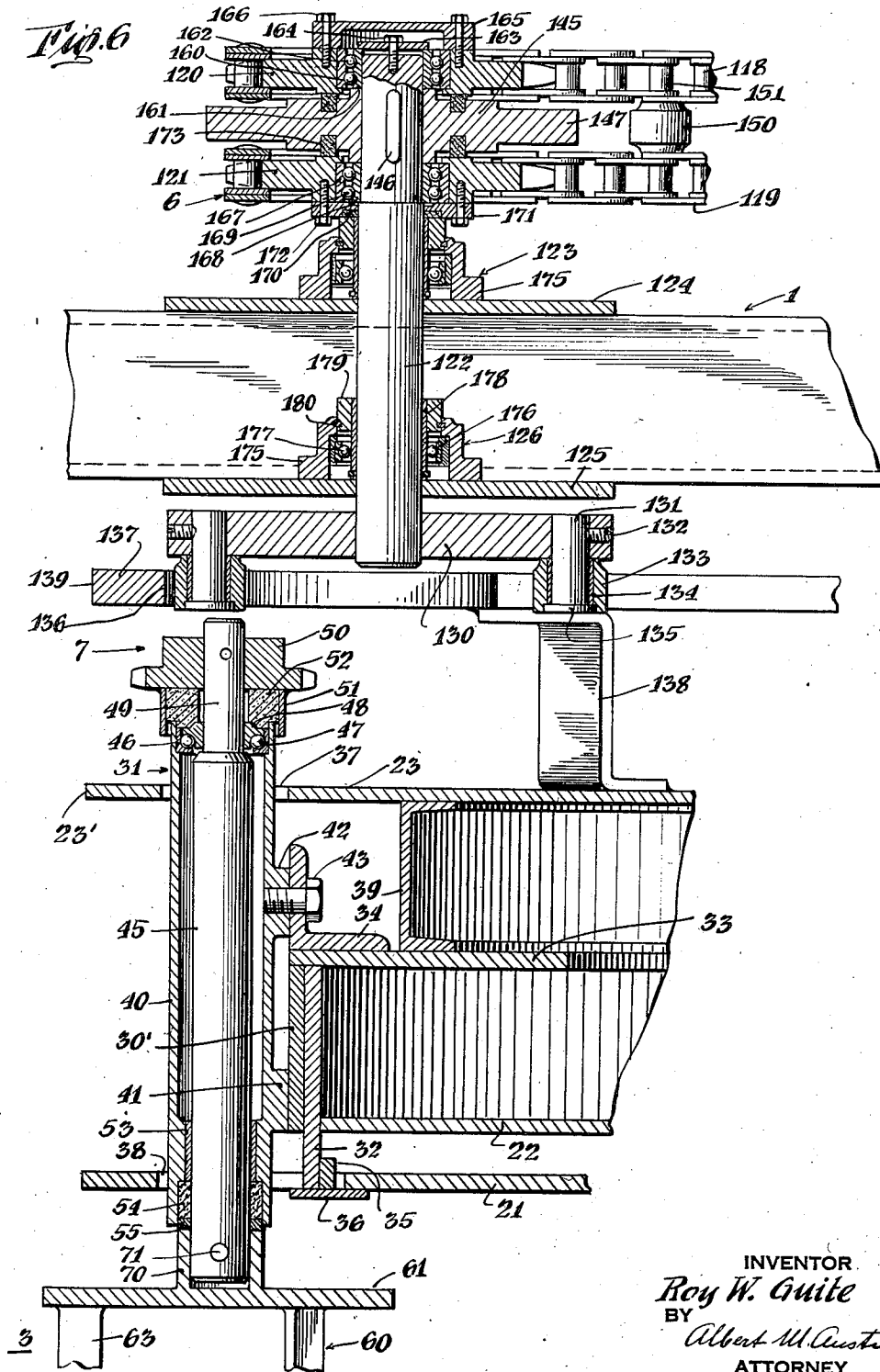
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# BLAST CLEANING APPARATUS

Filed March 20, 1941

6 Sheets-Sheet 6



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## UNITED STATES PATENT OFFICE

2,310,488

## BLAST CLEANING APPARATUS

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Application March 20, 1941, Serial No. 384,330

21 Claims. (Cl. 51-9)

This invention relates to blast cleaning apparatus, and more particularly to a machine for blast cleaning metal castings, forgings and like articles in which the articles are successively advanced into one or more blasting zones and rotated during their residence in the blasting zones.

In accordance with this invention, a rotatably mounted frame is provided from which the articles to be cleaned are suspended from spaced hangers supported upon the frame. The frame and article supporting hangers are enclosed within a blast cabinet into which one or more streams of abrasive are projected at blasting velocities.

An important feature of the invention is the provision of mechanism for automatically rotating the supporting frame in stop-and-go stages so that the article suspended from each hanger is successively brought into the blasting zones, there to reside for a predetermined cleaning interval before being advanced out of the blasting zones. The advancing mechanism is so constructed that the length of time during which the article resides in the blasting zone or zones can be determined and controlled so that each article will be properly and thoroughly cleaned of scale and other debris without overblasting or damage to the articles undergoing treatment. Mechanism is further provided to automatically rotate the articles during their residence in each blasting zone.

The apparatus is admirably adapted for cleaning bomb and shell casings and similar articles, where it is desired to blast clean both the exterior and the interior surfaces thereof. An abrasive throwing wheel is preferably provided which is constructed and arranged to fire a fan-shaped stream of abrasive against the exterior surface of the article during residence of the article at the first blasting station and while the article is there rotated. An air blast nozzle may be positioned at the first blasting station to direct an abrasive blast against the interior surface of the article while the exterior surface of the article is being cleaned by the abrasive blast projected from the abrasive throwing wheel. When the exterior surface of the rotating article at the first blasting station has been sufficiently cleaned and treated, the advancing mechanism automatically comes into play to rotate the supporting frame so as to move the article at the first blasting station a predetermined distance to a second blasting station. At the second blasting station a second abrasive blast nozzle may be positioned which is so inclined as to clean the interior sur-

faces which were not thoroughly cleaned at the first blasting station. When the second nozzle has performed its task, the advancing mechanism again comes into play to rotate the supporting frame and advance the article from the second to a third blasting station where a third blast nozzle is positioned to fire an abrasive stream against the interior surfaces of the article to clean those surfaces which have not been sufficiently cleaned during residence of the article at the first and second blasting stations. It will be appreciated that further blast nozzles and additional abrasive throwing wheels may be provided as may be necessary to clean all the exterior and interior surfaces of the particular casting, forging, or like article to be cleaned.

The blasting operations take place in one section of the cabinet only so that a substantial section of the supporting frame is positioned outside of the blasting zones to provide a blast free zone where the cleaned articles may be removed from the hangers and the articles to be cleaned put in place. Thus loading and unloading of the apparatus can continue without interruption and without danger to the workmen engaged in loading and unloading the hangers.

For the cleaning of bomb and shell casings an improved supporting cage is provided which is constructed to receive casings of different lengths and diameters and which rigidly retains the casings in proper position for most effective blast cleaning.

The apparatus operates automatically to successively advance the articles into the respective blasting stations where they remain for a predetermined time interval before being automatically advanced out of the final blasting station and to the unloading zone. The mechanism operates to almost instantly advance the articles from one station to the next so that the abrasive throwing wheel or wheels and blast nozzles may be continuously operated without material damage to the equipment. The advancing mechanism is positive in operation and advances the articles the correct distance so that each article is properly positioned and centered to receive the full effect of each abrasive blast. The apparatus is sturdy and strong in construction and is highly adapted for high speed production requirements.

An object of this invention is to provide an improved blast cleaning apparatus wherein metal articles can be blast cleaned efficiently and economically with a minimum of attention and from which the articles may be easily and quick-

ly removed and inserted without injury or risk to the operator.

Another object of this invention is to provide improved blast cleaning apparatus having mechanism associated therewith for automatically advancing the articles to one or more blasting stations, there to reside for a predetermined time interval before being advanced to the next succeeding blasting station or out of the final blasting station.

Another object of this invention is to provide blast cleaning apparatus having automatic means for advancing successive articles into and out of a series of blasting zones and rotating the articles during residence in said blasting zones.

A further object of this invention is to provide an improved blasting apparatus employing centrifugal abrasive throwing wheels and air blast nozzles so arranged and synchronized as to efficiently perform the particular blast cleaning function for which they are particularly adapted.

Other objects of this invention 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 the blast cleaning apparatus;

Fig. 2 is a front elevational view of the apparatus;

Fig. 3 is a side elevational view of the apparatus showing certain parts broken away to illustrate certain features of construction;

Fig. 4 is an enlarged top plan view showing more particularly the mechanism for advancing and rotating the workpieces, certain parts being broken away to illustrate structural details;

Fig. 5 is an enlarged vertical cross-sectional view through the workpiece advancing and rotating mechanism as the same appears when looking in the direction of the arrows 5—5 of Fig. 4; and

Fig. 6 is an enlarged vertical cross-sectional view of a fragmentary portion of the work advancing and rotating mechanism.

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

Referring more particularly to the drawings, the blast cleaning apparatus generally comprises a workpiece supporting frame 1 supported upon a vertically extending rotatably mounted shaft or pedestal structure 2. The frame 1 is provided with hanger structures 3 rotatably supported around the periphery of the supporting frame 1. This structure is contained in a suitable housing 4. Power transmission mechanism 5 suitably mounted on top of the cabinet 4 is operably connected to mechanism 6 operable to advance the workpiece supporting hangers 3 step by step into a blasting zone wherein mechanism 7 is provided for rotating the workpieces *w* carried

by hangers 3 during their residence in the blasting zone.

The exterior surfaces of the workpiece *w* are subjected to an abrasive blast projected by an abrasive throwing wheel 8 contained within an auxiliary housing 9 positioned adjacent the workpiece containing housing 4. Abrasive throwing wheel 8 is driven by a motor 10 which may be positioned outside of the auxiliary cabinet 9.

Where it is desired to clean the interior of workpieces in the form of hollow tubes or shells, the apparatus is provided with a series of air blast nozzles 11 positioned to direct a stream of abrasive against the interior surfaces of such tubular workpieces. The air blast nozzles 11 are supplied with abrasive from a compressor unit 12 positioned exteriorly of the housing 4. An abrasive cycling system 13 collects the thrown abrasive from the bottom of housing 4 and supplies cleaned and screened abrasive to the abrasive throwing wheel 8 and the air blast nozzles 11.

The main housing 4 is formed of heavy plate metal supported and reinforced by framing and bracing members, and comprises a relatively straight rear wall 14 and straight side walls 15 and 16 which together form a generally rectangular enclosure housing approximately two-thirds of the workpiece supporting frame 1. The front of the cabinet is enclosed by a generally arcuate-shaped front wall 17 which presents an opening 18 through which the workpieces can be inserted and removed. Hanging rubber curtains 56 extending inwardly on each side of the door opening form a curtained vestibule 18' which protects the loading and unloading operator from ricocheting abrasive. The cabinet 4 is provided with a top wall 19 which has a large circular opening 19' through which the upper portion of the workpiece supporting frame 1 projects. The cabinet is provided with an inclined bottom or hopper 20 which carries the abrasive and debris into a collecting trough 20'. The lower portion of the hopper may extend into a pit *p* provided in the floor *f* upon which the cabinet rests.

The structure which supports the workpieces *w* and the mechanism for advancing the workpieces in step-by-step relation into the blast zone and rotates the workpieces in the blasting zone for a predetermined period, constitutes an important feature of this invention and will now be more particularly described.

Referring more particularly to Figs. 1, 2, 4 and 5, the workpiece supporting framework comprises a horizontally disposed wheel-like frame 1 fixed to shaft 2, the wheel frame being formed by horizontally disposed circular plates 21, 22 and 23 of sturdy construction, held together in unitary assembly by suitable bracing. The shaft 2 extends through aligned apertures in plates 21, 22 and 23. Plate 21 is secured to a collar 24 which embraces the shaft 2, plate 22 is secured to a similar collar 25 which embraces the shaft 2, and plate 23 is secured to a collar 26 which also embraces the shaft 2. The lower plates 21 and 22 may be secured in fixed spaced relationship by suitable radiating gussets 27, and plates 22 and 23 may be held in fixed spaced relationship by radiating gussets 28, fixed to a collar 29 which encloses and may be riveted to the collars 25 and 26. The collars 24, 25 and 26 are so shaped that when secured to their respective frame plates 21, 22 and 23 they may be telescoped onto the shaft 2. The frame 1 rests upon and is secured to a supporting plate 30'' which is welded to the shaft

2. A rigid framework fixed to and rotating with the shaft 2 is thus provided.

A plurality of hanger structures 3 are fixed in uniform spaced relationship to the periphery of the frame forming plates 21, 22 and 23. Each hanger structure 3 comprises a hanger sleeve 31 which abuts against a circular metal band 30 formed of heavy metal plate fixed to the periphery of the horizontal supporting plate 22. The rim plate 30 is further braced by a plurality of spaced vertical struts 32 welded thereto. The lower end of each strut 32 seats against an abutment ring 35 carried by the frame plate 21 so that the loaded hanger sleeves 31 will not flex or buckle the rim plate 30. The abutment ring 35 may be welded to a ring plate 36 which in turn is welded to the underside of frame plate 21. The rim plate 30 may be provided with an intumed shelf portion 33 formed of heavy plate which is suitably secured as by welding to the rim plate 30. A circular shaped rail 39 of channel-shape cross-section is welded to the shelf plate 33 and the upper frame forming plate 23. The circular rail member 39 may be of somewhat less diameter than the rim plate 30 so that a circular rail member 34 of angle-shaped cross-section may be seated upon and secured to the outer periphery of the shelf plate 33. The rim plate 30, the struts 32 and the circular rail member 39 serve to integrally secure the peripheries of the horizontal frame forming plates 21, 22 and 23 in a rigid structural assembly so that the framework thus formed will carry great weight without weaving or buckling during rotation. The top frame plate 23 may be greater in diameter than the intermediate frame plate 22 so that the peripheral edge 23' thereof extends beyond the opening 19' in the top wall 19 of the cabinet to block the upward movement of abrasive. Suitable apertures 37 are provided in the frame plate 23 through which the hanger sleeves 31 extend. Similarly the lower frame plate 21 may be of increased diameter to baffle upwardly flying abrasive, appropriate apertures 38 being therein provided to receive the hanger sleeves 31.

The hanger sleeves 31, as shown more particularly in Figs. 5 and 6, each comprise a tubular casing 40 which projects a distance below the lower frame plate 21 and above the top frame plate 23. Each sleeve 40 is provided with a lower abutment portion 41 which abuts the circular rim plate 30 and an upper abutment portion 42 which abuts the upright leg of the circular rail member 34. A sturdy screw bolt extending through the vertical leg of the circular rail member 34 is threaded into a threaded aperture in the upper abutment portion 42 of the sleeve 40, thus rigidly securing the hanger sleeves 31 in position. The screw bolts 43 may be conveniently manipulated in the space between the top frame plate 23 and rail members 34 and 39.

A hanger spindle 45 is positioned to rotate in each hanger sleeve casing 40. A circular raceway 46 fits within the upper end of the sleeve 40 and provides a track for ball bearings 47. A bearing collar 48 fixed to the reduced end 49 of the spindle 45 is supported upon the bearings 47 which roll in the raceway 46, so that the hanger spindle 45 can rotate within the sleeve 40 with a minimum of friction. A sprocket wheel 50 is fixed to the reduced end 49 of the spindle 45 and is driven by a drive chain which will hereinafter be described. A tubular sealing collar 51 is welded to the lower face of the sprocket 50 and overlaps the upper end of the tubular

hanger sleeve 40. A suitable bearing packing 52 may be positioned within the sealing collar 51 so as to exclude grit and other foreign matter from the spindle bearing.

The lower end of each hanger spindle 45 extends through a suitable anti-friction bearing collar 53 and suitable packing material 54 is positioned within the lower end of the sleeve 40 around the spindle 45 and retained in place by a sealing ring 55. A work supporting carrier 60 is fixed to the lower end of each hanger spindle 45, which may vary in design depending on the shape and character of the articles to be cleaned. Where heavy bomb and shell casings are to be cleaned, the carrier 60 may be in the form of a cage comprising a top plate 61 and a bottom plate 62 connected together by a plurality of spaced vertically extending struts 63. The lower plate 62 may be provided with a central opening 64 which is surrounded by a flared collar 65 on the inside face thereof which receives the nose of the shell *w* and serves to align the nose end of the shell with the opening 64 in the lower cage plate. To provide for shells of different lengths, a partition plate 66 may be provided having slots 67 cut into the periphery thereof to receive the strut bars of the cage. Partition plate 66 is thus free to slide vertically in the space enclosed by the strut bars 63. The partition plate 66 is relatively heavy and is provided with a recessed lower face 68 having a surrounding collar portion 69 shaped to fit around the exterior of the upper end of the shell *w* and retains the nose end of the shell in proper seating position within the collar 65 on lower plate 62 of the cage. When the shell is to be removed the plate 66 is lifted, permitting easy withdrawal of the cleaned shell and the insertion of a shell to be cleaned. The upper plate 61 is provided with a collar 70 integrally formed therewith which receives the end of the hanger spindle 45. A key bolt 71 extends through aligned apertures in the collar 70 and in the lower end of the spindle 45 to secure the cage thereto. It will be appreciated that cages of different sizes or other types of hangers than herein specifically shown may be used for this apparatus and can be easily attached to the end of the hanger shaft 45 by means of the key bolt 71.

The shaft 2 which supports the framework 1 from which the workpieces are suspended, is heavy and sturdy in construction and is supported at its lower end by a heavy channel-shaped member 75 whose ends are secured to and supported by the main housing 4. The channel-shaped supporting member 75 supports a thrust bearing which may comprise a sturdy bearing collar 76 secured to the flat upper side of the channel member 75. The collar member 76 contains an outer raceway ring 77 which is secured to the collar 76 and an inner raceway ring 78 fixed to the lower reduced end 79 of the shaft 2. Ball bearings 80, positioned between the stationary bearing ring 77 and the rotating bearing ring 78, permit substantially frictionless rotation of the shaft 2. A sealing sleeve 81 seats upon the bearing collar 76 and provides a seal for the bearing contained therein. A second sleeve 82 fixed to the shaft 2 telescopes over the upstanding neck of sealing sleeve 81 so as to provide a substantially dustproof seal for the thrust bearing positioned therebelow.

The upper end of the shaft 2 is likewise journaled in a suitable anti-friction bearing which is supported upon a plate 85 welded to the lower

side of a pair of parallel extending cross-beams 86 and 87 whose ends are supported by transversely extending channel-shaped sections 88 which are supported upon the top wall 19 of the housing 4. The plate 85 carries a sturdy bearing collar 90 which contains an outer raceway ring 91 fixed thereto and an inner raceway ring 92 fixed to the upper reduced end 93 of the shaft 2. Ball bearings 94 positioned between the raceway rings 91 and 92 permit the shaft 2 to rotate within the bearing collar 90 substantially without friction. A sealing plate 95 closes the upper end of the bearing collar 90 and the bearing contained therein.

Mechanism is provided for advancing the suspended cages 60 in step-by-step movement into the blasting zone of the abrasive throwing wheel 8, in which blasting zone the cage and the workpiece *w* supported therein reside for a predetermined period during which period it is rotated so that the outer surface of the workpiece *w* is blast cleaned by the thrown abrasive projected from the wheel 8. This mechanism then serves to advance this hanger and its workpiece successively into position over the respective blast nozzles 11 wherein the interior of the workpiece *w* is blast cleaned.

This mechanism is driven by motor 100 mounted upon the top wall 19 of the housing 4, the motor 100 being connected to speed reducing mechanism 101 through a drive belt 102. The driven shaft 103 of the speed reducing mechanism carries a sprocket 104 around which is trained a drive chain 105. The drive chain 105 is also trained around a driven sprocket 106 fixed to a stub shaft 107 rotatably supported in a bearing 108 carried by the cross-beams 86 and 87. The bearing 108, as shown in Fig. 5, is secured to a movable plate 109 that rests upon cross-beams 86 and 87, the plate 109 being adjustably secured thereto by means of bolts 110 which extend through slots 111 in the plate 109. Thus by loosening the bolts 110, the plate 109 and its bearing may be moved laterally a limited distance along the supporting beams 86 and 87 for a purpose that will presently appear. The plate 109 is provided with an upstanding wall 112 and a horizontally extending wall 113. The underside of the horizontally extending wall 113 carries a bearing 114 within which the upper end of the shaft 107 is journaled.

A pair of spaced sprockets 115 and 116 are secured to the shaft 107 by means of suitable collars 117 so that the sprockets 115 and 116 rotate with the shaft 107. A drive chain 118 is trained around sprocket 115 and a complementary drive chain 119 is trained around sprocket 116. Drive chain 118 is also trained around a sprocket 120 and drive chain 119 is also trained around a sprocket 121, sprockets 120 and 121 being rotatably supported on a vertical stub shaft 122 at the other end of the cabinet. The stub shaft 122 rotates in a bearing 123 fixed to a base plate 124 supported on the top side of the frame members 86 and 87. A second base plate 125 fixed to the lower side of frame members 86 and 87 also carries a bearing 126 through which the shaft 122 extends.

As shown more particularly in Figs. 4, 5 and 6, a cam arm 130 is fixed to the lower end of the stub shaft 122. Each end of the cam arm 130 carries a downwardly projecting stud 131 which may be removably secured to the cam arm by means of a set screw 132. Each stud 131 carries a roller 133 journaled thereon by means of a Babbitt

bearing 134. Each stud 131 has a head 135 which retains the roller 133 on the stud 131.

The rollers 133 are designed to roll around the inner periphery 136 of a cam track 137 which is fixed to the top plate 23 of the framework 1 by suitable spaced Z-shaped brackets 138. It will be noted that the cam track 137 has a circular outer periphery 139 which is of substantially the same diameter as the upper plate 23 of the frame and that its inner periphery is defined by semi-circular scalloped portions 140 extending inwardly from the outer periphery 139. Each scalloped portion 140 may be provided with a circular opening 141 in alignment with the sprocket 50 positioned therebelow to permit ready removal of the sprocket 50 when desired. The inner periphery 136 of each scallop 140 provides an edge along which the rollers 133 carried by the cam arm 130 may roll, as shown more particularly in Fig. 4. Thus as the cam arm 130 fixed to shaft 122 is rotated, the rollers 133 will follow around the scalloped edge 136 of the cam track 137 so as to rotate the track 137 and the entire framework 1 to which it is fixed in a generally clockwise direction as viewed in Fig. 4.

To effect intermittent or step-by-step advance movement of the framework 1 in a clockwise direction, the shaft 122 is rotated intermittently approximately 180°. The intermittent rotating movement of the shaft 122 is effected by the provision of a pawl member 145 which is fixed to the shaft 122 by means of a suitable spline 146. The pawl member 145 is positioned between the sprockets 120 and 121 which are free to rotate on the upper end of the stub shaft 122. The pawl member 145 is provided with a pair of diametrically opposed ears 147, as shown more particularly in Fig. 4, each ear 147 presenting an abutment surface 148. The spaced complementary chains 118 and 119 carry a roller 150 rotatably supported upon a vertically extending pin 151 fixed to the spaced chains 118 and 119. When the chains 118 and 119 are driven from the shaft 107, which shaft is continuously driven by the motor 100, the roller 150 is advanced around the free riding sprockets 120 and 121 and into contact with the abutment surface 148 of one of the ears 147 of the pawl 145. During continued travel of the roller 150 the pawl member 145 is rotated through an arc of approximately 180°, causing the shaft 122 to likewise be rotated through an angle of 180°. Thus the hanger spindles 45 each carrying an article supporting cage 60 are advanced a predetermined distance which is determined by the number of scallops 140 on the cam track 137.

To maintain the drive chains 118 and 119 relatively taut, an angle bar 155 extending transversely between and secured to the frame members 86 and 87 is provided. The angle bar 155 carries a pair of threaded adjusting bolts 156 whose ends are adapted to abut an upturned flange 157 provided upon the plate 109 which supports the chain shaft 107. By manipulating the adjusting screws 156 the shaft 107 may be moved away from the shaft 102 so as to maintain the drive chains 118 and 119 relatively taut.

The bearing which supports the sprocket 120, as shown in Fig. 6, may comprise a bearing ring 160 fixed to the interior of the sprocket 120 and a bearing ring 161 fixed to the end of the shaft 122, ball bearings 162 being provided therebetween. The end of shaft 122 may be capped by a primary cap 163 which overlaps the inner bearing ring 161 and is secured to the end of the shaft

by a threaded bolt 164. A secondary cap 165 extends over the shaft assembly and is secured to the sprocket 120 by bolts 166. The lower sprocket 121 may be similarly provided with an outer bearing ring 167 fixed to the interior thereof and an inner bearing ring 168 fixed to the reduced end of the stub shaft 122, roller bearings 169 being positioned between the inner and outer rings. A sealing gasket 170 positioned below the sprocket 121 is carried by a sealing plate 171 secured to the lower face of the sprocket 121 as by bolts 172. To shield the reduced end of the shaft 122 against the entry of foreign matter, circular packing rings 173 may be set into the pawl member 145 in position to ride in sealing contact with the lower surface of the sprocket 120 and the upper surface of sprocket 121.

The bearings 123 and 126 which support the stub shaft 122 may be similarly constructed, as shown in Fig. 6, each comprising a bearing collar 175 supported on the adjacent bed plate. The bearing collar 175 contains a bearing ring 176 forming a raceway for balls 177 which roll around a bearing sleeve or collar 178 fixed to the shaft 122. A sealing collar 179 fixed to the inner bearing collar 178 rotates within a sealing gasket 180 carried in the upper edge of the bearing collar 175.

Mechanism is provided to continuously rotate the hanger spindles 45 during their residence in the blast cleaning streams. This rotating mechanism may also be driven by the motor 100 by means of a sprocket 185 fixed to the shaft 103 of the speed reducing mechanism. A drive chain 186 is trained around the sprocket 185, the chain 186 also being trained around a sprocket 187 fixed to a shaft 188. The shaft 188 is positioned exteriorly of the top wall 19 of the housing 4 and adjacent the outer periphery 139 of the cam track 137. The shaft 188 is rotatably supported in bearings 189 carried by a bracket 190 fixed to the top wall 19 of the housing 4. A sprocket 191 is fixed to the lower end of the driven shaft 188. A continuous drive chain 192 is trained around the sprocket 191 and is so arranged that the inner reach thereof will engage a predetermined number of sprockets 50 fixed to the hanger spindles 45. The other end of the continuous drive chain 192 is trained around a sprocket 193 rotatably supported upon a stub shaft 194 suitably fixed to the top wall of the housing 4. A predetermined tension may be maintained upon the inner reach of the drive chain 192 by means of an idler sprocket 195 over which the outer reach of the drive chain 192 is trained. The idler sprocket 195 rotates upon a suitable stub shaft 196 fixed to a bracket 197 which may be adjustably secured to the top wall of the cabinet 4.

When the motor 100 is thrown into operation, the driven shaft 188 is rotated which advances the drive chain 192 in the direction of the arrow shown in Fig. 1, which in turn rotates a predetermined number of the sprockets 50 and their associated work supports 60 so that the workpiece *w* is rotated within the blast stream. If desired, the drive chain 192 may be driven by a separate motor and variable speed reducer so that the work supports 60 may be rotated independently of the stop-and-go advance movement of the frame 1.

The abrasive throwing wheel 8 is positioned adjacent the side wall 15 of the cabinet and is arranged to throw a fan-shaped stream of abrasive through an opening provided in the side wall 15 of the cabinet against the workpiece *w* posi-

tioned at the initial blasting station *a*. Such abrasive throwing wheels 8 are generally well known and preferably comprise a pair of spaced side wall plates 200 and 201 which are arranged in fixed spaced relationship by means of suitable studs or spacers. A plurality of channel-shaped abrasive throwing blades 202 are radially arranged in spaced relationship between the side wall plates 200 and 201, the inner ends of the blades extending inwardly short of the axis of rotation of the wheel to provide a central space. A normally stationary tubular control member 203 extends into the central space and is provided with a discharge outlet 204 in the tubular side wall thereof. An impeller 205 is positioned within the tubular control member 203 and is fixed to rotate with the side wall discs 200 and 201. Abrasive is supplied to the impeller 205 by means of a suitable supply spout 206 having at its upper end an abrasive receiving funnel 207. The side wall disc 200 is fixed to a hub 208 which is secured to one end of a drive shaft 209 rotatably supported in spaced bearings 210. The bearings 210 are fixed to a sturdy base plate 211 mounted on the exterior face of the cabinet side wall 15. The wheel shaft 209 carries a sheave 214 around which a V-belt drive 212 is trained. The V-belt drive 212 is also trained around the sheave 213 of the motor 10. The motor 10 is also sturdily mounted upon the base plate 211.

Abrasive throwing wheel 8 is enclosed within an auxiliary housing 9 comprising generally spaced front and rear walls 215 and 216, a side wall 217 and a top closing wall 218. A portion of the hub 208 of the wheel extends through a suitable opening provided in the front wall 215 of the auxiliary cabinet. The side wall 15 of the main cabinet may be provided with an opening which is closed by the auxiliary cabinet 9 so that the abrasive thrown by the abrasive throwing wheel 8 is free to enter the main housing 4 and impinge the workpiece *w* positioned at blasting station *a*.

The compressor unit 12 is of well known construction and need not be described in detail. It comprises generally a compression tank 220 which receives abrasive from the abrasive supply pipe 221. The high pressure air line 222 supplies compressed air to a mixing device 223 which also receives abrasive from the compression tank 220. The abrasive suspended in the air stream is blown through three air blast hose lines, 224, 225 and 226, each hose terminating in an air blast nozzle 11.

The nozzle 11 fixed to the blast hose 224 may be positioned to blast the interior of the workpiece or shell *w* while residing at blasting station *a*. This nozzle is arranged to project a stream of abrasive directly into the shell interior where the blast stream fans out and cleans the interior surface of the shell wall as the workpiece *w* is rotated at that station. It will be noted that the exterior surface of the shell is cleaned at this station by abrasive projected from the abrasive throwing wheel 8. Blast hose 225 carries a nozzle 11 which is inclined and positioned at blast station *b*. The nozzle as thus arranged will fire the abrasive against a section of the interior side wall of the shell during rotation of the shell at the station *b*. The nozzle 11 attached to blast hose 226 is positioned at station *c* and is inclined at a different angle to blast clean the upper section of the shell interior as the shell is rotated at that station.

The compression tank 220 may be positioned

exterior to but adjacent the cabinet 4 and for convenience in arrangement may be provided with a main blast line 227 which is connected directly to the mixing device 223, as shown more particularly in Fig. 1. The hose lines 224, 225 and 226 may be connected to the main blast line 227 by suitable couplings 228. The free end of the main blast line 227 is closed by means of a suitable cap plug 229. The nozzles 11 are adjustably supported by collars 270 adjustably secured to a suitable frame bar 271.

The abrasive cycling system 13 may comprise an elevator casing 230 within which is positioned a bucket elevator 231, and comprises generally a series of abrasive receiving buckets 232 fixed to a supporting belt 233. The lower end of the bucket belt 233 is trained around a lower drum 234 positioned at the bottom of the elevator casing 230, the drum 234 being fixed to a suitable shaft 235 journaled in the side walls of the elevator casing 230. The shaft 235 carries a pulley wheel 236 which is operably connected by means of a drive belt 237 to a pulley 238 fixed to the end of a shaft 239 which is connected to a feed screw 240 positioned within the trough portion 20' at the bottom of the hopper 20. The opposite end of the feed screw 240 may be journaled in a suitable bearing 241.

The upper end of the bucket supporting belt 233 is trained around a drum 242 at the top of the elevator casing 230, this drum being fixed to a shaft 243 journaled in the side walls of the elevator casing 230. The projecting end of the shaft 243 carries a pulley wheel 244 operably connected by the drive belt 245 to a pulley 246 fixed to a shaft 247 rotatably mounted in bearings 248 which are fixed to the adjacent side walls of the elevator casing 230. Shaft 247 carries a pulley wheel 249 operably connected by drive belt 250 to the drive sheave 251 of a motor 252. The motor 252 may be suitably supported by or secured to the adjacent side wall of the elevator casing.

The abrasive and debris falling onto the hopper 20 drops into the trough 20' where it is conveyed by the conveyor screw 240 into the boot of the elevator casing 230. The elevating buckets 232 fixed to the elevator belt 233 carry the abrasive and debris upwardly in the elevator casing 230 and discharge it into a screening and separating chamber 253 where the debris and spent abrasive is removed from the usable abrasive. The usable abrasive drops down into a hopper 254 at the lower end of the separator chamber 253. The hopper 254 terminates a discharge funnel 255 which carries a movable closure valve 256. When the closure valve 256 is open the abrasive drops down into a secondary feed funnel 257 supported upon the top wall 218 of the auxiliary cabinet 9 and then into the primary feed funnel 207 on the feed spout 206. The second hopper 260 at the lower end of the separator chamber 253 leads to the abrasive supply spout 221 which supplies abrasive to the compression tank 220. The hopper legs 254 and 260 of the separator 253 also provide convenient storage hoppers for the cleaned abrasive. Dust and other air-suspended particles may be removed from the separator 253 by suitable exhaust systems connected to the dust discharge port 261. The cabinet 4 is also provided with an exhaust port 262 through which dust laden air in the cabinet 4 may be removed.

In operating the apparatus, the elevator motor 252 is energized to drive the abrasive cycling sys-

tem 13. The conveyor operating motor 100 is thrown into operation, the sliding doors 18 opened and the shell casing or other articles *w* to be cleaned are positioned within the cages 60 during residence adjacent the door opening in the front wall 17 of the cabinet. Rubber curtains 56 suspended from the front wall 17 of the cabinet may be provided to hang over the door opening to protect the workmen from abrasive that might ricochet from the cabinet interior.

The complementary drive chains 118 and 119 carrying the roller 150 therebetween continue to advance at a uniform speed when driven by the motor 100 through the speed reducing mechanism 101. During the advance movement of the complementary chains 118 and 119, roller 150 is advanced into abutting contact with the abutment surface 148 of the pawl 145. As the chains 118 and 119 continue to move around the idler sprockets 120 and 121, the pawl 145 engaged by the roller 150 is rotated through an angle of approximately 180°. Since both the pawl 145 and the cam arm 130 are fixedly secured to the shaft 122, the cam arm 130 is likewise rotated through the same 180°. The rollers 133 carried by the cam arm 130 engage the scalloped inner edge 136 of the cam track 137 fixed to the rotatable supporting frame 1. One of the rollers 133 moves into the space between one pair of scalloped portions 140, and as the cam bar 130 continues to rotate the roller 133 thus positioned exerts a driving pressure on the forward scalloped portion in the direction of the arrow shown in Fig. 4. When the supporting frame 1 has been rotated a distance equal to the peripheral length of one of the scalloped portions 140, the leading roller 133 is carried out of its position between that pair of scalloped portions and the roller 133 at the other end of the cam arm is moved into the space between the next adjacent pair of scalloped portions. When this has taken place, the roller 150 carried by the drive chains 118 and 119 has moved out of engagement with the ear 147 of the pawl 145 and the supporting frame 1 comes to rest.

At this at rest position another article supporting cage 60 has been brought into loading position at the door opening in the front wall 17, and similarly article supporting cages have advanced into the respective blasting zones *a*, *b* and *c*. The loading operation is continued until all of the cages 60 have been loaded with articles *w* to be cleaned and an article *w* is positioned at each blasting station *a*, *b* and *c*. The wheel driving motor 10 is thrown into operation and the abrasive valve 256 swung open to supply the wheel with abrasive. The nozzles 11 at the respective blasting stations *a*, *b* and *c* are also placed in operation when the cages 60 have been loaded with the workpieces *w*.

It will be noted that the supporting frame 1 and the workpiece supporting cages 60 remain at rest while the roller 150 fixed to the complementary chains 118 and 119 has moved from the pawl 145 around the drive sprockets 115 and 116 and back to the idler sprockets 120 and 121 into position to again engage one of the ears 147 of the pawl 145. During this time interval the articles *w* are undergoing blasting treatment at blasting stations *a*, *b* and *c*. The time period of this blasting treatment can be controlled to fine limits by regulating the speed of the speed reducer mechanism 101 so as to vary the speed of travel of the complementary drive chains 118 and 119.

The period of time it takes the roller 150 to travel 180° around the idler sprockets 120 and 121

while in operative engagement with the pawl 145 determines the time interval required to shift the supporting frame one stage, during which stage a partially blasted workpiece is moved into the next succeeding blasting zone, an unblasted workpiece is brought into the first blasting zone, and a fully blasted workpiece is carried out of the final blasting zone. The time required to effect this shift is exceedingly small, making it unnecessary to cut off the abrasive supply to the blasting wheel and nozzles.

The cages 60 are easy to load inasmuch as they are brought to a full stop and so remain until the workpieces in the blasting zones have been cleaned to the desired degree. During this interval the operator has sufficient time to remove the cleaned workpiece *w* from the cage 60 and replace therein an uncleaned workpiece. Loading and unloading thus go on continuously during operation. The apparatus operates automatically with a minimum of attention and once the speed reducing mechanism 101 has been set to drive the complementary drive chains 118 and 119 at the proper speed to insure satisfactory cleaning of the workpieces, the cleaning operation can continue without interruption.

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. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive to define a blasting zone, a conveyor having a cam track associated therewith, means for supporting the workpiece on said conveyor, and automatic means for moving said conveyor to advance the workpiece into said blasting zone and out of said blasting zone, said advancing means being ineffective to rotate said frame for a predetermined time interval during residence of the workpiece in said blasting zone, said advancing means including a driving motor, a variable speed reducer having a driving connection to said motor, an endless flexible member having a driving connection with said variable speed reducer, a rotatably mounted shaft, a pawl fixed to said shaft, an element connected to said flexible member adapted to detachably engage said pawl to rotate said shaft during only a portion of the path of travel of said flexible member, and an arm fixed to said shaft movable into and out of engagement with the cam track associated with said conveyor to advance said conveyor a predetermined distance during rotation of said shaft.

2. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive to establish a blasting zone, a continuous conveyor, a workpiece carrier suspended from said conveyor, automatic means for moving said conveyor to advance the workpiece into said blasting zone and out of said blasting zone, said advancing means being ineffective to rotate said frame for a predetermined time interval during residence of the workpiece in said blasting zone, said advancing means including a continuous cam track fixed to said conveyor, a driving motor, a variable speed reducer having a driving connection to said motor, an endless flexible member having a constant driving connection with said variable speed reducer, a rotatably mounted shaft, a pawl fixed to said shaft, an ele-

ment connected to said flexible member adapted to detachably engage said pawl to rotate said shaft during only a portion of the path of travel of said flexible member, and an arm fixed to said shaft movable into and out of engagement with said continuous cam track to advance said conveyor a predetermined distance during rotation of said shaft, and means for rotating said carrier and its workpiece during residence of the workpiece in said stream.

3. Blast cleaning apparatus including in combination, a blasting cabinet, means for projecting a stream of abrasive to define a blasting zone in said cabinet, a rotatably mounted article supporting frame having a section thereof movable into a position adjacent said blasting zone, means for supporting a workpiece from said frame section, and automatic means for rotating said frame to advance the workpiece into said blasting zone and out of said blasting zone, said advancing means being ineffective to rotate said frame for a predetermined time interval during residence of the workpiece in said blasting zone, said advancing means including a continuously driven flexible member, a rotatably mounted shaft, a pawl fixed to said shaft, an element connected to said flexible member adapted to detachably engage said pawl to rotate said shaft during only a portion of the path of travel of said flexible member, and an arm fixed to said shaft for movement into and out of engagement with said frame to rotate said frame a predetermined distance during rotation of said shaft.

4. Blast cleaning apparatus including in combination, a cabinet, means for projecting a stream of abrasive into said cabinet to define a blasting zone therein, a supporting frame mounted for rotation in a substantially horizontal plane having a peripheral section thereof positioned adjacent said blasting zone, means for suspending a workpiece from the periphery of said frame, means for automatically rotating said frame to advance the workpiece into said blasting zone and out of said blasting zone, said advancing means being ineffective to rotate said frame for a predetermined time interval during residence of the workpiece in said blasting zone, said advancing means including a continuous undulating cam track fixed to said frame, a continuously driven flexible member, a rotatably mounted shaft, a pawl fixed to said shaft, an element connected to said flexible member adapted to detachably engage said pawl to rotate said shaft during only a portion of the path of travel of said flexible member, and an arm fixed to said shaft for movement into and out of engagement with said cam track to rotate said frame a predetermined distance during rotation of said shaft, and means for rotating the workpiece during residence in said blasting zone.

5. Blast cleaning apparatus including in combination, a cabinet, means for projecting a stream of abrasive into said cabinet to define a blasting zone therein, a conveyor mounted for movement in a substantially horizontal plane having a section thereof positioned adjacent said blasting zone, a plurality of workpiece supporting hangers suspended from said conveyor in uniform spaced relationship, and means for automatically moving said conveyor to advance the workpieces successively into said blasting zone and out of said blasting zone, said advancing means being ineffective to move said conveyor for a predetermined time interval during residence of each workpiece in said blasting zone,

said advancing means including, a substantially continuous undulating cam track fixed to said frame, a driving motor, a variable speed reducer having a driving connection with said motor, an endless conveyor advancing chain having a driving connection with said variable speed reducer, a rotatably mounted shaft, a pawl fixed to said shaft, an element connected to said conveyor advancing chain adapted to detachably engage said pawl to rotate said shaft through a predetermined arc only during a portion of the path of travel of said chain, means fixed to said shaft movable into and out of engagement with said cam track to advance said conveyor a predetermined distance during rotation of said shaft, an endless spinner chain operatively connected to said speed reducer, and sprockets associated with said hangers adapted to be moved into and out of engagement with said spinner chain to rotate said hangers and the workpieces supported thereon during residence of the workpieces in said blasting zone.

6. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, a rotatably mounted supporting frame having a peripheral section thereof positioned adjacent said blasting zone, means for rotatably supporting a workpiece on said frame, and automatic means for rotating said frame in stop-and-go stages to carry the workpiece into the blasting zone and then out of the blasting zone after residence during a predetermined period therein, said advancing means including, a substantially endless undulating cam track fixed to said frame, a driving motor, a variable speed reducer having a driving connection with said motor, an endless frame-rotating chain having a driving connection with said variable speed reducer, a rotatably mounted shaft, a pawl fixed to said shaft, an element connected to said frame-rotating chain adapted to detachably engage said pawl to rotate said shaft through a predetermined arc only during a portion of the path of travel of said chain, means fixed to said shaft movable into and out of engagement with said cam track to rotate said frame a predetermined distance during rotation of said shaft, an endless spinner chain operatively connected to said speed reducer, and sprockets associated with said workpiece supporting means adapted to be moved into and out of engagement with said spinner chain to rotate said workpiece supporting means during residence of the workpiece in said blasting zone.

7. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, a conveyor having a section thereof positioned adjacent said blasting zone, an undulating cam track fixed to said conveyor means for supporting a workpiece from said conveyor, and automatic means for advancing said conveyor in stop-and-go stages to carry the workpiece into the blasting zone and then out of the blasting zone after residence during a predetermined time interval therein, said means including a continuously driven chain, a rotatably mounted shaft, a pawl fixed to said shaft, a stud associated with said continuously driven chain adapted to detachably engage said pawl to rotate said shaft during only a portion of the path of travel of said chain, and an arm fixed to said shaft adapted to operatively engage said cam track to advance said conveyor a predetermined distance during rotation of said shaft.

8. Blast cleaning apparatus including in com-

5 bination, means for projecting a stream of abrasive into a blasting zone, a rotatably mounted supporting frame having a peripheral section thereof positioned adjacent said blasting zone, means for supporting a workpiece on said frame, and automatic means for rotating said frame in stop-and-go stages to carry the workpiece into the blasting zone and then out of the blasting zone after residence during a predetermined time interval therein, said means including an undulating cam track fixed to said frame, a continuously driven chain, a rotatably mounted pawl, means associated with said continuously driven chain adapted to detachably engage said pawl to rotate the same during only a portion of the path of travel of said chain, and means operably connected to said pawl and positioned to intermittently engage said cam track to rotate said frame a predetermined distance during rotation of said pawl.

9. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, a movable conveyor having a cam surface, spaced means for supporting a plurality of workpieces from said conveyor, and means operative to move said conveyor to first advance said workpieces successively into said blasting zone, then retain said workpieces successively in said blasting zone for a predetermined time interval and then advance the workpieces successively out of the blasting zone, said means including a continuous drive chain, means for continuously driving said chain, a shaft, a pawl fixed to said shaft, an element projecting from said chain adapted to engage said pawl to rotate said shaft during only a portion of the path of travel of said drive chain, and a cam arm fixed to said shaft operable to move into and out of engagement with said conveyor cam surface to advance said conveyor a predetermined distance during rotation of said shaft.

10. Blast cleaning apparatus including in combination, a plurality of means for projecting separate streams of abrasive into a series of spaced blasting zones, a movable conveyor, spaced means for supporting a plurality of workpieces from said conveyor, and means operative to move said conveyor to first advance said workpieces successively into said spaced blasting zones, then retain said workpieces successively in each of said blasting zones for a predetermined time interval and thence advance the workpieces successively out of the final blasting zone, said means including a continuous flexible drive member, means for continuously driving said flexible member, a shaft, a pawl fixed to said shaft, an element projecting from said flexible member adapted to engage said pawl to rotate said shaft during only a portion of the path of travel of said flexible member, a cam track fixed to said conveyor, and a cam member fixed to said shaft adapted to engage said cam track to advance said conveyor a predetermined distance while said element engages said pawl.

11. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, a rotatably mounted supporting frame having a peripheral section thereof positioned adjacent said blasting zone, means for supporting a workpiece from said frame, and means operative to first advance said workpiece into said blasting zone, then retain said workpiece in said blasting zone for a predetermined time interval and then advance the workpiece out of said blasting zone, said means

including a pair of spaced sprockets, a continuous drive chain trained around said sprockets, means for continuously driving said chain, a shaft, a pawl fixed to said shaft, an element projecting from said chain adapted to detachably engage said pawl to rotate said shaft during travel of said element around one of said sprockets, a cam track fixed to said frame, and a cam arm fixed to said shaft adapted to engage said cam track to rotate said frame a predetermined distance while said element engages said pawl.

12. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, a rotatably mounted workpiece supporting frame having a peripheral section thereof positioned adjacent said blasting zone, and means for rotating said frame by stop-and-go stages to first advance said workpiece into said blasting zone, then retain said workpiece in said blasting zone for a predetermined time interval and then advance the workpiece out of said blasting zone, said means including an undulating cam track fixed to said frame, a pair of continuous complementary drive chains, a pair of sprockets at each end of said chains for supporting the same, means for driving said chains, a shaft for rotatably supporting an adjacent pair of said sprockets, a pawl fixed to said shaft between said paired sprockets, an abutment element connected to said spaced chains adapted to engage said pawl to rotate said shaft through a predetermined arc during travel of said abutment element around the adjacent paired sprockets, and a cam arm associated with said shaft operably connected to engage said cam track to rotate said frame a predetermined distance during rotation of said shaft.

13. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, a rotatably mounted article supporting frame having a peripheral section thereof positioned adjacent said blasting zone, and means for rotating said frame by stop-and-go stages to first advance said article into said blasting zone, then retain said article in said blasting zone for a predetermined time interval and then advance the article out of said blasting zone, said means including a pair of continuous complementary drive chains, a pair of sprockets at each end of said chains for supporting the same, means for driving said chains, a shaft for rotatably supporting an adjacent pair of said sprockets, a pawl fixed to said shaft between said paired sprockets, an abutment element connected to said spaced chains adapted to engage said pawl to rotate said shaft through a predetermined arc during travel of said abutment element around the adjacent paired sprockets, a continuous cam track fixed to said frame, and a cam arm fixed to said shaft adapted to engage said cam track and rotate said frame a predetermined distance during rotation of said shaft.

14. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, a rotatably mounted article supporting frame having a peripheral section thereof positioned adjacent said blasting zone, and means for rotating said frame by stop-and-go stages to first advance said article into said blasting zone, then retain said article in said blasting zone for a predetermined time interval and then advance the article out of said blasting zone, said means including a pair of continuous complementary drive chains, a pair of sprockets at each end of said chains for supporting the

same, means for driving said chains, a shaft for rotatably supporting an adjacent pair of said sprockets, a pawl fixed to said shaft between said paired sprockets, an abutment element connected to said spaced chains adapted to engage said pawl to rotate said shaft through a predetermined arc during travel of said abutment element around the adjacent paired sprockets, a continuous cam track fixed to said frame, a cam bar fixed to said shaft, and a roller rotatably secured to each end of said cam bar adapted to engage said cam track and rotate said frame a predetermined distance during rotation of said shaft.

15. Blast cleaning apparatus including in combination, a cabinet, an abrasive throwing wheel for projecting a stream of abrasive through said cabinet at one blasting zone, air blast mechanism including a blast nozzle positioned within the cabinet operable to project a stream of abrasive at a second blasting zone, a conveyor for advancing the article into said first blasting zone positioned to receive the wheel blast against the exterior surface thereof during residence in said first blasting zone, said conveyor having mechanism associated therewith for advancing the article from said first blasting zone to said second blasting zone wherein the interior cavities of the articles are subjected to the abrasive blast from said nozzle during residence of the article in said second blasting zone, said mechanism being further operative to advance the blasted articles from said second blasting zone to an unloading zone, means including an undulating cam track fixed to said conveyor, a continuous drive chain, means for continuously driving said chain, a rotatable shaft, a pawl fixed to said shaft, an abutment element connected to said chain and adapted to engage said pawl to rotate said shaft through a predetermined arc during the travel of said abutment element a predetermined distance, and an arm fixed to said shaft adapted to detachably engage said cam track to advance said conveyor a predetermined distance during rotation of said shaft.

16. Blast cleaning apparatus including in combination, a cabinet, means for projecting a stream of abrasive into said cabinet to define a blasting zone therein, an article supporting frame mounted for rotation in a substantially horizontal plane having a peripheral section thereof positioned adjacent said blasting zone, means for suspending an article from the periphery of said frame, said means including a tubular sleeve fixed to said frame, a spindle rotatably mounted in said sleeve, a cage fixed to the end of said spindle, a vertically movable plate carried by said cage and adapted to rest on the article to be cleaned, means for rotating said spindle, and means for automatically rotating said frame to advance the article into said blasting zone and out of said blasting zone, said advancing means being ineffective to rotate said frame for a predetermined time interval during which the article resides in said blasting zone.

17. Blast cleaning apparatus including in combination, means for projecting a stream of abrasive into a blasting zone, an article supporting conveyor, means for advancing said conveyor by stop-and-go stages to first advance said article into said blasting zone, then retain said article in said blasting zone for a predetermined time interval, and then advance the article out of said blasting zone, said advancing means including a cam track fixed to said conveyor, a pair of continuous complementary drive chains, a pair

of sprockets at each end of said chains for supporting the same, means for continuously driving said chains at variable speeds, a rotatable shaft, a pawl fixed to said shaft, an abutment element connected to said chains and adapted to engage said pawl to rotate said shaft through a predetermined arc during the travel of said abutment element a predetermined distance, and an arm fixed to said shaft adapted to detachably engage said cam track to advance said conveyor a predetermined distance during rotation of said shaft.

18. Blast cleaning apparatus including in combination, a cabinet, means for projecting a stream of abrasive into said cabinet to define a blasting zone therein, an article supporting conveyor, means for advancing said conveyor and the article supported thereon through said blasting zone, said conveyor having an article supporting spindle, a cage comprising a bottom plate having a seat for the article, a top plate fixed to the end of said spindle, vertical bars connecting said top and bottom plates, and a vertically movable plate guided by said bars and adapted to rest on the article to be cleaned, and means for rotating said spindle and cage in said blasting zone.

19. In blast cleaning apparatus having a movable conveyor and a workpiece supporting spindle supported from said conveyor, the combination of a workpiece supporting cage adapted to be connected to said spindle, said cage including, a workpiece supporting bottom plate, a top plate connected to said spindle, spaced guide bars fixed to said top and bottom plates, and a vertically movable plate positioned between and movable along said guide bars adapted to rest on the article to be cleaned.

20. Blast cleaning apparatus including in combination, a cabinet, means for projecting a stream of abrasive into said cabinet to define a blasting zone therein, an article supporting frame mounted for rotation in a substantially horizontal plane whereby the peripheral section thereof may be moved through said blasting zone, a plurality of

work supporting sleeves fixed to said frame in spaced relationship, a spindle rotatably supported by each of said sleeves, a work supporting device fixed to each of said spindles, a continuous cam track associated with said frame, driving means adapted to engage said cam track to rotate said frame by stop-and-go stages whereby the article supported on each of said spindles may reside in said blasting zone for a predetermined time interval, a sprocket fixed to each of said spindles, and a continuously driven drive chain positioned adjacent said blasting zone adapted to successively engage said sprockets to rotate said impeller when positioned adjacent said blasting zone.

21. Blast cleaning apparatus including in combination, a cabinet, means for projecting a stream of abrasive into said cabinet to define a blasting zone therein, an article supporting frame mounted for rotation in a substantially horizontal plane whereby the peripheral section thereof may be moved through said blasting zone, a plurality of work supporting sleeves fixed to said frame in spaced relationship, a spindle rotatably supported by each of said sleeves, a work supporting device fixed to each of said spindles, a continuous cam track associated with said frame, and driving means adapted to engage said cam track to rotate said frame by stop-and-go stages whereby the article supported on each of said spindles may reside in said blasting zone for a predetermined time interval, said means including a continuously driven drive chain, a vertically extending shaft, a pawl fixed to said shaft, an abutment element carried by said chain adapted to engage said pawl to rotate said shaft through a predetermined angle during the travel of said chain, and a cam arm fixed to said shaft positioned to engage said cam track to rotate said frame through a predetermined angle upon rotation of said shaft.

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