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APPARATUS FOR ABRASIVELY TREATING METAL CASTINGS, FORGINGS, AND THE LIKE

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This invention relates to apparatus for abrasively treating metal castings, forgings and the like.

In the cleaning, polishing, hardening or other treatment of metallic castings, forgings or the like by a stream of abrasive particles, it is generally desirable to expose all or predetermined portions of the surfaces of the articles uniformly to the action of the stream of abrasive. Where the articles are relatively small and rugged they can be exposed conveniently for treatment in a tumbling mill or like apparatus. However, tumbling is not suitable in many instances, for example, where the articles are large and heavy, or are delicate and brittle, or have substantial projections or cavities. Furthermore, it is often desirable to expose the articles to the abrasive stream in a predetermined, controlled manner in order to insure complete treatment of certain portions or all of the surface of each article.

Where relatively large quantities of articles are to be treated, it is also desirable to pass them in succession through the abrasive stream in a more or less continuous feeding operation to eliminate the necessity for shutting down the apparatus, as is necessary in batch operations. Preferably, the operation should be adapted to be carried out partially or completely by automatic apparatus.

In accordance with the present invention, the article to be treated or so-called work piece is advanced into a treating zone wherein it is subjected to the action of one or more streams of abrasive particles. The stream or streams have a divergent fan-like shape and the work piece is moved about the stream or streams whereby the angularity of impingement of abrasive particles against the various surfaces of the work piece is varied, thereby to effect complete treatment of the various surfaces including cavities, depressions and other irregular portions. The work piece may be rotated or turned while in the abrasive stream or streams to more fully expose the various portions to the action of the abrasive. In certain cases, the direction of flight of the abrasive particles is varied as the work piece is moved about in the treating zone whereby the stream follows the movement of the work piece and a greater range of movement of the work piece is obtainable and consequently a greater range of variation of angularity of impingement.

The apparatus includes one or more abrasive projecting devices each of which preferably is of the centrifugal throwing wheel type provided with means for controlling the direction of flight of the thrown abrasive and adapted to project a fan-like divergent stream. A conveyor mechanism is provided for advancing the work pieces into the treating zone and includes one or more carriers for the work pieces and a mechanism for advancing the carriers. A mechanism, synchronized with or connected to the advancing mechanism, is provided for manipulating each carrier whereby the work piece is moved in the desired manner while in the stream or streams and then carried out of the treating zone. There is also provided mechanism for controlling the abrasive projector or projectors whereby the abrasive stream or streams follow the movement of the work piece or work pieces while in the treating zone.

An object of this invention is to provide a novel abrasive projector of the rotary centrifugal type embodying a control member for controlling the direction of flight of the thrown abrasive and a novel mechanism for actuating the control member either manually, or automatically by actuation of a movable, article-conveying apparatus.

Another object of the invention is to provide a novel apparatus for abrasively treating various metallic articles wherein the articles are advanced into the stream of treating particles and manipulated in the stream in such a way that all or predetermined portions of the articles are exposed for treatment.

Still another object of the invention is to provide apparatus of the class described wherein articles are automatically advanced into the treating stream and moved about in the stream so that not only are all surfaces of the articles treated but also any cavities or depressions as are provided in articles of irregular shape.

Still a further object of the invention is to provide novel apparatus wherein the direction of flight of the abrasive particles may be varied automatically in a predetermined manner or may be controlled in accordance with the movement of the article to be treated.

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 front elevational view of one form of apparatus suitable for carrying out the invention;

Fig. 2 is a horizontal sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is an enlarged fragmentary top view of the apparatus shown in Fig. 1, the lower portion of the structure being shown merely in outline;

Fig. 4 is an enlarged fragmentary sectional view taken along line 4—4 of Fig. 3 and illustrating particularly a portion of the article elevating mechanism and the throwing wheel control;

Fig. 5 is a fragmentary sectional view taken along line 5—5 of Fig. 4;

Fig. 6 is an enlarged fragmentary view in elevation showing the cooperation between the drive chain and the conveyor chain, certain of the parts being shown in cross section;

Fig. 7 is a fragmentary cross sectional view taken along line 7—7 of Fig. 6;

Fig. 8 is a perspective view of the driving dog illustrated in Figs. 6 and 7;

Fig. 9 is an enlarged fragmentary view showing one of the throwing wheels and associated control mechanism, certain of the parts being shown in cross section;

Fig. 10 is a fragmentary view of a cross section taken along the line 10—10 of Fig. 9;

Fig. 11 is an enlarged fragmentary top plan view of the outlet end of the housing or cabinet and illustrating the door opening mechanism; and

Fig. 12 is a fragmentary view in elevation showing the outlet doors and operating mechanism therefor.

In the following description and in the claims, various details will be identified by specific names for convenience, but they are intended to be as generic in their application as the art will permit. Like reference characters denote like parts in the several figures of the drawings.

In the drawings accompanying and forming part of this specification, certain specific disclosure of the invention is made for purposes of explanation, but it will be understood that the details may be modified in various respects without departure from the broad aspect of the invention.

Referring now particularly to Figs. 1 to 3, the apparatus includes a housing 80 having respectively an inlet chamber 81, a cleaning chamber 82 and an outlet chamber 83. Abrasive projectors A and B, which may be generally similar, are mounted on angularly arranged portions 84*a* and 84*b* respectively of the front wall 84 and are adapted to project the streams *a* and *b* in the chamber 82.

The projector A includes a wheel 1, shown more in detail in Figs. 9 and 10, and which comprises spaced parallel side plates 2 and 3 suitably secured together as by studs 4 having reduced end portions 5 entering openings in the side plates and secured, as by plug welding. The side plate 2 preferably is secured as by bolts 7 to a hub member 8 which is suitably mounted on a shaft 9 for rotation therewith.

Throwing blades 10 are disposed between and carried by side plates 2 and 3 and extend radially thereof from the periphery to points inwardly short of the center. Each throwing blade may have side flanges 11 adapted to seat in grooves 12 in the side plates 2 and 3 and is secured by a screw 13 extending through the side plate 2 and entering a recess 14 in the blade 10.

An impeller 15 is disposed in the circular space defined by the ends of the blades 10 and may include spaced parallel side plates 16 and 17 carrying a plurality of radial blades 18. The impeller 15 is secured suitably as by bolts 19 to a center plate 20 which in turn is attached to the hub 8 as by screws 21.

Disposed within the circular space defined by the ends of the throwing blades and surrounding the impeller 15 is a control member 25 preferably of generally cylindrical shape. The control member 25 is partially closed at the end adjacent the hub by an inturned end flange or wall 26. The control member 25 projects through an opening 22 in the side plate 3 and has a generally trough-like extension 27.

The control member is provided with a discharge opening 28 which may take the form of a single opening or a series of spaced openings suitably located in the control member.

A suitable feeding means, such as a nozzle 30, is associated with the wheel and is positioned to deposit abrasive material into the path of rotation of the impeller blades 18. The nozzle 30 may extend into the control member 25 and may be sealed therein by a suitable sealing material 31, such as rubber. The sealing material may be contained in a groove 32 formed integral with the nozzle 30 or defined by a separately formed end member.

The wheel is operated by rotating the shaft 9 which rotates the side plates 2 and 3 and the throwing blades 10. Abrasive is fed to the impeller 15 through the nozzle 30 and the impeller hurls the abrasive through the opening 28 on to the throwing blades 10. Abrasive is carried along the leading surfaces of the throwing blades and is projected from the blades adjacent the periphery.

The abrasive spreads out fanwise to form a stream which is approximately equal to the width of the throwing blades and which produces a generally elongated impingement pattern on a plane spaced from the wheel and parallel to the axis of rotation. With wheels of similar construction and size rotated at the same speed, a fixed relation exists between the clock-dial position of the opening 28 of the control member 25 and the point of discharge of the abrasive from the blades 10. By adjusting the position of the opening 28, the direction of the abrasive thrown by the wheel may be regulated.

It is to be understood that the term "abrasive" as herein used is intended to include suitable treating material, both that which is inherently abrasive and that which exerts a smoothing and polishing action. The abrasive may include smooth steel shot, cracked steel grits, quartz sand or other granular materials suitable for cleaning, polishing, hardening or otherwise modifying the surface characteristics of the articles treated.

While the direction of the stream of abrasive can be controlled, it is sometimes desirable to provide a housing for the wheel, one suitable housing being shown particularly in Figs. 9 and 10 of the drawings. The housing 35 may be generally arcuate in shape and the wall adjacent the nozzle 30 has an opening 36 to admit the nozzle. The space around the nozzle 30 may be partially closed by a collar 37 having an inturned flange 38 and secured in position by a securing ring 39. At the other side of the hous-

ing 38 there is provided an opening 48 to permit the hub 8 and shaft 9 to extend out of the housing and this opening may be sealed by a suitable gasket 41 contained in a ring-like housing 42.

A suitable control mechanism 50 may be mounted adjacent the wheel for adjusting the position of the control member 25. The trough-shaped portion 27 of the control member 25 is suitably connected, as by clamp members 51 and 52, to a rotatable bearing block 56 having an internal passage 58 to receive a spindle 59. The spindle 59 has a threaded portion 60 screwed into a bracket 61 and secured as by a nut 62. The bracket is suitably supported as by attachment to a supporting bracket 63.

The spindle 59 is formed with a cylindrical portion 66 journaled in a bearing 67 at one end of the block 56 and a reduced cylinder portion 68 journaled in a bearing 69 at the other end of the block. The central portion of the spindle 59 may be tapered, as shown, for convenience in assembling and the reduced end 68 may be threaded as indicated at 70 to receive a retaining nut 71. The end of the passage 58 may be closed by a cover 72 suitably secured to the block 56.

The bearing block 56 may be rotated about its axis by a lever 75 suitably secured to the block as by bolts 76, and an actuating rod 77 may be connected to the lever 75 for actuating the same. It will be seen that, when the rod 77 is actuated to move the lever 75, this motion is transmitted to the bearing block 56 and in turn to the control member 25, whereby the clock-dial position of the opening 28 is adjusted accordingly.

Each shaft 9 (Fig. 2) mounting each wheel 1 is journaled in bearings 90, which may be secured to the adjacent wall portion 84*a* or to the adjacent wall portion 84*b*. Each wheel is driven by a motor 91 connected by a suitable drive 92 to the shaft 9.

The projector B is preferably of generally similar construction to the projector A and is mounted on the wall portion 84*b*, while the projector A is mounted on the wall portion 84*a*. It will be seen that the projectors A and B are so mounted that the streams *a* and *b* converge and impinge against the work piece *wp* when the latter is in the position shown in Fig. 2.

The lower portion of the housing 80 preferably is formed as a hopper 93 to collect spent abrasive which has been thrown by the projectors A and B. A suitable conveyor 94 may be provided for carrying spent abrasive to an elevator 95 adapted to elevate the spent abrasive to a storage hopper 96. The elevator 95 is driven by a motor 97, and a drive connection 98 may be provided for driving the conveyor 94 from the elevator 95. Conduits 99*a*, 99*b* are provided for conducting the abrasive from the hopper 96 to the spouts 30, 30.

A conveyor mechanism is provided for advancing work pieces *wp* through the housing. This mechanism operates to elevate and lower the work pieces while in the cleaning chamber and at the same time rotates them for the purpose of presenting the various surfaces to the abrasive streams. This mechanism comprises essentially a track having one or more hangers movable thereon which are driven by an endless drive member, a portion of the track being removable and connected to an elevator mechanism synchronized with the driving mechanism whereby a hanger is halted on the removable track portion which is then elevated and rotated to impart similar movement of the hanger and work piece while the latter is in the abrasive stream or streams.

A track 100 which preferably is continuous, except as hereinafter described, is supported above the housing 80 by suitable means which, for the purposes of simplicity of the drawings, is not shown in detail. The supporting means may comprise any suitable arrangement of framework 101*a* of sufficient strength for supporting the weight of the track and associated mechanism.

Mounted for movement on the track 100 is one or more, and preferably a plurality of, hangers 101 each comprising an elongated shank 102 carrying a hook portion 103 at its lower end for supporting the work piece *wp*. At its upper end the hanger comprises a yoke 105 carrying one or more pairs of wheels or rollers 106 riding on the track 100. The hangers 101 are connected to and driven by a conveyor chain 110 trained over sprockets 111 rotatably mounted on shafts 112 which preferably are located adjacent the ends of the housing 80.

The conveyor chain 110 may be constructed in any suitable manner but preferably comprises a plurality of link members 114 connected by pins 115 carrying spacing rollers 116. At spaced points along the chain corresponding to the desired spacing between hangers, a driving yoke 120 is connected to the chain, the yoke preferably being inserted in the chain and secured to the adjacent links by pin bolts 119. The end 121 of the yoke member is shaped to receive the shank 102 of the hanger.

Secured to the chain 110 adjacent the driving yoke 120 and preferably attached by pin bolts 119 is a driving lug 117 having a suitable shape providing shoulders 118.

The conveyor chain is driven by a pair of spaced drive chains 126, each of which is trained over a plurality of sprockets 127 mounted on shafts 128 respectively. Each shaft 123 preferably is journalled in bearings 129 secured on brackets 130 which may be supported in a suitable manner (not shown). One of the shafts 128 preferably is driven as by a motor 132 connected through a suitable drive 133 to a pinion 135 which meshes with a gear 136 carried on the shaft to be driven.

The driving chain 126 may be constructed in any suitable manner and for example, may comprise a plurality of links 137 connected by pins or rollers 138 and carries a driving dog 139 pivotally mounted on a shaft 140. The dog 139 comprises a sleeve-like hub portion 141 and spaced arms 142, each of which arms is provided with a shoulder 143 adapted to engage the corresponding shoulder 118 of the driving lug 117 when the chain 126 carries the dog 139 into suitable position. Sleeves 145 are provided for centering the dog 139 on the shaft 140.

The dog 139 is urged into engagement with the lug 118 by springs 144 having their ends secured to the shaft 140 and the hub 141 respectively.

The shaft 140 extends inwardly from one of the chains 126 and is mounted in a shaft yoke or connector 146 having flanges 148 and 149 providing bearings for the shaft. The shaft preferably is held against rotation in its bearings as by a pin 150. At the other end of the yoke or shaft connector is a flange 157 carrying a stud shaft 147 which is secured in the chain 126 whereby to support the yoke 146.

The arms 142 of the dog 139 carry at their

free ends rollers 151 mounted on pins 156 secured in openings 158. The rollers 151 ride in a guide track 152 adjacent the conveyor chain 110 which track has an upper flange 153' for holding the roller down and thereby causing the dog 139 to engage the driving lug 117.

The track 152 preferably is provided with a suitably shaped entrance portion 154 and tail portion 155. The entrance portion insures that the roller is engaged by the track 152 and the tail portion 155 permits the roller to be withdrawn from the track without binding. If desired, the track may be continuous and the rollers thereof are not disengaged therefrom during the complete movement of the drive chain 126.

It will now be seen that, when the motor 132 is actuated, the drive chain 126 is caused to travel around its path and carry the dog 139 into engagement with a driving lug 117 on the conveyor chain. The driving lugs are so positioned on the conveyor chain that when one driving lug is carried to the end of the movement in which it is in engagement with the dog, the succeeding driving lug is brought into position to be engaged by the dog on its next trip. Thus, during the period of disengagement of the dog with one driving lug and engagement with the next succeeding driving lug, the conveyor chain is stationary even though the main driving motor 132 remains energized.

Referring now particularly to Fig. 1, a lift mechanism 160 is provided adjacent the cleaning chamber 82 for imparting vertical movement to the hanger when it is in a position wherein the work piece is in the stream of abrasive. The track 100 is provided with a removable section 161 carried on a vertical shaft 162 mounted in a frame 163. The shaft is journalled in a cross head 164 vertically slidable in the frame 163, which cross head carries rollers 153 bearing against the sides of the frame 163 for guiding the cross head substantially without friction. The cross head preferably is formed with side members 165 connected by cross members 166 having secured therebetween a suitable bearing such as may be constituted by bearing members 167 and 168 having anti-friction bearing members 169. The shaft 162 is supported by the cross head 164 and is held against axial movement as by a pin 170 but it is permitted to rotate freely by the bearing above described.

The cross head is provided with projecting studs, such as rollers 171, which ride in swingable elevating levers 172 which may be anchored in a suitable manner as by a link 173 pivotally connected to a fixed portion of the apparatus, such as the bracket 174. Carried on the shafts 140 and 147 respectively are rollers 175, 175 positioned to engage the elevating levers 172 respectively. The latter rest freely upon the rollers 175, 175 and, when the rollers are carried upwardly by the ascending movement of the chain 126, the elevating levers 172 are elevated and thereby lift the cross head 164 and the shaft 162, the track section 161 and the hanger 101.

The shaft 162 carries at its upper end a head 179 provided with studs 176 which may be formed as rollers and which ride in a helical guide 177 secured in the frame 163. As the cross head 164 and shaft 162 are elevated, the helical guide 177 operates on the studs 176 to turn the head 179 and shaft 162 on their common axis and thus the associated mechanism including the track section 161 and shaft 102 are rotated.

The cross head carries rollers 153 which bear against the frame 163 to guide the cross head and reduce friction.

When the chain 126 is moved further along its path, the rollers 175 are lowered and the elevating levers 172 are rocked downwardly thereby permitting the cross head 164 and associated members to return to their original position. During this downward movement the members connected with the cross head are also rotated about their common axis. A cylindrical guide 178 is provided for guiding the track section in its combined vertical and rotary movement.

Owing to the spread of the streams *a* and *b*, and particularly the divergent paths of the several portions of the streams, the various surfaces of the work piece are fully exposed to the action of the streams. The completeness of the exposure can be increased by causing the streams to follow the vertical movement of the work piece. Since a greater vertical travel of the work piece is thus permitted without the same being carried out of the streams, hence a greater range of angularity of impingement of the particles on the work piece can be obtained.

While the adjusting movement of the streams *a* and *b* can be effected by manually manipulating the actuating rods 77 of either or both of the projectors A and B, it is preferable in many cases to provide for automatic control of the streams, synchronized with the movement of the work piece. This can be accomplished by mechanism such as illustrated particularly in Figs. 1 and 4.

A cable 180 is attached to a portion of the vertically reciprocable structure, such as a lug 181 on one of the elevating levers 172. The cable is suitably guided as by pulleys 182 and 183 and is connected to a weighted cam 184 having T-shaped flanges 185 slidable in correspondingly shaped slots 186 in a guide block 187. Riding on the surfaces of the cam block 184 are followers 188, 188 which may be a roller carried on crank levers 189, 189 pivotally mounted on a stationary portion of the apparatus as for example, brackets 190. The actuating rods 77 respectively are connected to the arm of the crank levers 189, 189 and may be adjusted with respect thereto by insertion in any one of several spaced openings 191 or in any other suitable manner.

It will be apparent from the foregoing that movement of the elevating levers 172 imparts a corresponding movement to the cam block 184. As the latter is elevated or lowered, the followers 188 are caused to move inwardly or outwardly and impart a downward or upward movement to the actuating rods 77 respectively. The cam block may be provided with differently inclined surfaces or other suitable mechanisms may be provided whereby one of the streams *a* or *b* is caused to travel upwardly at a more rapid rate than the other stream. In the present example, the streams are caused to travel at approximately equal rates. Furthermore, if desired, the vertical adjustment of one or both of the streams may be such that the stream travels more rapidly than the work piece and traverses the same with a sweeping movement.

The housing 80 preferably is divided into inlet chamber 81, cleaning chamber 82 and outlet chamber 83, as above stated. The housing 80 is provided with an opening 200 in the top wall throughout its length for permitting the shank 102 of the hanger 101 to pass into the housing. This opening preferably is closed as by one or

more sets of flexible sealing members 201 suitably supported as by brackets 202.

Inlet and outlet openings 203 and 204 are provided in the rear wall of the housing 80 for permitting the entrance and exit of the work pieces and a portion of the hanger. Each of these openings can be closed by swinging doors 205 and 206, as illustrated particularly in Figs. 2 and 12.

The swinging doors 205 and 206 are pivotally mounted on inclined hinge rods 207 and 208 associated with hinges 209. The hinge rods are so inclined that the doors 205 and 206 normally swing to closed position. Carried on the upper ends of the hinge rods 207 and 208 are actuating levers 210 and 211 which, when the doors are in closed position, intersect in the path of movement of the hanger 101. When the shank 102 of the hanger 101 engages the actuating levers 210 and 211 it forces the doors 205 and 206 to open prior to the time that the work piece *wp* reaches the opening. Hence, by the time the work piece has reached the opening, the doors are fully opened and do not interfere with the passage of the work piece.

Doors 25 and 216 of somewhat similar construction may be provided for separating the inlet chamber from the treating chamber and for separating the latter from the outlet chamber. These doors may be operated in a manner generally analogous to the inlet and outlet doors above described.

The operation of the apparatus is as follows:

The motor 132 is energized to drive the chains 126, 126. The dog 139 is carried around by the chains 126 and is guided by the track 152 into engagement with the driving lug 117. During the period of engagement between the dog 139 and the driving lug 117 the chain 110 is advanced thereby to urge the several carriers 101 along on the supporting track 100.

At a suitable point outside of the housing 80 work pieces *wp* are attached to the carriers 101 and, upon movement of the carriers are carried into the housing through the inlet and eventually into the treating chamber 82.

Either or both of the motors 90 are energized to drive the corresponding wheels of the projectors A and B and abrasive is supplied to the projectors from the hopper 96. The motor 97 is energized to actuate the conveyor 94 and elevator 95 thereby to return spent abrasive to the hopper 96.

When the dog 139 is disengaged from the lug 117, the conveyor chain 110 is halted and thus the carriers are halted. One of the carriers is halted in the track section 161, and its work piece is in the streams *a* and *b*.

When the dog 139 is carried upwardly away from the drive chain 110, the roller 175 engage the free ends of the elevating levers 172 and carry them upwardly thereby elevating the cross head 164 and the carrier 101 supported on the track section 161.

When the cross head 164 is elevated and carries with it the carrier 101, the corresponding work piece is moved upwardly in the streams *a* and *b* and the angularity of impingement of the abrasive on the work piece is varied. The carrier 101 also is rotated, thereby to expose the several surfaces of the work piece to the action of the abrasive streams. As the elevating levers 172 are rocked upwardly they act through the cable 180 and associated mechanism to rotate the control members 25 of the projectors A and B whereby the streams *a* and *b* follow the work piece in its upward and downward movement.

Upon further actuation of the driving chains 126 the elevating levers are again lowered and the section 161 is lowered into position in alignment with the remainder of the track to permit the carrier to be advanced along on the stationary portion of the track. The driving chains 126 again act upon the chains 110 and the carrier is moved off the removable track section 161. The next carrier is then moved into position in the elevator.

The carriers are thus advanced along the track, step by step, and the work pieces are advanced through the housing and finally out through the outlet. They can then be removed conveniently from their carriers.

In the illustrative embodiment of the invention, the carriers are moved into cooperative relation with the elevating mechanism singly, thus the articles are singly and successively carried into the treating zone. However, it is within the contemplation of the invention to provide for the advancing of a plurality of articles into the treating zone simultaneously. This may be accomplished by providing a treating zone of such extent, and a treating stream of sufficient extent or a sufficient number of streams whereby a plurality of carriers can be moved into the zone simultaneously. Alternatively, it is also contemplated that a single carrier will be provided which is capable of supporting two or more articles simultaneously for treatment during a single passage of the carrier.

From the foregoing it will be seen that the present invention provides a novel apparatus for cleaning or otherwise treating metallic castings, forgings or other articles of various sizes and shapes, which articles may be of considerable size and irregular contour and which may have very irregular projections or depressions. The abrasive stream or streams are of fan-like, divergent shape and thus the particles impinge against the articles from various directions. Furthermore, the articles are rotated about in the stream or streams and thus fully exposed to the action of the treating particles. In addition, the articles are moved about within the treating zone and the streams follow the articles so that a still further there variation in angularity between the direction of the particles and the surfaces of the articles is obtained. Thus, articles of even the most irregular contour can be fully exposed to the action of the particles.

The apparatus is substantially automatic in operation, the articles being carried into the treating zone and manipulated therein and thereafter removed from the treating zone without the necessity of manual manipulation of the articles or apparatus. The mechanism for controlling the direction of the abrasive stream or streams may be controlled manually where such is desired, or may be interconnected with the conveying apparatus in a manner disclosed whereby this operation also is fully automatic.

The elevating mechanism and the conveying mechanism are mechanically interconnected so that the carriers are advanced to carry the articles into the treating zone in timed sequence and only one or a predetermined plurality of articles are in the treating zone at one time, thus insuring against mal-functioning of any portion of the device.

The conveyor mechanism and door operating mechanism are fully automatic and the various

doors through which the articles pass are automatically opened and closed in accordance with the operation of the conveyor. Thus, the apparatus may be operated with a maximum of efficiency and maximum safety of the attendants.

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. Apparatus for abrasively cleaning metal castings, forgings and like workpieces which comprises, means for establishing a stream of abrasive particles, a conveyor comprising a track and a plurality of carriers movable thereon, means for suspending said workpieces from said carriers, an elevator adapted to elevate each carrier when the workpiece suspended therefrom is in said stream, and driving means adapted alternately to advance said carriers to bring the workpiece suspended therefrom into said stream and to elevate the carrier and workpiece suspended therefrom in said stream.

2. Apparatus for abrasively cleaning metal castings, forgings and like workpieces which comprises an abrasive projector of the rotary centrifugal type having means associated therewith for controlling the direction of flight of the abrasive particles, conveyor means for advancing a work piece into said stream, means for moving the work piece in said stream in a direction transversely to its direction of movement into said stream, and means connecting said last named means and said direction controlling means whereby said stream follows said work piece when the latter is moved transversely.

3. Apparatus for abrasively cleaning metal castings, forgings and like metal articles comprising means for establishing a stream of abrasive particles, means for advancing an article into said stream including a carrier from which the article is suspended, means for supporting and guiding said carrier, and means for driving said carrier to advance the article suspended therefrom into said stream, means for elevating said carrier and the article suspended therefrom when said article is in said stream whereby said particles strike the surfaces of said article from varying angles, and means for actuating said elevating means in timed relation with said driving means.

4. Apparatus for abrasively cleaning metal castings, forgings and like metal articles comprising means for establishing a stream of abrasive particles, means for advancing an article into said stream including a carrier from which the article is suspended, means including a track for supporting and guiding said carrier, a traveling mechanism for driving said carrier, means for elevating said carrier and the article suspended therefrom when said article is in said stream, and means cooperating with said traveling mechanism for actuating said elevating means in timed relation with said driving means.

5. Apparatus for abrasively cleaning metal castings, forgings and like workpieces comprising an abrasive projector of the rotary centrifugal type having means for controlling the direction of flight of the thrown abrasive so as to project a divergent fan-like abrasive stream having an elongated impingement pattern, a suspension device for suspending the workpiece so as to provide substantially full exposure of the top and bottom ends and all sides of the workpiece, means for advancing the suspension device to move the work piece suspended therefrom into said stream in a direction transversely of the longitudinal axis of the impingement pattern, and means for moving the article while in said stream in the direction of the longitudinal axis of said impingement pattern whereby the angularity of impingement of abrasive on said article is varied, said advancing means being operative to move said article out of said stream.

6. Apparatus for abrasively cleaning metal castings, forgings and the like comprising an enclosed blast chamber, means including a rotary centrifugal throwing wheel for projecting a stream of abrasive particles into said chamber, a plurality of carriers each adapted to support a workpiece in suspended position, means for intermittently advancing workpieces into said chamber, into said stream and out of said chamber, means for maintaining said carriers and the workpieces suspended therefrom in fixed predetermined spaced relation, means for elevating said carriers successively when the workpiece suspended therefrom is in said stream, and means actuating said elevating mechanism when said carriers are halted.

7. In an abrading machine, a circuitous track member, a plurality of workpiece suspension devices movable along said track member, an endless member connecting said workpiece suspension devices in predetermined spaced relationship, and means for advancing the workpieces supported on said suspension devices by stop-and-move stages successively from a loading zone into a blasting zone and out of said blasting zone into an unloading zone, said advancing means including, a continuous drive element, power means for continuously moving said drive element, said drive element having one flight thereof moving along said track, another flight thereof moving away from said track, and another flight thereof moving toward said track, and a dog member connected to said drive element operative to move into engagement with said endless member when said dog member approaches said track, thereafter to remain in engagement with said endless member until said dog member has advanced to a predetermined point and thereafter to disengage said endless member whereby said carriers and said endless member remain stationary until said dog has been moved around the circuitous path defined by said drive element to the point where said dog again moves into engagement with said endless member, and guide means extending along a portion of said endless member for retaining said dog member in positive engagement with said endless member during the predetermined advance movement thereof.

8. In an abrading machine, a workpiece supporting carrier, means for advancing said carrier by successive stop-and-go stages from a loading zone into a blasting zone and out of said blasting zone into an unloading zone, means for vertically reciprocating the article supported on said carrier while in the blasting zone, and means for rotating the article supported on said carrier while undergoing said vertical reciprocating movement, said rotating means comprising an upwardly spiralling track, and means connected to said article supporting carrier movable along said track.

9. In an abrading machine, a substantially continuous track, a workpiece supporting carrier movable along said track, said track having a disjoined section of sufficient length to support said

workpiece carrier, means for maintaining said carrier in supported position on said disjoined section, means for lifting and lowering said disjoined section, the carrier supported thereon and the workpiece supported thereby, and a centrifugal blasting machine operative to project a stream of abrasive at blasting velocities against the workpiece supported on said carrier during the raising and lowering movement of said workpiece.

10. In an abrading machine, a workpiece supporting carrier, means for advancing said carrier by successive stop-and-go stages from a loading zone into a blasting zone and out of said blasting zone into an unloading zone, a continuous drive chain, means for driving said drive chain continuously in a predetermined direction, said drive chain having one flight moving in an upward direction and another flight thereof moving in a downward direction, a lever operatively connected to said carrier, a fulcrum element supporting said lever for pivotal movement, and means connected to said continuous drive chain for raising and lowering said lever, said carrier and the workpiece supported thereon when the workpiece is in said blasting zone.

11. In an abrading machine, a blasting chamber, a workpiece suspension device extending into said blasting chamber, an abrasive projector of the centrifugal type arranged to project a fan-shaped stream of abrasive into said blasting chamber and against the workpiece positioned therein, an elevating mechanism operatively connected to said suspension device for reciprocating the workpiece in a substantially vertical direction in said blasting chamber, and means exterior to said chamber operatively connected to said suspension device for rotating the workpiece in the abrasive stream while the workpiece is reciprocated.

12. In an abrading machine, a blasting chamber, a workpiece supporting device extending into said blasting chamber, an abrasive projector of the centrifugal type arranged to project a fan-shaped stream of abrasive into said blasting chamber, control means associated with said projector for controlling the direction of discharge of the abrasive thrown therefrom, an elevating mechanism operatively connected to said supporting device for reciprocating the workpiece in a substantially vertical direction in said blasting chamber, and means operatively connecting said control means to said supporting device for shifting the direction of discharge of the thrown abrasive in synchronism with the reciprocating movement of the workpiece.

13. In an abrading machine, a blasting chamber, means for moving a workpiece in said blasting chamber, an abrasive projector of the centrifugal type arranged to project a fan-shaped stream of abrasive into said blasting chamber, said projector including a rotatably mounted rotor provided with radially arranged abrasive throwing blades extending inwardly short of the axis of rotation of said rotor to provide a central space, a pivotally mounted abrasive deflector positioned within said central space for controlling the direction of discharge of the abrasive thrown from said rotor, means for supplying abrasive to said deflector, and means operatively connected to said deflector and said workpiece moving means for shifting the direction of discharge of the thrown abrasive in synchronism with the movement of the workpiece whereby said directed stream is projected against the workpiece during a predetermined movement thereof in said blasting chamber, said deflector shifting means including a fixed spindle in axial alignment with the axis of said rotor, a collar rotatably mounted on said spindle, means for fixedly securing said collar to said deflector, a lever fixed to said collar projecting laterally therefrom, a slidably mounted cam member, means operably connecting said cam member to said workpiece moving means, a pivotally mounted crank lever in rocking engagement with said cam member, and means for connecting said crank lever to said collar lever.

14. In an abrading machine, a blasting chamber, means for moving a workpiece in said blasting chamber, an abrasive projector including a rotatably mounted rotor provided with abrasive throwing blades substantially radially arranged and extending inwardly short of the axis of rotation of said rotor, a pivotally mounted tubular control member having an abrasive discharge aperture therein for controlling the direction of discharge of the abrasive thrown into said chamber, means for impelling the abrasive out through said discharge opening, means for supplying abrasive to said impeller, and means operatively connected to said control member and said workpiece moving means for pivoting said control member to shift the direction of discharge of the thrown abrasive in synchronism with the movement of the workpiece whereby said directioned stream is projected against the workpiece during a predetermined movement thereof in said blasting chamber, said control member pivoting means including a fixed spindle in axial alignment with the axis of said rotor, a collar rotatably mounted on said spindle, means for fixedly securing said collar to said control member, a lever fixed to said collar projecting laterally therefrom, a pivotally mounted crank lever, means operably connected to said workpiece moving means for rocking said crank lever, and means connecting said crank lever to said collar lever.

15. Apparatus for blast cleaning metal articles including, in combination, centrifugal means for projecting a divergent, fan-like stream of abrasive particles at abrading velocities, a trackway, a work carrier moving along said trackway having a suspension device for supporting the article to be cleaned so as to provide substantially full exposure of the top and bottom ends and all sides of the article, means for advancing said work carrier along said trackway into, through and out of said abrasive stream, means for rotating the article thus supported in said stream, and means for moving the article simultaneously during rotation thereof back and forth in said stream in the direction of change of variation in angularity of the fan-shaped stream whereby the article is struck by abrasive particles traveling in various directions, said back-and-forth moving means including a lever arm, a fulcrum support for said arm about which said arm may be oscillated, continuously driven means for oscillating said arm, means detachably connecting said work carrier to said arm, and means for moving said carrier into and out of operating engagement with said oscillating arm.

16. Apparatus for blast cleaning metal articles including in combination, a centrifugal machine for projecting a divergent, fan-like stream of abrasive particles at abrading velocities, a work carrier, means for suspending the article to be cleaned from said carrier to provide substantially full exposure of the top and bottom

ends and all sides of the article, a horizontally extending track for supporting the work carrier, means for advancing the article thus suspended into, through and out of the stream, mechanism for reciprocating the article in said stream in the direction of change of variation in angularity of the portions of the stream, said reciprocating mechanism including an arm, means mounting said arm for oscillating movement, driving means for oscillating said arm, means detachably connecting said carrier to said arm, and means for moving said carrier into and out of operating engagement with said oscillating arm, and means for rotating the article in the stream substantially simultaneously during the reciprocating movement thereof.

17. In abrading apparatus, in combination, a rotor mounted for rotation including, throwing blades extending inwardly short of the axis of rotation of said rotor to provide a central abrasive receiving space, an abrasive deflector positioned within said central space having a discharge portion whose clockdial position determines the direction of abrasive discharge from said rotor, means for supplying abrasive to said deflector, a carrier for supporting a workpiece, means for movably supporting said deflector to vary the clockdial position of the discharge portions thereof including a fixed spindle having its axis generally in alignment with the axis of said rotor, a collar rotatably mounted on said spindle, means fixedly securing said collar to said deflector, and an arm fixed to and projecting laterally from said collar, means for reciprocating the carrier and workpiece supported thereon, and means operatively connected to said arm and carrier driven by the reciprocating movement of said carrier for rocking said deflector in synchronism with the reciprocating movement of said carrier whereby the discharged abrasive follows the workpiece.

18. Apparatus for blast cleaning metal castings, forgings and the like including, a housing having an inlet and an outlet opening, means for projecting a stream of abrasive into said housing, a track disposed above said housing, a plurality of carriers supported on said track each having a depending article-supporting portion, an opening extending through the length of the top wall of said housing positioned to permit movement of the depending portion of said carriers through said housing, a pair of doors for closing each inlet and outlet opening, hinge means for said doors including a hinge spindle fixed to each of said doors, hinge elements fixed to the adjacent wall of the cabinet for rotatably supporting each of said hinge spindles and its associated door, the hinge spindle for each pair of adjacent doors being inclined to the vertical so as to normally urge said doors into closed position, and a laterally projecting arm fixed to each of said spindles adapted to be engaged by a portion of said carrier for moving said doors into open position.

19. In an abrading machine, a track, a plurality of workpiece suspension carriers movable along said track, means for intermittently advancing the workpieces suspended from said carriers from a loading zone to a blasting zone and from the blasting zone to an unloading zone, said means including a movably supported endless member having at least a portion thereof extending along at least a portion of said track, fork elements fixed to and extending laterally from said endless member each adapted to engage one of said carriers to maintain said carriers in predetermined spaced relationship, an endless drive element having a portion thereof extending a predetermined distance along a section of said endless member, power means for continuously moving said drive element along an endless path, and means connected to said endless drive element operatively to releasably engage said endless member to intermittently advance said carriers along said track.

20. In an abrading machine, a track, a plurality of workpiece supporting carriers movable along said track, a movably supported endless conveyor chain having at least a portion thereof extending along at least a portion of said track, open slot elements fixed to and projecting laterally from said conveyor chain each adapted to engage one of said carriers for maintaining said workpiece supporting carriers in predetermined spaced relationship, and means for advancing said carriers by stop-and-move stages from a loading zone into a blasting zone and out of said blasting zone into an unloading zone, said means including an endless drive chain, power means for continuously moving said drive chain, a device carried by said drive chain adapted to engage said conveyor chain, and means for moving said device into and out of engagement with said conveyor chain during the movement of said continuously driven drive chain.

21. In an abrading machine, an endless track, a plurality of article suspending carriers each including a trolley movable along said track member and an article supporting hook suspended therefrom, an endless conveyor chain positioned adjacent said endless track, yoke members each adapted to engage one of said carriers and fixedly connected to and projecting laterally from said conveyor chain whereby said carriers are maintained in predetermined spaced relationship along said track member, an endless drive chain, a dog device carried by said drive chain, means for guiding said dog device into and out of engagement with said conveyor chain whereby said carriers are successively advanced by stop-and-go stages from a loading zone into a blasting zone and from the blasting zone into an unloading zone, and power means for driving said drive chain.

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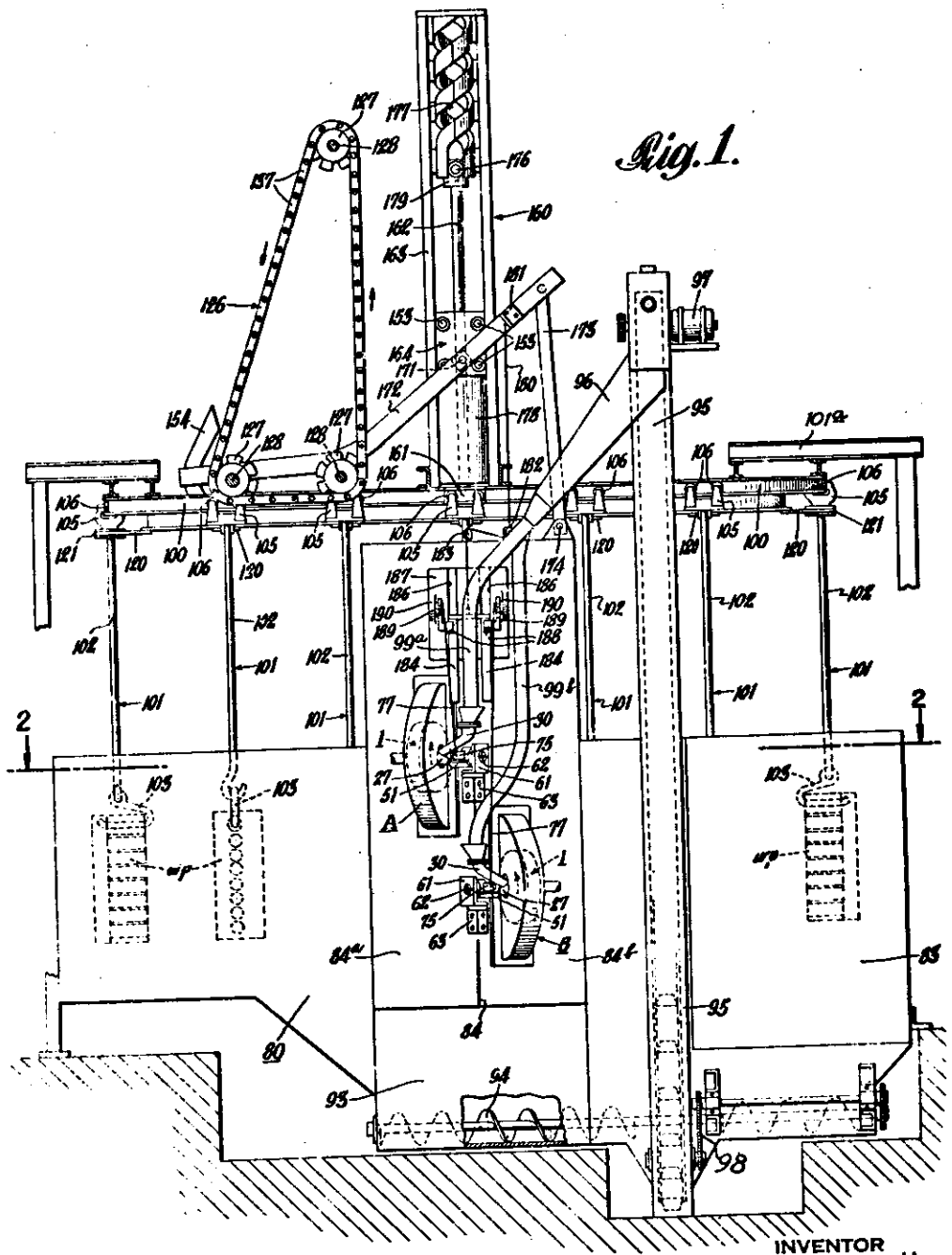
P105

April 29, 1941. D. C. TURNBULL 2,240,248

APPARATUS FOR ABRASIVELY TREATING METAL CASTINGS, FORGINGS, AND THE LIKE

Filed Feb. 17, 1938 7 Sheets-Sheet 1

Fig. 1.



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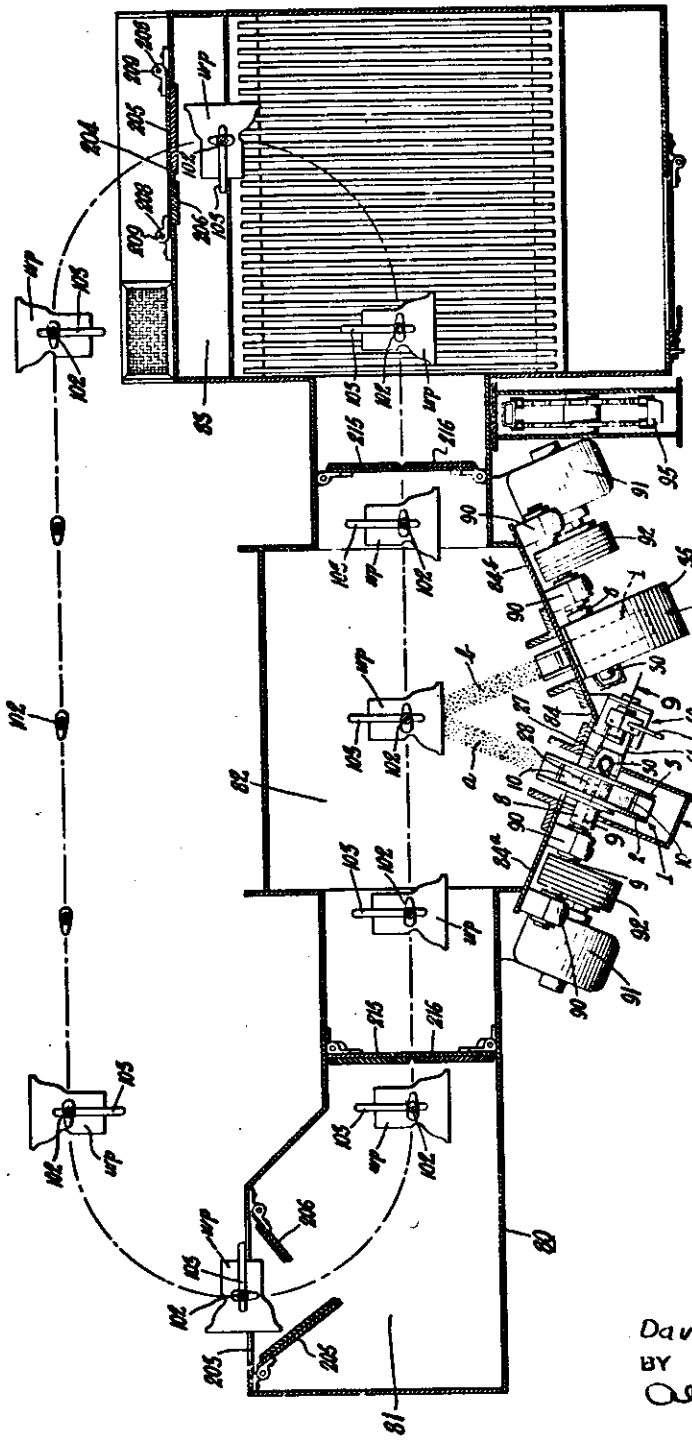

Fig. 2.

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Filed Feb. 17, 1938 7 Sheets-Sheet 3

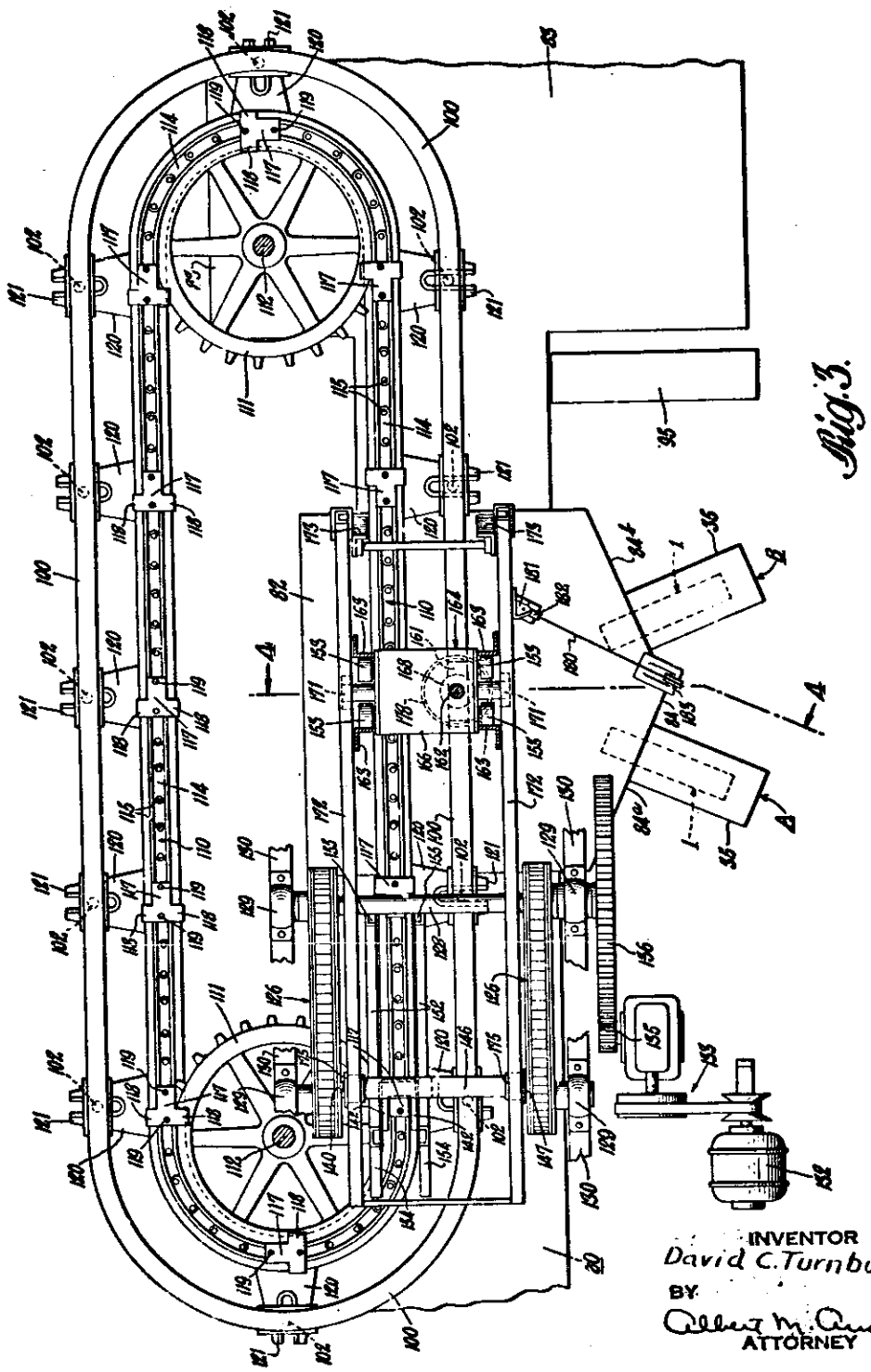

Fig. 3.

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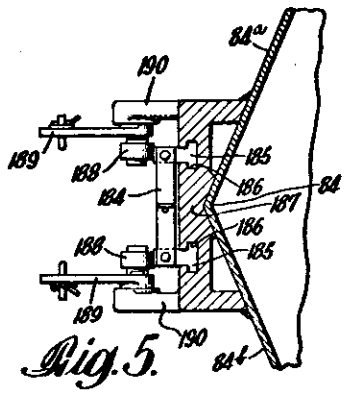

Fig. 5.

Fig. 4.

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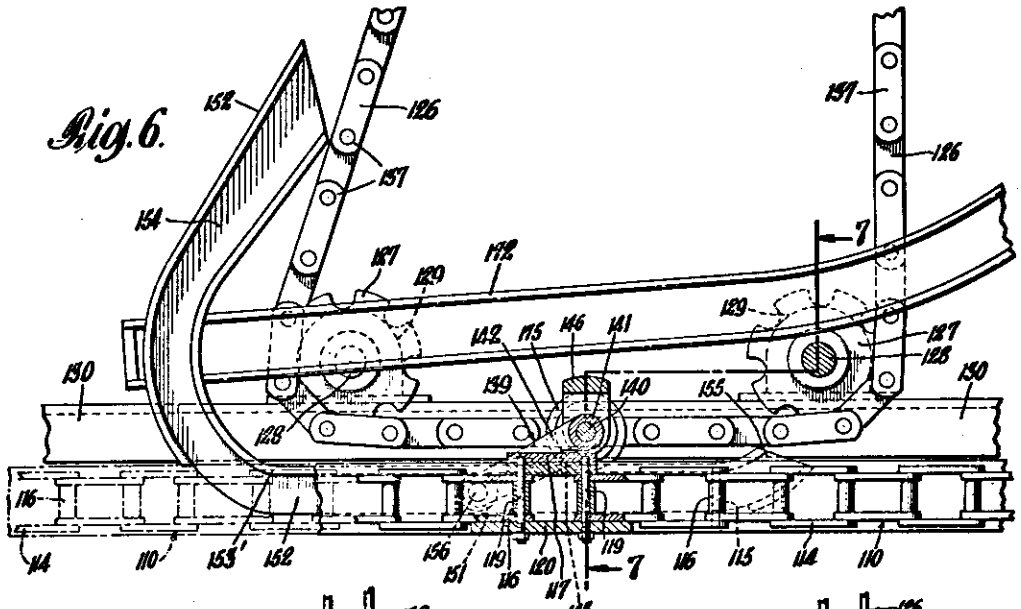
Filed Feb. 17, 1938 7 Sheets-Sheet 5

Fig. 6.



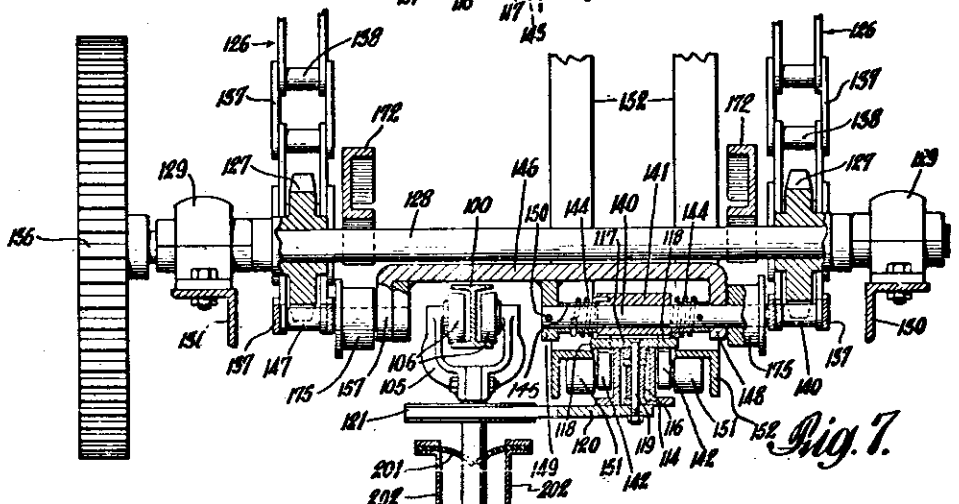


Fig. 7.

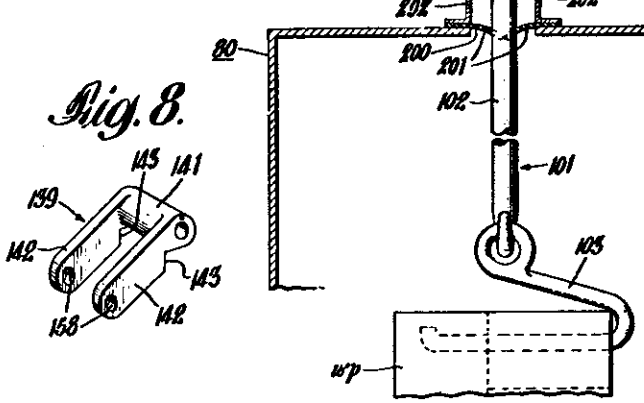


Fig. 8.

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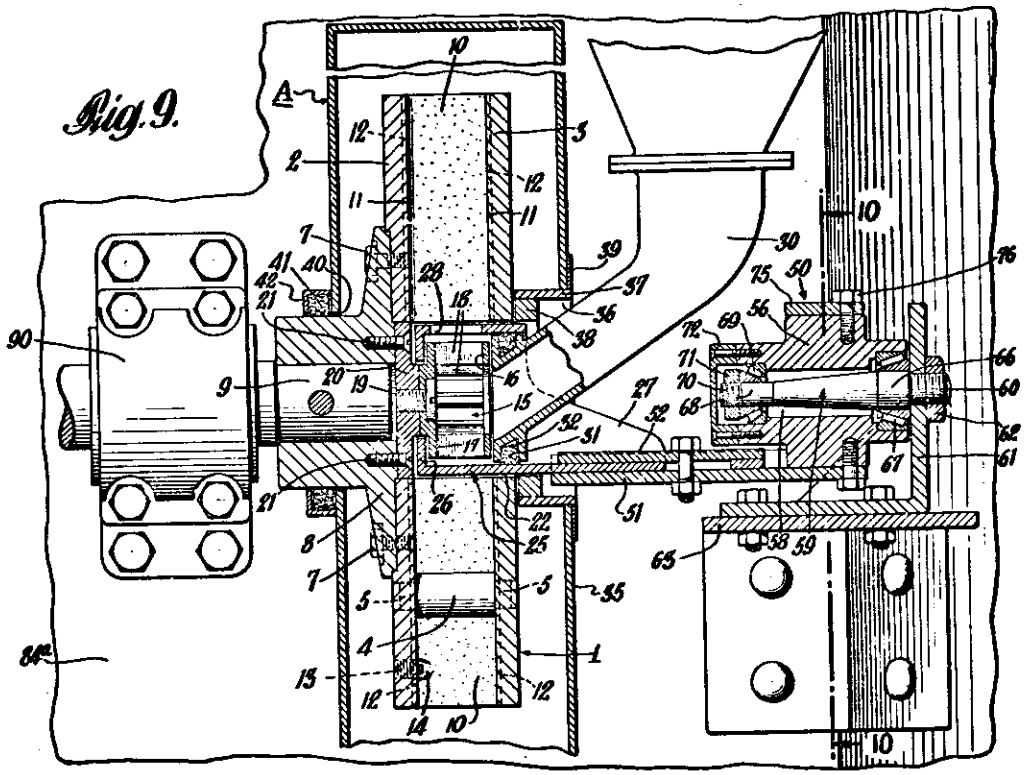
Filed Feb. 17, 1938 7 Sheets-Sheet 6

Fig. 9.



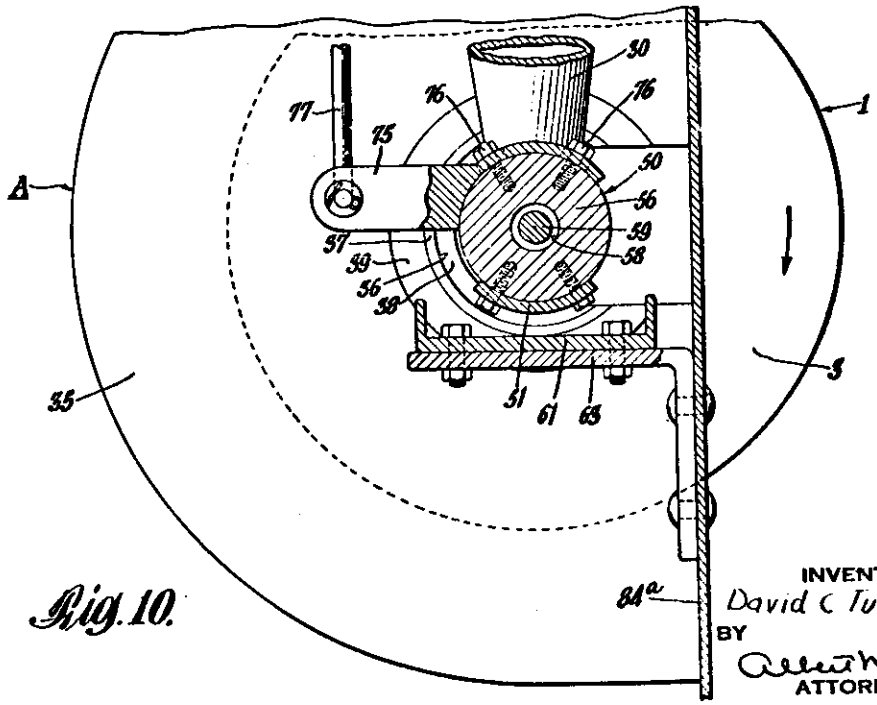


Fig. 10.

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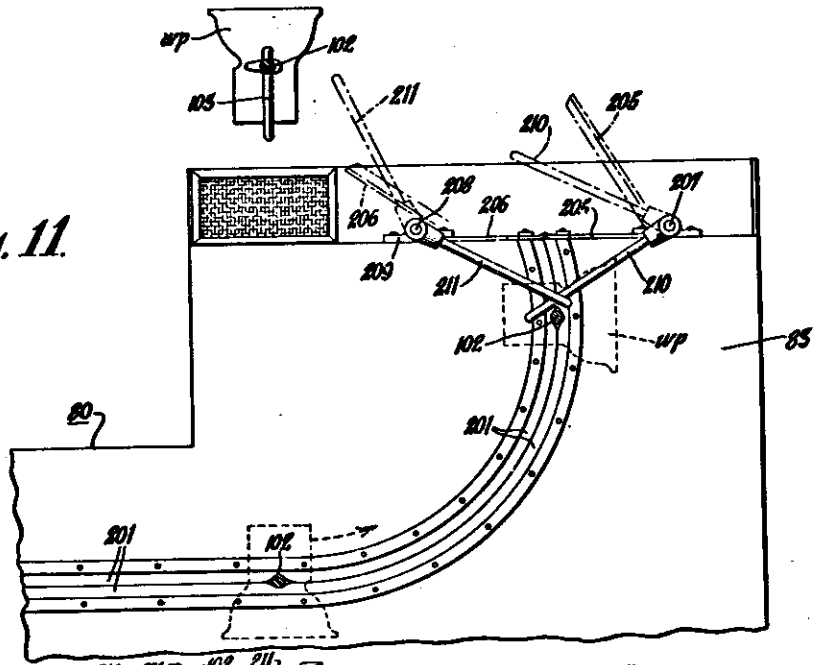
Fig. 11.



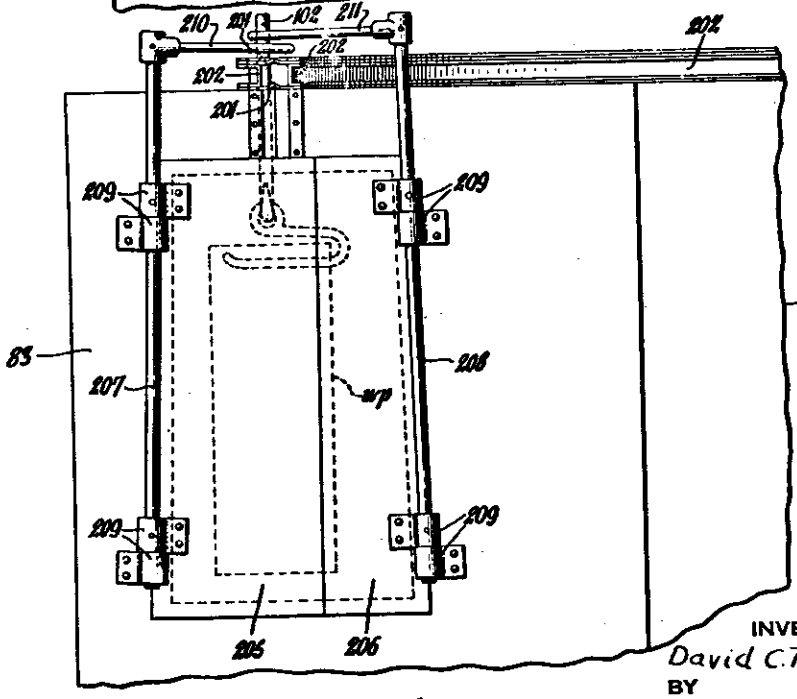


Fig. 12.

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