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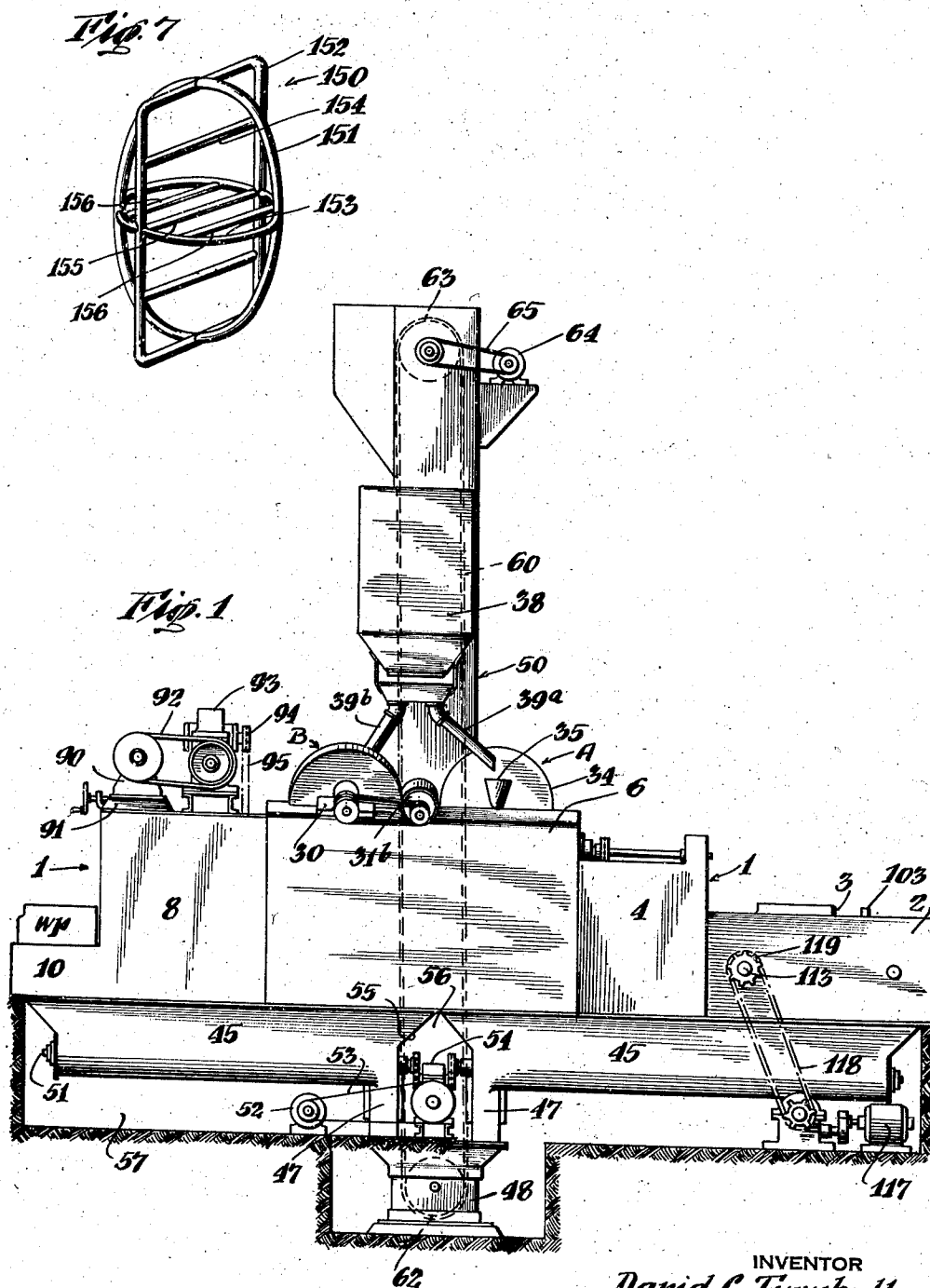
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APPARATUS FOR TREATING METAL ARTICLES

Filed Sept. 24, 1938

6 Sheets-Sheet 1



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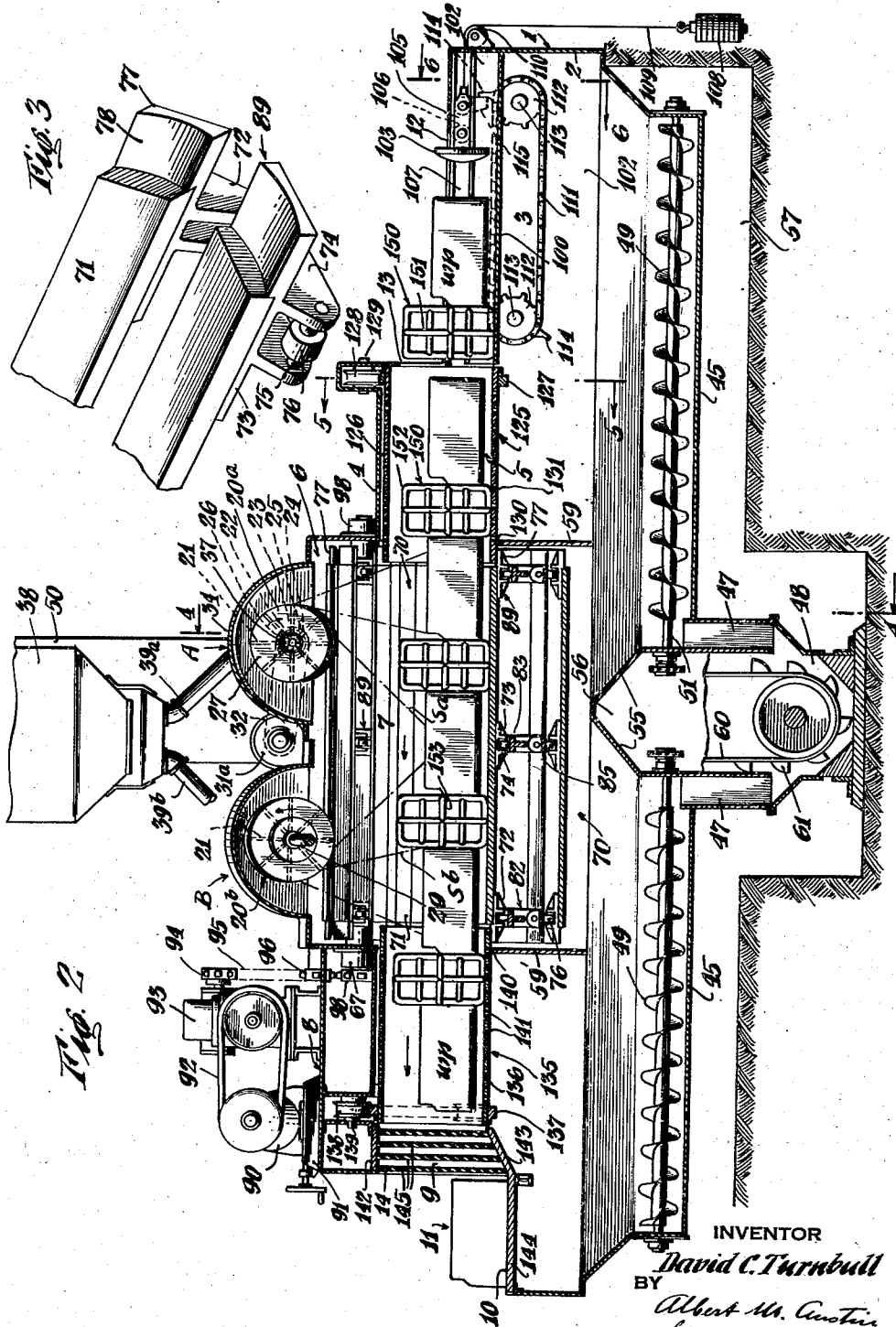


Fig. 3

Fig. 2

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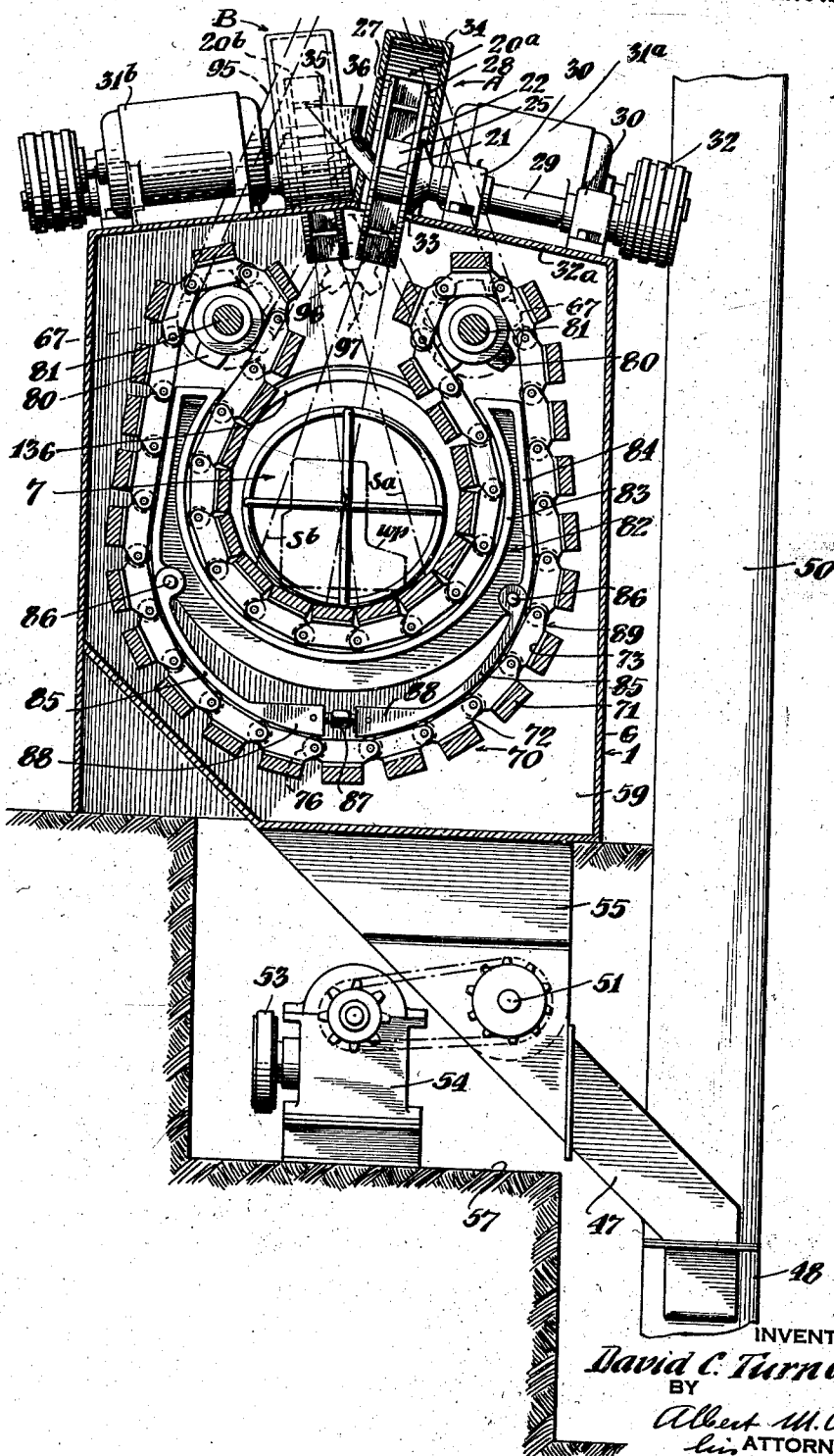
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APPARATUS FOR TREATING METAL ARTICLES

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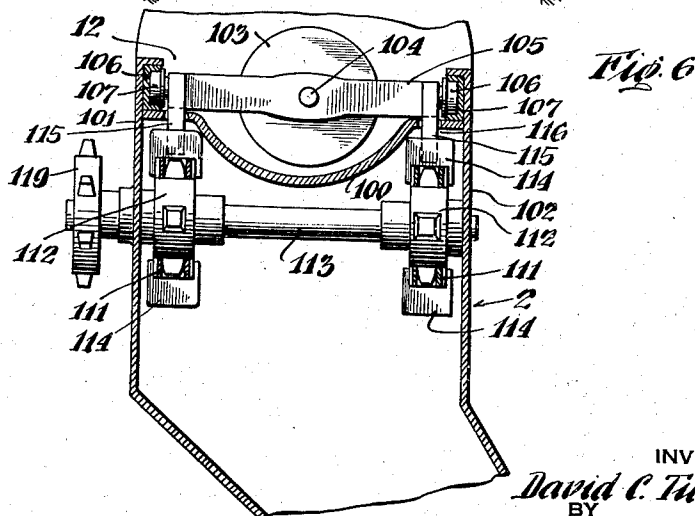
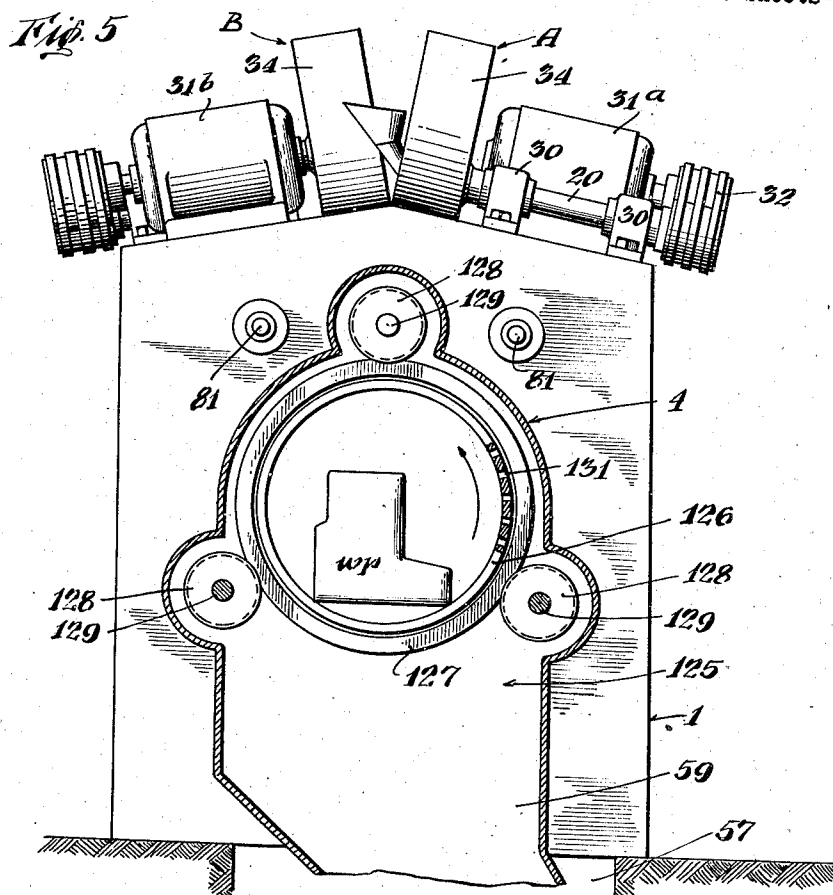
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APPARATUS FOR TREATING METAL ARTICLES

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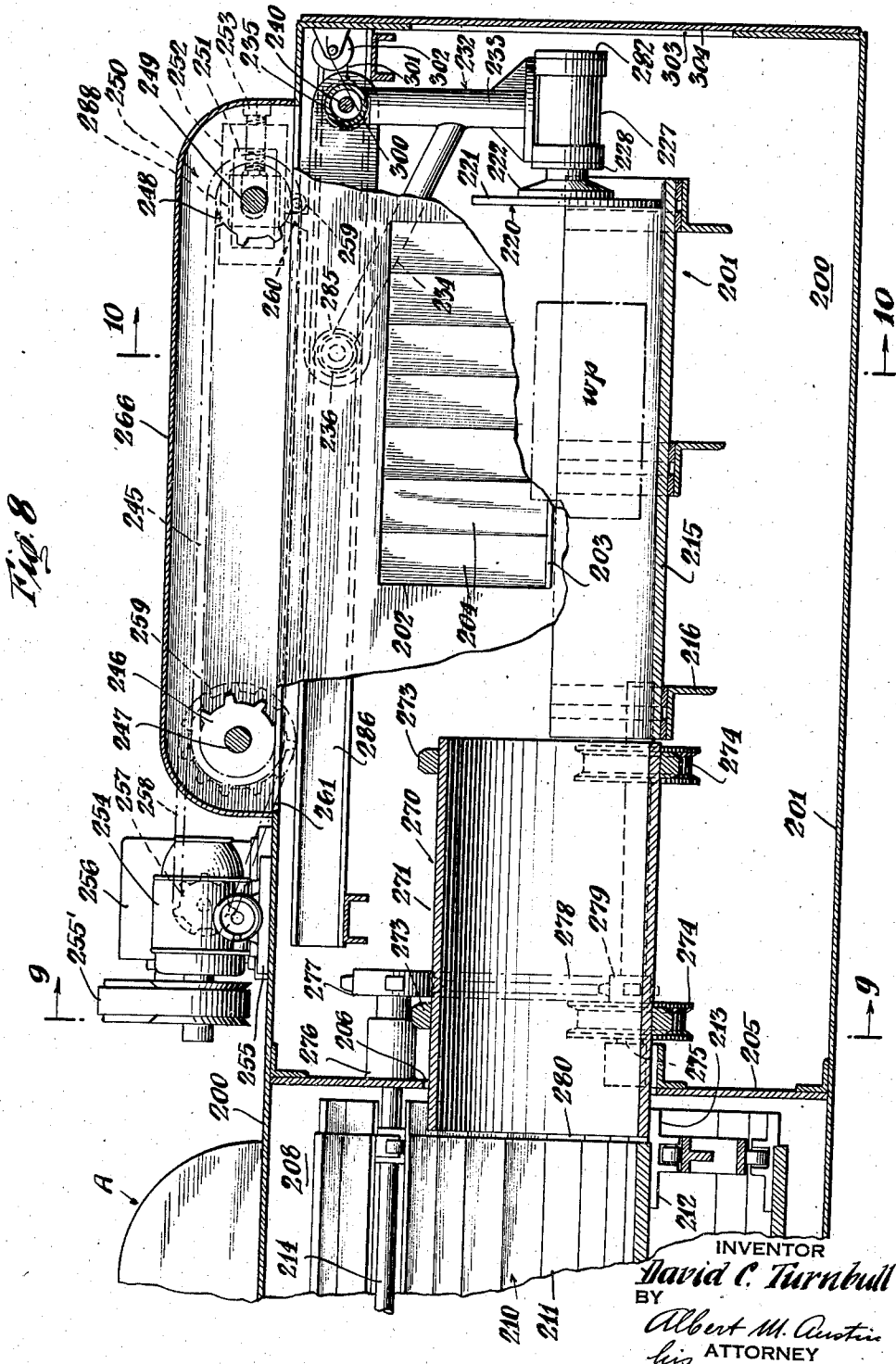
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APPARATUS FOR TREATING METAL ARTICLES

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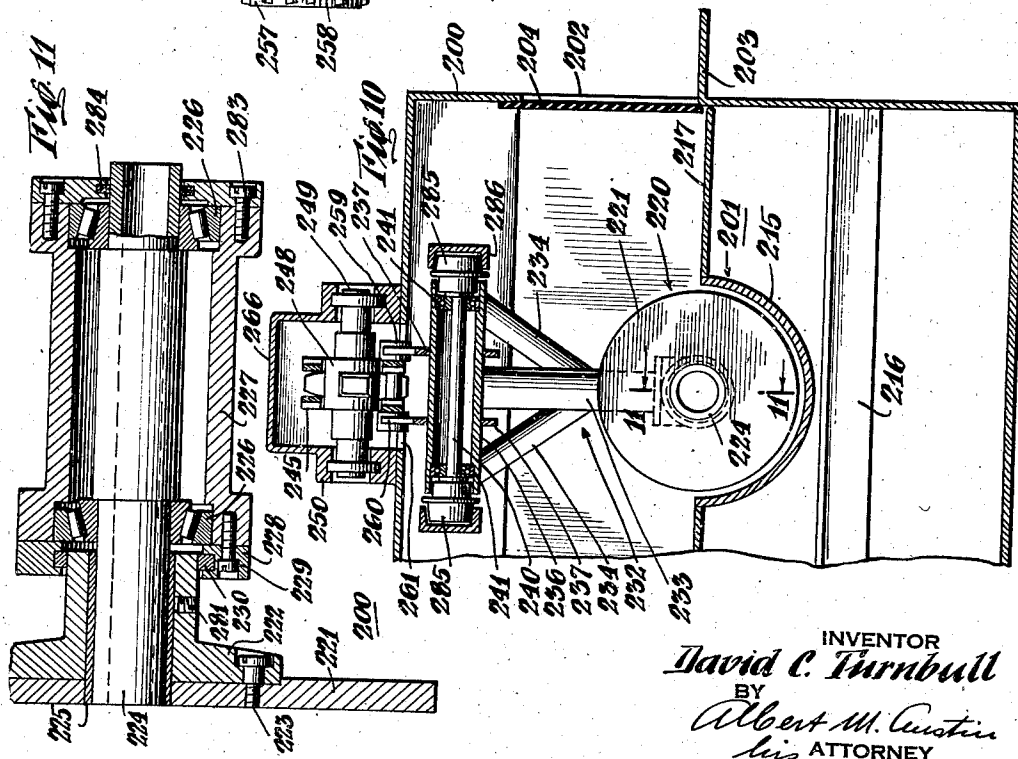
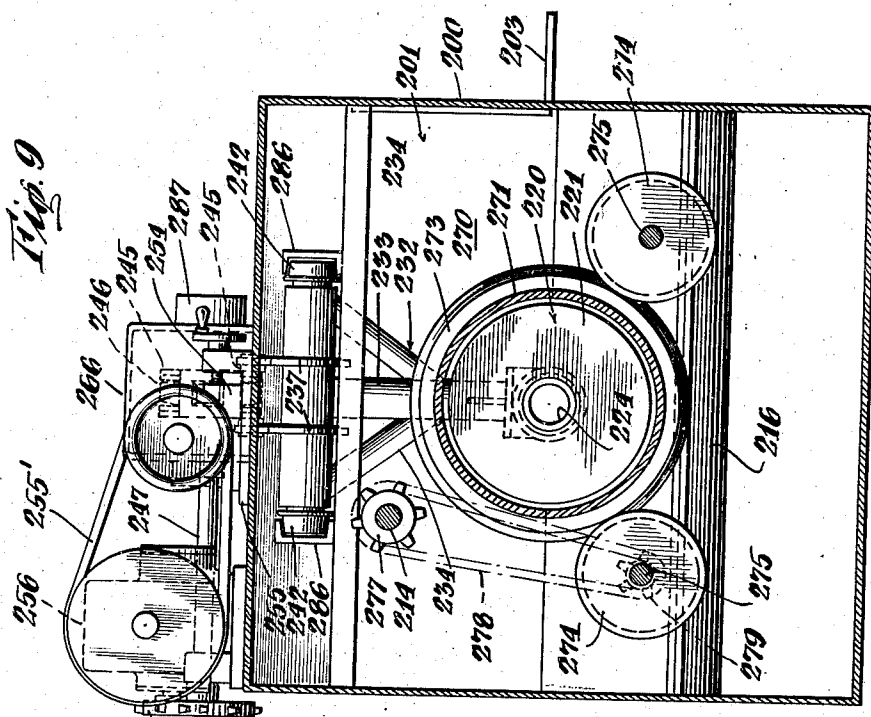
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APPARATUS FOR TREATING METAL ARTICLES

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6 Sheets-Sheet 6



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APPARATUS FOR TREATING METAL ARTICLES

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Application September 24, 1938, Serial No. 231,499

14 Claims. (Cl. 51—9)

The invention relates to apparatus for treating metal articles. More particularly, the invention relates to abrading apparatus for cleaning, polishing, hardening or otherwise treating the surfaces of castings, forgings, stampings and other metal objects.

In cleaning castings, forgings or other metal objects with a stream of granular abrading material hurled at abrading velocities, it is desirable to manipulate the objects so that all or predetermined portions of the surfaces thereof are suitably presented to the stream of abrading material. In some instances, the articles can be suitably presented by tumbling them in a tumbling mill or by means of a conveyor of known construction. However, where the articles are large and heavy, awkwardly shaped, fragile or otherwise unsuitable for tumbling, and where all or most of the surfaces are to be cleaned, it is difficult to manipulate the objects so as to expose the various surface portions and particularly cavities, depressions and the like suitably to the stream of abrading material. It is also desirable that the operation be one which can be carried out in a substantially continuous manner as compared to a batch operation.

In accordance with the present invention, the apparatus includes one or more abrasive projectors, preferably of the rotary centrifugal throwing wheel type having means associated therewith for controlling the direction of flight of the thrown abrading material. A conveyor is provided for advancing the objects into the abrasive stream or streams, turning them about in the stream or streams and thereafter moving them from the stream or streams. The conveyor includes an endless flexible member, suitably mounted so as to define a generally trough-shaped floor or supporting surface and adapted to be traveled whereby an article supported thereon is turned about in the stream or streams. A pusher mechanism is provided which is adapted to push the articles along the endless flexible member. A loading mechanism is provided for depositing the articles onto the supporting surface gently and without undue shock and comprises a tubular member adjacent and generally aligned with the endless flexible member. Preferably, a generally similar tubular unloading member is provided for receiving the articles as they are discharged from the endless flexible member. The loading and unloading members are preferably rotated at the speed of travel of the endless flexible member and are either driven by the supporting member or by a drive synchronized with

the drive for the supporting member. Preferably, the workpieces are deposited on the supporting and conveying mechanism so as to form a continuous line or column in which each workpiece abuts the preceding workpiece, and the pusher mechanism operates on the last workpiece to push the entire column along the supporting and conveying mechanism. Preferably, an open, frame-like spacer member is disposed between successive workpieces in order to space apart the ends of adjacent workpieces to permit the stream or streams of abrading material to strike against and clean the ends of the workpieces.

An object of the present invention is the provision of apparatus for the cleaning of metal castings, forgings and other metal members wherein the workpiece is positively advanced through a stream of abrading material and is turned about in the stream under control whereby to present all or predetermined portions of the surfaces to the abrading action of the stream.

Another object of the invention is the provision of apparatus for abrasively cleaning large and heavy metal objects of such construction as cannot be conveniently tumbled, whereby all or predetermined surface portions of the objects, and particularly cavities and depressions, are suitably exposed to the abrasive stream.

Still another object of the invention is the provision of apparatus for abrasively cleaning metal objects wherein the objects are automatically manipulated to remove therefrom any moulding sand, core sand, or other foreign material, prior to entry of the object into the abrasive stream.

Still another object of the invention is the provision of apparatus for abrasively cleaning metal objects wherein the objects are automatically manipulated after removal from the abrasive stream whereby to remove any abrading material or other debris from the surfaces of the objects and from cavities or depressions thereof.

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 hereof, in which

Fig. 1 is a side elevational view of one form

of apparatus constructed in accordance with the invention;

Fig. 2 is a vertical sectional view taken longitudinally through the apparatus of Fig. 1;

Fig. 3 is an enlarged, fragmentary, perspective view of a detail of the endless flexible member;

Fig. 4 is an enlarged, fragmentary, cross-sectional view taken along line 4—4 of Fig. 2;

Fig. 5 is an enlarged, fragmentary, cross-sectional view taken along line 5—5 of Fig. 2;

Fig. 6 is an enlarged, fragmentary, cross-sectional view taken along line 6—6 of Fig. 2;

Fig. 7 is an enlarged, perspective view of one of the spacers;

Fig. 8 is a fragmentary, side elevational view, partially in cross-section, of another embodiment of the invention and illustrating particularly the construction at the loading end of the apparatus;

Fig. 9 is a transverse cross-sectional view taken along line 3—3 of Fig. 8;

Fig. 10 is a fragmentary, cross-sectional view taken along line 10—10 of Fig. 8; and

Fig. 11 is an enlarged, fragmentary, cross-sectional view taken along line 11—11 of Fig. 10.

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.

Referring now particularly to Figs. 1 and 2 of the drawings, the apparatus comprises a housing or cabinet 1 having a plurality of sections 2, 4, 5, 6 and 10, providing respectively a loading station 3, inlet chamber 5, abrading chamber 7, outlet chamber 8 and discharging station 11. A loading or charging opening 12 is provided in the loading section 2, an inlet opening 13 is provided in the inlet section 5, and an outlet or discharge opening 14 is provided in the outlet section 8. Supporting and conveying means, hereinafter more fully described, are provided for advancing articles to be cleaned through the housing or cabinet from the loading station 3 to the discharging station 11.

One or more abrasive projectors may be suitably mounted on the top wall of the abrading chamber section 6 for projecting a corresponding number of streams of abrading material, or abradant, against workpieces in the abrading chamber 7. In the present example two such projectors A and B are shown which project streams *sa* and *sb* respectively, of abrading material. Although the projectors A and B may take various forms, preferably they are of the centrifugal throwing wheel type having means associated therewith for controlling a direction of flight of the thrown abrading material. Inasmuch as both of the abrasive projectors are substantially similar, only one of them will be described in detail.

The abrasive projector A includes a rotary centrifugal throwing wheel 20a (see Figs. 2 and 4) having a plurality of throwing blades 21 which extend in a generally radial direction from adjacent the periphery of the wheel to points inwardly short of the rotating axis of the wheel to provide a central space 22. Disposed in the central space 22 is an impeller 23 having a plurality of radially directed vanes 24. Surrounding and spaced from the impeller 23 is a relatively stationary and independently mounted control member 25 having one or more suitably arranged discharge outlets 26.

The throwing blades 21 may be supported by one or more side wall members 27, 28, one of which supports the blades on a shaft 29 for rotation. The shaft 29 is suitably journaled in bearings 30 and is driven from a motor 31a connected to the shaft 29 by a suitable drive 32. The impeller 23 preferably rotates with the blades 21.

The wheel 20a preferably is mounted on a top wall portion 32a of the housing section 6 and may extend through an opening 33 or may be positioned so as to project its streams *sa* of abrading material through this opening. A casing 34 may be provided for enclosing the portion of the wheel which extends above the top wall 32a.

The wheel 20a is supplied with abrading material from a feed spout 35 which extends through an opening 36 in the casing 34 and through an opening 37 in the side wall 27 and which delivers the abrading material to the impeller 23. The feed spout 35 is preferably supplied with abrading material from a storage hopper 38, having a feed pipe 39a extending therefrom and leading to the feed spout 35. The wheel 20b of the other abrasive projector B may be supplied with abrading material in a similar manner from the hopper 38 by a feed pipe 39b.

When the wheel 20a is rotated by the motor 31a and supplied with abrading material, the impeller 23 discharges the abrading material through the opening 26 of the control member 25 and into the path of the throwing blades 21. The abrading material is carried along the leading faces of the throwing blades 21 and is hurled therefrom, adjacent the periphery of the wheel, at the desired abrading velocity. The abrading material spreads out fanwise from the wheel in a stream *sa* which produces an elongated impingement pattern. The direction of flight of the abrading material may be controlled by suitable adjustment of the clock-dial position of the outlet opening of the control member 25 about the axis of rotation of the throwing blades.

The wheel 20b is driven by the motor 31b and is supplied with abrading material by the feed pipe 39b and projects the streams *sb* in an analogous manner. For a purpose which will hereinafter appear, the wheels 20a and 20b preferably are canted slightly in opposite directions, as will be seen from Fig. 4 of the drawings, and the streams *sa* and *sb* are not in the same plane.

The spent abrading material which has been thrown by the projectors A and B into the abrading chamber 7 falls to the bottom of the housing 1 (see Figs. 1, 2 and 4) and is collected in one or more hoppers such as the hoppers 45, 45, which may, if desired, extend into a pit 57 below the level of the floor on which the apparatus is installed. A discharge outlet or chute 47 leads from the hopper 45 to the lower portion 48 of an elevator 50. A screw conveyor 49 preferably is suitably mounted in each hopper 45 and is driven from a motor 52 connected to a drive 53 which may, if desired, drive a speed reducing unit 54, suitably connected to the shaft 51 of the screw conveyor 49. In the present example a plurality of screw conveyors 49 are provided and they may all be driven from the same driving mechanism. The driving mechanism may be installed in suitable space 56 defined by end walls 55 of the hoppers 45.

The elevator 50 preferably comprises an endless belt 60, carrying a plurality of lift buckets 61, and trained over drums 62, 63 mounted for rotation in the elevator housing. The elevator

is driven by a motor 64 connected by a drive 65 to the shaft of one of the drums 63.

The storage hopper 38 may be disposed in position to receive abrading material by gravity from the upper end of the elevator 50. However, if desired, suitable screening and separating apparatus (not shown) may be provided between the upper end of the elevator 50 and the hopper 38 for the purpose of removing from the spent abrading material any foreign material or debris, such as scale, sand, dust or the like.

A conveyor is provided for advancing the workpieces into the abrading chamber, supporting them therein for cleaning, and advancing them out of the abrading chamber after cleaning. The conveyor includes a supporting turning device located in the abrading chamber and adapted to support the workpiece or workpieces in the stream or streams of abrading material and to turn them about therein.

Referring particularly to Figs. 2 and 4, the supporting and turning device comprises essentially an endless flexible member 70 so supported as to define a generally trough-shaped supporting surface. The endless flexible member 70 preferably is constituted by a plurality of rigid, elongated members, such as slats or bars 71 extending in a generally parallel direction. The bars 71 are carried by and secured together by a plurality of chains 89; in the present example, three such chains are illustrated. The bars preferably are formed of or faced with abrasion-resisting metal; in some cases it may be preferable to face the bars with a non-metallic abrasion-resisting material, such as rubber.

Each chain 89 (see Fig. 4) comprises a plurality of links 72 (see Fig. 3 for a detailed view) each of which is provided with a base 73, adapted to be attached to or forming a portion of one of the bars 71, and a plurality of flanges 74 adapted to receive a pin 75 carrying a roller 76. The pins 75 serve to connect adjacent links to form the chain. The base 73 is also formed with a portion 77 which projects beyond the end of the corresponding bar 71 and which has an arcuate face 78 for a purpose hereinafter illustrated.

Each chain 89 (see Fig. 4) is trained over a pair of spaced sprockets 80 carried on shafts 81 for rotation, the chain being draped so as to position the bars 71 in inner and outer arcuate flights, the inner flight providing a trough-shaped supporting surface for the workpieces. Each chain 89 is guided in its path by a guide member 82, having an inner flange 83 of generally arcuate shape for engaging the rollers 76 of the inner flight of the corresponding chain. The guide member 82 is provided by its outer edge with a flange or rail 84, around which the outer flight of the chain 89 is trained.

In order to provide for adjusting the tension on the chain 89, the outer flange or rail 84 may be made expansible. For example, the outer flange may be split and includes one or more movable segments 85 pivoted as by pins 86 to the guide member 82. In the present example, two such segments 85 are provided and are connected by a turnbuckle 87 engaging the enlarged end portions 88 of the segments 85. It will be seen that the tension on the chain may be adjusted by suitable adjustment of the turnbuckle 87.

The endless flexible member 70 is caused to execute traveling movement around its path in order to turn about in the streams articles which are supported on the inner flight. The endless

flexible member 70 may be traveled by driving it from a motor 90 (see Fig. 2), adjustably mounted on a support 91 fixed to the top wall of the housing 1. The motor 90 may be connected by a drive 92 to a speed reducing mechanism 93, which in turn drives a sprocket 94. Trained over the sprocket 94 is a chain 95 which is also trained around sprockets 67, 67 (see also Fig. 4) secured to the shafts 81 and also trained around an idler sprocket 96 carried on a shaft 97.

When the motor 90 is energized, it operates through the connections above described to drive the sprockets 67 in the same direction and thus rotates the shafts 81 which cause the sprockets 80 to rotate and effect traveling movement of the endless flexible member 70.

For advancing the workpieces onto and longitudinally along the supporting surface defined by the endless flexible member 70, a pusher mechanism (see Fig. 2), located at the loading station 3, is provided.

The loading station section 2 (see Figs. 2 and 6) is provided with an opening 12 in the top wall, as above described, in order to permit the introduction of workpieces *wp* into the housing. Below the opening 12 is a generally arced supporting floor or trough 100, which preferably extends between the side wall portions 101 and 102.

Reciprocable in the loading station section 2 is a pusher head 103 carried by a pusher frame 105, and preferably rotatably mounted thereon as by means of a stub shaft 104. The pusher frame 105 carrying the pusher head 103 is mounted by rollers or wheels 106 which cooperate with guides or tracks 107 fixed to the side walls 101 and 102 respectively.

The pusher frame 105 is normally retracted (to the right as viewed in Fig. 2) by a suitable retracting mechanism. In the present example, the retracting mechanism is illustrated as comprising a weight 108, connected to the pusher frame 105 by a cable 109 trained over a pulley 110. The weight 108 urges the pusher frame 105 rearwardly, but permits advancing movement of the frame in the opposite direction, upon application of a suitable force. It will be understood that another suitable retracting mechanism may be substituted for retracting the frame, as for example, spring means (not shown).

The pusher frame 105 is periodically advanced toward the abrading chamber 7 (to the left as viewed in Fig. 2) by a suitable advancing mechanism. The advancing mechanism herein illustrated comprises a plurality of endless chains 111 (see Figs. 2 and 6), each of which is trained over a plurality of sprockets 112 carried on shafts 113. The chains 111 carry one or more chain lugs 114 adapted to engage frame lugs 115 depending from the pusher frame 105 and extending through openings 116 in the floor 100 and into the path of the chain lugs 114 as they are carried along the upper flight of the chains 111. The chains 111 are suitably driven as by a motor 117 connected by a drive 118 to a sprocket 119 secured to one of the shafts 113.

When the motor 117 is driven it operates, through the drive 118 and sprocket 119, to drive the shaft 113 and effect traveling movement of the chains 111. The chain lugs 114 engage the frame lugs 115 and urge the pusher frame 105 forwardly (to the left as viewed in Fig. 2) against the force of the weight 108 until the chain lugs 114 are moved out of engagement with the frame

lugs 115. The frame 105 then is rapidly retracted by the weight 108.

Where one set of chain lugs is provided the frame will be urged to the left once for each trip of the chains 111. The chains 111, however, may be provided with a plurality of chain lugs, in which case the frame will be reciprocated a corresponding number of times for each trip of the chains. It will be noted that the driving mechanism for the pusher can be so designed and operated as to cause the work to turn in the abrasive streams for any selected period.

Disposed between the inner end of the floor 100 and the end of the endless flexible member 70 is an inlet or loading vestibule 125 (see Figs. 2 and 5). The loading vestibule 125 preferably comprises a cylindrical metal tube 126 which may be formed from abrasion-resisting metal, or may be lined with such metal or lined with other abrasion-resisting material, such as rubber. The tube 126 preferably is provided with a flange or rail 127 at the outer end, which supports this end of the tube on a plurality of, and preferably three, rolls 128 carried on shafts 129. When three rolls are provided, they are arranged preferably in a generally triangular formation with two of the rolls below the tube 126 and one of the rolls above, in the manner illustrated in Fig. 5 of the drawings. The tube 126 is provided with openings 131 therein to permit debris to pass out of the tube.

In certain cases, it may be desirable to provide an additional set of supporting rolls similar to the rolls 128 for supporting the end of the tube 126 at the other end. In such cases, an additional flange or rail 127 is provided on the inner end of the tube 126. The tube 126 then is supported in a manner generally similar to that illustrated in Figs. 8 to 11, instead of by the one set of rolls as shown in Fig. 2.

The inner end of the tube 126 extends through an opening 130 in the partition 59 and is supported on the extensions 77 of those links 73 which constitute the inner flight of the chain 89 at the right hand end (as viewed in Fig. 2) of the endless flexible member 70. The surfaces 78 of the extensions 77 which engage the tube 126 are shaped to fit snugly against the end of the tube 126. In certain instances it may be desirable to provide the bars 71 with extensions to engage the tube 126 instead of providing the extensions 77 on the bases 73 as illustrated herein. The extensions 77 are so positioned that they maintain the lower portion of the inner surface of the tube substantially at the level of and close to the lower portion of the inner surface.

It will be seen that the lower flight of the endless flexible member 70 thus constitutes a support for the inner end of the tube 126, and that the tube 126 serves to maintain the desired arcuate configuration of the inner flight of the endless flexible member 70. In the present example the tube 126 engages the extensions 77 with sufficient friction, so that the tube 126 is driven in the same direction and approximately at the same speed as the bars 71 of the inner flight of the flexible member. However, if desired, separate driving mechanism (not shown) may be provided for driving the tube 126.

When two sets of supporting rolls are employed and the vestibule is separately driven it need not be supported on the endless flexible member but can merely abut this member in the manner shown. In this connection it will be noted that while some space is shown between the vestibule

and the ends of the rails, this space can be, and preferably is, eliminated so far as possible.

Disposed at the discharge end of the endless flexible member (see Fig. 2) is an outlet or unloading vestibule 135 which preferably is generally similar in construction to the inlet or loading vestibule 125. The outlet vestibule comprises a cylindrical metal tube 136 formed with perforations or openings 141 and having a flange or rail 137 at the outer end which cooperates with an upper roll 138 carried on a shaft 139 for rotation and lower rolls (not shown) which preferably are arranged in a manner generally similar to the rolls 128 which support the inlet vestibule 125. The inner end 135 extends through an opening 140 in the partition 59 and preferably is supported upon the end of the inner flight of the endless flexible member 70 in a manner generally similar to that in which the inner end of the vestibule 125 is supported.

The outlet vestibule 135 is disposed with its floor in substantial alignment with the floor of the inner flight of the endless flexible member 70 and is adapted to receive workpieces that are pushed off the discharge end of the endless flexible member 70. The discharge vestibule 135 is rotated by engagement with the endless flexible member, but if desired, may be provided with separate driving means (not shown).

A discharge opening (Fig. 2) is provided in the housing 1 adjacent the outlet end of the unloading vestibule 135 and preferably is closed by one or more flexible curtains 145 which depend from the ceiling 142 of the housing at this point. The housing is provided with a floor 143 which preferably is inclined downwardly from the floor of the outlet end of the unloading vestibule 135 and extends to an unloading floor or platform 144 disposed outside of the housing 1, which platform provides an unloading or discharging station 11.

For the purpose of spacing successive workpieces on the conveyor in order to expose the opposing end surfaces of the adjacent workpieces to the action of the streams of abrading material, one or more spacers (see Fig. 2) are provided. Each spacer comprises an open frame-like structure having end portions adapted to abut the ends of adjacent workpieces and a side portion adapted to engage the sides of the conveyor and center the spacer thereon.

One novel form of spacer 150 (see Fig. 7) is constituted by a plurality of members which may be either rods or tubes suitably secured together as by welding. The spacer 150 comprises a generally circular member 151 and a generally rectangular member 152 disposed in a plane perpendicular to the plane of the circular member 151 and secured to the latter at the top and bottom. A second ring 153 extends substantially medially around the frame and is connected to the members 151 and 152 to assist in maintaining them in rigid relation. One or more strut members 154 extend between the sides of the rectangular member 152 for stiffening it. A plurality of strut members are provided for stiffening the spacer so that it withstands the heaving longitudinal thrust on the line of workpieces. In the present example, a central strut member 155 and two side strut members 156 are provided.

The apparatus is suitable for cleaning any objects, such as metal castings, forgings and the like, which can be pushed along on the several supporting surfaces without piling up. The invention is particularly well adapted for cleaning

large heavy objects, such as cylinder blocks and the like, and in the present illustrative example, it is illustrated in connection with the cleaning of cylinder blocks and the like.

5 The operation of the apparatus is as follows:

The driving motors 31a and 31b for the abrasive projectors A and B are energized to drive the abrasive throwing wheels 20a and 20b and the wheels are supplied with abrading material from the hopper 38. The wheels 20a and 20b project the streams of abrading material sa and sb respectively into the space within the inner flight of the endless flexible member 70 and against workpieces wp supported thereon.

15 It will be noted that the throwing wheels 20a and 20b are canted or inclined in opposite directions so that the streams sa and sb sweep portions of this space on opposite sides of the vertical center line; thus, as will be seen particularly from Fig. 4, the stream sa is directed against a workpiece wp on the supporting surface from one direction and the stream sb is directed against the workpiece wp in another direction whereby there is a substantial range of "side to side" angularity of the streams.

20 It will be noted also that the throwing wheels 20a and 20b are mounted oppositely and are driven in opposite directions whereby they project their respective streams sa and sb in more or less opposed relation relative to the supporting surface. Thus the angularity of the two streams sa and sb varies throughout a substantial angle.

25 The restricted size and shape of the chamber defined by the endless flexible member tends to confine the abrading material of the abrasive streams, thus causing considerable rebounding which expends itself on the workpieces, thus adding to the effectiveness of the abrasive streams, especially where the workpieces are of irregular shapes.

30 The motor 52 is energized to drive the screw conveyors 49 and the motor 64 is energized to drive the elevator 60 whereby to return spent abrasive to the hopper 38.

35 The driving motor 90 is energized to drive the endless flexible member 70 and cause it to travel around its path, the endless flexible member being guided around its path by the guiding means above described.

40 The motor 117 is energized to drive the chain 111 and to effect reciprocation of the pusher head 103, as above described.

45 The workpiece wp to be cleaned is deposited through the opening 12 onto the trough or floor 100 in advance of the pusher head 103. The pusher head advances the workpiece along the floor 100 and into the inlet vestibule 125. The vestibule 125 is rotated by cooperation with the endless flexible member as above described (or by its own driving mechanism where the same is provided) and turns the workpiece wp about an axis extending in a generally longitudinal direction. Thus, any moulding sand, core sand or other foreign matter carried on the workpiece 50 or in the cavities thereof or loosely adhering to the workpiece is caused to drop off the workpiece and fall to the floor of the loading vestibule 125 from whence it passes through the openings 131 and drops into the hopper 45. The turning movement of the loading vestibule 125 effects a gentle turning of the workpiece wp and in most cases a gentle tumbling which tends to shake loose the adherent foreign material.

55 A second workpiece wp is next deposited on the floor 100 in advance of the pusher head and

pushed into abutment with the first workpiece and thereafter is further advanced, whereby the force on the second workpiece wp is transmitted to the first workpiece wp to advance the same longitudinally along the loading vestibule 125.

5 In order to expose the end surfaces of the workpieces wp to the action of the streams of abrading material sa and sb, it is usually preferable to provide means for spacing apart successive workpieces. Preferably, this is accomplished by interposing an open frame-like spacer 150, such as illustrated particularly in Figs. 2 and 6, and described hereinbefore. The spacer 150 is positioned so that the end portions 152 bear against the end surfaces of successive workpieces wp and the side portion 151 extends generally transversely of the movement of the workpieces wp whereby to position the spacer 150 substantially centrally of the several portions of the conveying mechanism. Preferably, the side portion 151 is generally circular in form whereby the spacer will turn readily with the workpieces. Furthermore, the circular form conforms generally with the shape of the loading vestibule, the endless flexible member and the unloading vestibule.

15 Where a spacer 150 is interposed between successive workpieces wp, it is inserted through the opening 12 in a position ahead of the workpiece wp on the trough-shaped floor 100 and, when the pusher head 103 is advanced to push the workpiece into the loading vestibule 125, the spacer 150 is pushed into contact with the trailing end surface of the preceding workpiece wp. Depending upon the relative length of the loading vestibule 125 and the workpieces wp, the leading workpiece wp is advanced onto the arcuate supporting surface defined by the inner flight of the endless flexible member 70 and into the stream sa of abrading material projected by the abrasive projector A after one or more succeeding workpieces have been advanced into the loading vestibule 125.

20 The traveling movement of the endless flexible member 70 causes the workpiece wp to be turned about in the stream whereby to bring the various surface portions of the workpiece wp into the stream. The workpiece wp is turned about an axis extending in a generally longitudinal direction and in many cases is gently tumbled by this turning movement depending upon the size and shape of the workpiece. However, preferably the shape and size of the supporting surface defined by the inner flight of the inner flexible member 70 are such that no severe tumbling action is produced. It will be understood, however, that where the workpiece is capable of withstanding shocks it is possible to permit substantial tumbling action.

25 Further workpieces wp are introduced through the opening 12 and advanced by the pusher head 103 into contact with the preceding work piece whereby a line or file of workpieces wp is formed which extends along the loading vestibule 125, the endless flexible member 70 and the unloading vestibule 135, as illustrated in Fig. 2. It will be seen that, upon the addition of each workpiece to the line and the forward movement of the pusher head against the last added workpiece, the entire line is given a forward movement to advance the entire series of workpieces. Adjustment or variation of this movement may be effected by suitable control of the movement of the pusher head.

30 The loading vestibule 125 and unloading vesti-

bule 135 preferably are driven in the same direction as and at approximately the same velocity of the inner flight of the inner flexible member 70 whereby the workpieces *wp* are transferred from the loading vestibule 125 to the endless flexible member 70 and from the endless flexible member 70 to the unloading vestibule 135 without shock. It has been found that in many cases owing to the synchronized movement of the several supporting members, the entire line of workpieces *wp*, together with the interposed spacers 150, turn about the longitudinal axis of movement simultaneously and thus there is little or no rubbing or chafing between the successive workpieces (where no spacers are employed) or between the workpieces and the spacers (where the spacers are employed). Moreover, where the spacers are employed they may, if desired, be covered with a soft material, such as rubber or fabric, and thus prevent any injury to the ends of the workpieces in the event that any relative movement takes place between the workpieces and the spacers.

The workpieces are advanced along the supporting surface defined by the endless flexible member 70 and finally discharged therefrom and deposited onto the discharge vestibule 135. Each workpiece is turned about in the discharge vestibule 135 by the rotation of this member and any loosely adherent foreign matter, such as loosened scale, spent abrading material, or the like, is removed and falls through the openings 141 of the discharge vestibule 135 and into the hopper 45. Generally, the workpiece will be gently tumbled and such adherent material shaken loose.

The workpiece *wp* is finally forced through the discharge opening 14 and onto the platform 144. Wherein an inclined floor 143 is provided, this facilitates removal of the workpiece from the discharge vestibule 135.

The workpieces can be removed from the platform 144 at the unloading station 11 either manually or by suitable automatic conveyor apparatus (not shown). The spacers 150 may be returned to the loading station either manually or by truck or by suitable conveyor means (not shown). Because of the open, frame-like construction of the spacers, they can conveniently be returned by an overhead conveyor (not shown) employing hook-like carriers. Alternatively, since the spacers have one or more circular portions they can be rolled along a suitable trough or guideway (not shown).

When no further workpieces are deposited in the loading mechanism, further reciprocating movements of the pusher head will not cause the workpieces on the conveying mechanism to advance. In this event, a pusher bar (not shown) or rod of suitable length and rigidity is inserted through the opening 13 and operated to push the last workpiece of the line whereby to advance the line through the inlet vestibule 125, abrading chamber, outlet vestibule 135.

In accordance with the invention, the apparatus may take various forms. Referring now to Figs. 8 to 11, inclusive, a second form of apparatus is illustrated. In particular, there is illustrated another form of loading mechanism suitable for employment with a conveyor and abrasive projectors similar to those illustrated in Figs. 1 to 6, inclusive.

The apparatus (see Figs. 8, 9 and 10) includes a housing 200 generally similar in construction

to the housing 1 above described, except as regards the loading end of the apparatus. The housing 200 is formed with a loading section 201 having a loading or charging opening 202 in the side wall thereof. Extending outwardly from the opening is a shelf 203 to facilitate introducing workpieces through the opening 202. The opening 202 preferably is closed by one or more flexible curtains 204.

The loading section 201 preferably is separated from an abrading chamber section 208 by a partition 205 having an opening 206 extending therethrough for a purpose which will hereinafter appear.

Disposed in the loading section 201 is a trough or arcuate floor 215 open at both ends, which may be suitably supported on cross members 216 in position to receive workpieces *wp* which are inserted through the opening 202. If desired, one or more floor members 217 may extend from adjacent the opening 202 to the trough 215 to facilitate the sliding of workpieces *wp* into position in the trough 215.

Extending between the end of the trough 215 and the end of the endless flexible member 210 is a loading vestibule 270 which preferably is formed by a rigid tubular member 271 open at both ends. The tubular member 271 is supported for rotation by a plurality of rolls 274 (see Figs. 8 and 9) carried on shafts 275. Preferably, the rolls have grooved peripheries adapted to receive flanges or rails 273 rigidly secured to the tubular member 271. The tubular member 271 has an end portion 230 extending through an opening 206 in the partition 205 and adapted to bear against the extensions 213 of the endless flexible member 210.

The tubular member 270 may be driven with the endless flexible member 210 as described in connection with the previously described form of the invention, but in the present embodiment is illustrated as being driven by one or more of the supporting rolls 274. In the present example, one of the supporting rolls 274 is driven from a shaft 214 which may, if desired, be the driving shaft of the endless flexible member 210. The shaft 214 is journaled in a bearing 276 and carries a sprocket 277 over which is trained a chain 278 which is also trained around a sprocket 279 fixed to the shaft 275. When the shaft 214 is driven, it operates to rotate the tubular member 271 about a central longitudinal axis. It will be understood that, if desired, the loading vestibule illustrated particularly in Figs. 2 and 5 of the drawings may be substituted for the loading vestibule 270 illustrated in Fig. 8.

A pusher 220 is reciprocable along the trough 215 for the purpose of advancing workpieces along the trough 215 and into the loading vestibule 270. The pusher 220 comprises a head plate 221 (see Figs. 8 and 11), carried for free rotation by a hollow shaft 224, the head plate 221 being mounted by a hub 222 and connected thereto as by screws 223; preferably a bushing 225 is interposed between the shaft and the adjacent portions of the head plate 221 and hub 222, and the hub is locked on the shaft as by one or more set screws 281. The hollow shaft 224 is rotatably mounted in a bearing housing 227 carrying one or more suitable bearings, such as the roller bearings 226. The ends of the bearing housing 227 preferably are sealed around the shaft 224 as by end plates 228 and 282 secured to the housing as by screws 229 and 283, and by a sealing ring 30 provided around the hub and a sealing

ring 284 provided around the shaft at the other end.

The bearing housing 227 carrying the rotatably mounted pusher head 221 is carried by a frame 232 for reciprocating movement in the loading section 201. The frame 232 comprises an upright frame member 233 connected to a rear cross member 235 and forwardly inclined upright members 234 connected between upright member 233 and a forward cross member 236. The cross members 235 and 236 are connected by spaced plates 237. The frame members 233, 234, 235 and 236 may be of any suitable construction, but preferably they are tubular, in order to provide maximum strength and minimum weight; and also for a purpose hereinafter appearing.

The frame 232 is supported in guides or tracks 286 by wheels or rollers 242 carried on a shaft 240 extending through the cross member 235 and journaled in bearings 241 housed in the cross member 235. The front end of the frame carries wheels or rollers 285 which are journaled in the front cross member 236 in a generally similar manner.

It will be seen that the frame 232 is firmly and securely mounted and guided for reciprocating movement in a generally horizontal direction along the guides or tracks 286 whereby to permit an analogous reciprocating movement of the pusher head plate 221 along the trough 215.

The frame 232 carrying the pusher 220 is advanced by an endless chain 245 trained over sprockets 246 and 248 carried on shafts 247 and 249 journaled in bearings 287 and 250, respectively, supported on the top wall of the housing 200. The rearward bearings 250 (one of which is shown) are adjustable in order to provide for adjustment of the tension on the chain 245. Preferably, the bearings 250 comprise blocks 288 slidable in a way 251 formed in a bearing support 252 rigidly positioned in a suitable manner. An adjusting screw 253 is threaded into the bearing support 252 and is connected to the bearing blocks 250 whereby upon suitable turning movement of the screw, the blocks are adjusted horizontally.

The chain 245 is driven from a motor 254 adjustably supported on a bracket 255 fixed to the top wall of the housing 200. The motor 254 is connected by a suitable drive 255' (and preferably a speed reducer 256) to a sprocket 257 over which is trained a chain 258 also trained over a sprocket 259 carried on the shaft 247 which carries the sprocket 246. When the motor 254 is energized it operates through the mechanism just described to drive the chain 245.

The chain 245 carries one or more sets of rollers 259 adapted to engage lugs 260 upstanding from the frame members 237 whereby the forward movement of the lower flight of the chain 245 advances the frame 232 when the rollers 259 engage the lugs 260. It will be noted that in order to permit this interengagement, an opening 261 is provided in the top wall of the housing 200. A hood or roof 266 may be provided to enclose the chain 245 and certain or all of the associated mechanism.

The pusher 220 is normally retracted (to the right as viewed in Fig. 8) by a suitable retracting mechanism 300 which is yielding to permit the pusher to be advanced by the drive chain 245. The retracting mechanism 300 may comprise one or more flexible cables 301 normally wound upon a spring-urged reel or reels 302. The spring-urged reel 302 permits the cable 301 to be drawn out when the frame 232 is urged forwardly

by its driving mechanism but has sufficient force to return the frame 232 rapidly to its initial position. Other retracting devices, as for example, the gravity-operated mechanism described above, may be substituted for the mechanism shown in Fig. 8.

The operation of the apparatus disclosed in Figs. 8 to 11, and particularly the loading mechanism, is as follows:

The several driving mechanisms are operated to cause a traveling movement of the endless member, a turning movement of the inlet vestibule 270 and a reciprocating movement of the pusher 220. A workpiece *wp* is pushed through the opening 202 and deposited in the trough 215 in advance of the head plate 221 of the pusher 220. The drive chain 245 brings the rollers 259 periodically into engagement with the lugs 260 and thereby causes the pusher frame 232 to advance the pusher 220 into engagement with the workpiece *wp* and thereafter to urge the workpiece *wp* along the trough 215 and into the inlet vestibule 270 in a manner generally similar to that previously described.

When the pusher frame 232 reaches the end of its forward movement, the rollers 259 are disengaged from the lugs 260 and permit the retracting mechanism to return the pusher 220 to its retracted position. A second workpiece *wp* is then deposited in the trough 215 and advanced into abutment with the first workpiece *wp* (or into abutment with a spacer which in turn abuts the first workpiece *wp*). Succeeding workpieces *wp* are deposited in the trough 215 and advanced into the inlet vestibule 270 thereby forming a line or file of workpieces extending along the inlet vestibule 270, the endless flexible member 210 and the outlet vestibule (not shown).

It will be understood that after the last workpiece *wp* of those which are to be cleaned has been deposited in the trough and advanced into the loading vestibule 270, further reciprocations of the pusher 220 will not effect advancing movement of the workpieces *wp* supported on the conveyor mechanism. In this event, the end plate 304 is removed to permit access into the interior of the housing through the opening 303 and a pusher bar (not shown) or rod of any suitable construction and sufficient length and rigidity is inserted through the opening 231 in the hollow shaft 224 and into abutment with the last workpiece *wp*. By pushing against the last workpiece *wp* of the line or file the workpieces can be advanced along the conveying mechanism until the last workpiece is forced off the end of the conveying mechanism.

It will be understood that the portion of the apparatus not illustrated in Figs. 8 to 11 may be similar to the corresponding portions of the apparatus illustrated in Figs. 1 to 7 and that this operates in a similar manner upon the workpieces.

It will be seen that the present invention is suitable for abrading castings, forgings, stampings and other metal objects for the purpose of cleaning, polishing, hardening and the like. While the apparatus is suitable for cleaning or abrasive treatment of any objects which are capable of being pushed along in the manner described, nevertheless, the invention is especially well adapted for cleaning or treating large, heavy objects, such as cylinder blocks and the like.

The apparatus is capable of handling the objects with a minimum of shock or damage to the objects and capable of positively controlling the

manipulation of the objects through the abrasive stream in such manner as to expose the predetermined portions of the surfaces to the abrasive streams. Furthermore, the divergent nature of the streams, together with the positions of the streams relative to the conveyor, insure that the abrading particles strike the objects throughout a wide range of angularity and thus cavities, depressions, projections or other surface features are suitably presented to the streams.

The objects are turned about in the streams a sufficient number of times and are exposed to the streams for a sufficient length of time to insure complete and effective cleaning of the various surfaces. The abrasive throwing wheels are spaced apart so that there is no interference between their streams and the maximum effectiveness of the streams is obtained. Moreover, the wheels are so positioned that there is a considerable total spread of the streams in a direction laterally of the direction of travel of the objects. The spacers maintain the work-pieces in spaced relation and permit the abrading material to strike the end surfaces of the workpieces.

The pusher mechanism permits manual, semi-automatic or automatic loading of the workpieces into the apparatus and provides positive and controlled advancing movement of the workpieces. The speed of advance of the pusher can be controlled and the speed of retraction can also be controlled independently of the speed of advance. Thus it is possible to provide for a relatively slow advance and rapid return of the pusher head or vice versa. Hence the workpieces may be advanced rapidly and in effect, substantially continuously or they may be advanced step by step and may be halted for considerable periods within the streams. The workpiece is delivered to the inlet vestibule without undue shock, the revolvable head of the pusher being capable of turning while the workpiece is passed from the loading trough onto the inlet vestibule.

Both the inlet and outlet vestibules may be constructed so as to turn at the same speed as the endless flexible member and thus the workpieces are transferred from one to the other of these members without appreciable shock. The inlet vestibule turns the workpiece about and dumps therefrom any core sand or other adherent material and permits the workpiece to enter the abrading stream unencumbered by any such foreign matter. In an analogous manner, the unloading vestibule dumps from the workpiece any abrading material or loosened scale or the like which may tend to adhere to or remain on the workpiece. Either or both of the vestibules preferably are perforated or are formed by an open cage-like construction as by slats and rings in order to permit the dumped core sand, spent abrasive, loosened scale or other debris to fall from the vestibule into the collecting hopper.

The tubular vestibules at the ends of the flexible member provide a revolving chamber of substantial length without necessitating an unduly heavy construction with the consequent advantages of saving in space, weight, power consumption and the like. It will be seen that the loading vestibule, for example, is capable of supporting and rotating the trailing end of a workpiece while the leading end is entering the first abrasive stream. In an analogous manner, the unloading vestibule supports a leading end of a workpiece while the trailing end is still in the stream. Thus it is possible suitably to support even long heavy workpieces without unduly in-

creasing the length of the endless flexible member.

It will be noted that in the present invention the workpieces are turned at all times while in the abrading streams whether they are being advanced or not and thus there is no danger of excessive abrading of the workpieces with the consequent overheating or wearing away of the surfaces of the workpieces.

While certain novel features of the invention have been disclosed herein, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, means for supporting an article in said stream including an endless flexible member, means mounting said endless flexible member to define a generally trough-like supporting surface, means for traveling said member to effect a turning movement of an article supported thereon, and means operable independently of the movement of said endless flexible member for advancing said article therealong.

2. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, and a conveyor for advancing objects to be cleaned through said stream, said conveyor comprising means for supporting objects to be cleaned in said stream and for turning them about in said stream, a loading vestibule cooperating with said supporting means for turning objects about to remove adherent foreign matter and for depositing objects on said supporting means, and means movable independently of the movement of said loading vestibule and said supporting means for advancing objects along said loading vestibule and said supporting means.

3. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, and a conveyor for advancing objects to be cleaned through said stream, said conveyor comprising means for supporting objects to be cleaned in said stream and for turning them about in said stream, an unloading vestibule cooperating with said supporting means for turning objects about to remove adherent foreign matter and for receiving objects on said supporting means, and means movable independently of the movement of said unloading vestibule and said supporting means for advancing objects along said unloading vestibule and said supporting means.

4. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, and a conveyor for advancing objects to be cleaned through said stream, said conveyor comprising means for supporting objects to be cleaned in said stream and for turning them about in said stream, a loading vestibule cooperating with said supporting means at one end thereof for turning articles about to remove adherent foreign matter and for depositing objects on said supporting means, an unloading vestibule at the other end of said supporting means for turning objects about to

remove adherent foreign matter and for receiving articles from said supporting means, and means movable independently of the movement of said vestibules and said supporting means for advancing objects along said loading vestibule and said supporting means.

5. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, and a conveyor for advancing objects to be cleaned through said stream, said conveyor comprising means for supporting objects to be cleaned for movement through said stream and for turning them about in said stream, and means including a reciprocating pusher operating upon an object on said supporting means for advancing the object along said supporting means and through said stream.

6. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, and a conveyor for advancing objects to be cleaned through said stream, said conveyor comprising movable means for supporting objects to be cleaned in said stream and for turning them about in said stream, a pusher, means mounting said pusher for reciprocating movement into engagement with objects on said supporting means to advance said objects therealong independently of the movement of said supporting means, a continuously movable drive member, means periodically engaging said drive member with said pusher for advancing said pusher, and means for retracting said pusher.

7. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, means for conveying objects in a line or file through said stream comprising an endless flexible member, means supporting said endless flexible member whereby a flight thereof defines a generally trough-shaped supporting surface, a rigid tubular vestibule disposed substantially in alignment with said flight of said endless flexible member and having its end supported by and in driven relation with said endless flexible member, means for effecting a traveling movement of said endless flexible member, and means positioned to engage the rearmost object of the line or file and exert an advancing force on substantially the entire line or file for advancing said objects along said vestibule and said supporting surface independently of the traveling movement thereof.

8. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, a centrifugal abrasive projector for projecting a stream of abrading material, means for conveying objects in a line or file through said stream comprising an endless flexible member, means supporting said endless flexible member in inner and outer trough-shaped flights whereby the inner flight defines a generally trough-shaped supporting surface, a rigid tubular vestibule disposed substantially in alignment with the inner flight of said endless flexible member and cooperating therewith to maintain the shape of the inner flight thereof, means for effecting a traveling movement of said endless flexible member and rotation of said tubular vestibule, and means positioned to engage the rearmost object of the line or file and exert an advancing force on substantially the entire line

or file for advancing said objects along said vestibule and said supporting surface independently of the traveling movement thereof.

9. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, means for projecting a plurality of divergent streams of abrading material, said means comprising a plurality of centrifugal abrasive projectors, and means for conveying through said streams objects to be cleaned, said conveying means comprising an endless flexible member, means supporting the same to define a generally upwardly open, trough-shape supporting surface, and means for advancing articles in a generally longitudinal direction along said supporting surface, said abrasive projectors being adapted to hurl against articles on said supporting surface abrasive streams which are elongated in the direction of travel of said articles and at least certain of said abrasive projectors being disposed on opposite sides of the longitudinal center line of said supporting surface inclined in opposite lateral directions whereby the streams hurled thereby extend through said opening and sweep portions of said trough-shaped supporting surface on opposite sides of the longitudinal center line thereof respectively.

10. In abrading apparatus for cleaning metal castings, forgings and the like, in combination, means for projecting a plurality of divergent streams of abrading material, said means comprising a plurality of centrifugal abrasive projectors, and means for conveying objects to be cleaned through said streams, said conveying means comprising an endless flexible member mounted to define a generally upwardly open trough-shape supporting surface, and means for advancing articles in a generally longitudinal direction along said supporting surface, said abrasive projectors being adapted to hurl against articles on said supporting surface abrasive streams which are elongated in the direction of travel of said articles and at least certain of said abrasive projectors being mounted on opposite sides of the longitudinal center line of said supporting surface and inclined in opposite directions whereby their streams are in generally opposed relation longitudinally of the path of movement of the objects and sweep portions of said trough-shaped supporting surface on opposite sides of the longitudinal center line thereof respectively.

11. In apparatus for abrasive cleaning of metal castings, forgings and the like wherein a series of workpieces is advanced along a supporting member and through a fan-like stream of abrading material, a spacer adapted to be disposed for free movement on said supporting member and between two successive workpieces for spacing the same to permit abrading material to impinge against the end surfaces of the successive workpieces, said spacer comprising a unitary, open, frame of rigid construction having two opposite end portions adapted for contact with the opposed ends of the successive workpieces and a side portion intermediate said end portions shaped to engage the supporting surface and maintain said spacer substantially centered with respect to said supporting surface as said spacer is advanced therealong.

12. The method of cleaning metal castings, forgings and the like which comprises, establishing a fan-like stream of abrading material, disposing a plurality of workpieces in a line or file and in force transmitting relation on a sup-

porting surface, applying an advancing force on the endmost workpiece and in the direction of the line or file whereby the force is transmitted through the several workpieces to advance the line or file through said stream, and turning all of the workpieces in the line or file whereby a workpiece in the stream is turned about in the stream to present the several surfaces of the said workpiece to the abrading action of the stream.

10 13. The method of cleaning metal castings, forgings and the like which comprises, establishing a fan-like stream of abrading material, disposing a plurality of workpieces in a line or file on a supporting surface, disposing a rigid spacing member between at least certain of the workpieces in said line or file whereby to space the opposed end surfaces thereof to thereby expose said end surfaces to the abrading action of said stream, applying an advancing force on the endmost workpiece and in the direction of the

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line or file whereby the force is transmitted to the several workpieces to advance the line or file through said stream, and turning all of the workpieces in the line or file whereby a workpiece in the stream is turned about in the stream to present the several surfaces of the said workpiece to the abrading action of the stream.

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14. In abrading apparatus for cleaning metal castings, forgings, and the like, in combination, means for establishing a stream of abrading material, means including a conveyor for advancing articles through said stream and a relatively open spacer disposed between successive articles on said conveyor for spacing said articles to permit said stream to impinge against the adjacent surfaces of said articles; said spacer being adapted for relatively free movement on said conveyor.

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