United States Patent

Wloszek

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[54] APPARATUS FOR SUPPORTING AND ROTATING A CIRCULAR WORKPIECE

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[52] **U.S. Cl.** **51/236**, 51/15

[51] **Int. Cl.** **B24b 41/06**

[58] **Field of Search** 51/7, 15, 236

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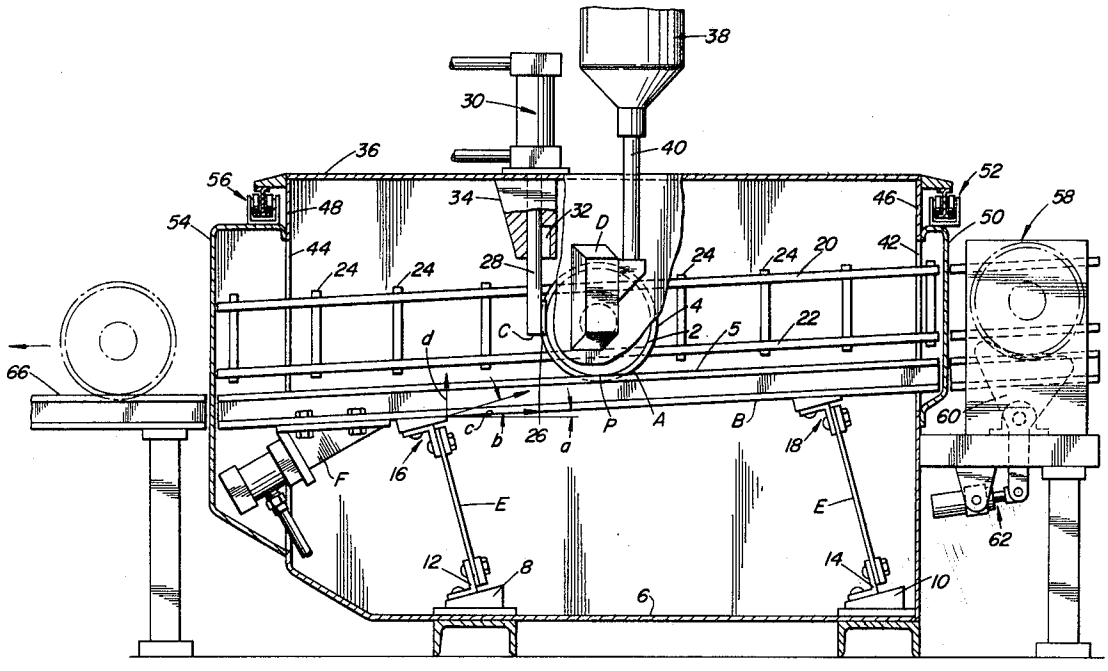
[57] **ABSTRACT**

Apparatus for supporting and rotating cylindrical members while being treated. The member is mounted upright on a rail which slopes downwardly toward the work station. On the downhill side of the work station, there is a stop to hold the wheel at the station until it is fully treated. The rail is vibrated on a line of movement between a vertical line and the uphill slope of the rail so that the member is raised slightly off the rail and away from the stop and then falls back onto the rail and rolls downhill against the stop. Another embodiment uses a mechanism of the slow-work-stroke-and-quick-return type, so that on the uphill stroke of the rail, the member rotates on the rail, whereas on the return stroke, the rail moves fast enough to slide under the member. In another embodiment, the rail is moved longitudinally a distance sufficient to rotate the wheel in its position against the stop through the required arc.

15 Claims, 3 Drawing Figures



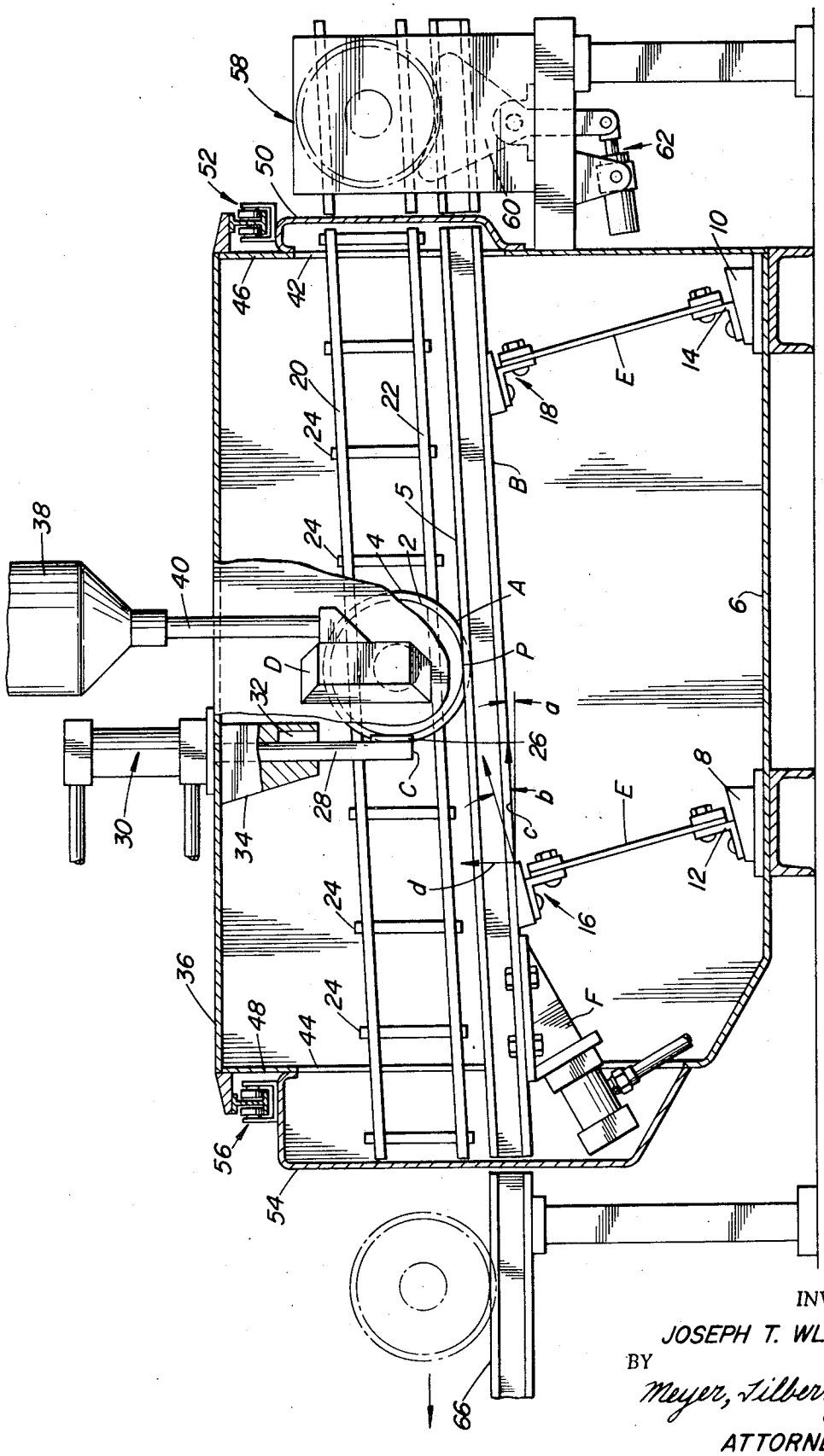


FIG. 1

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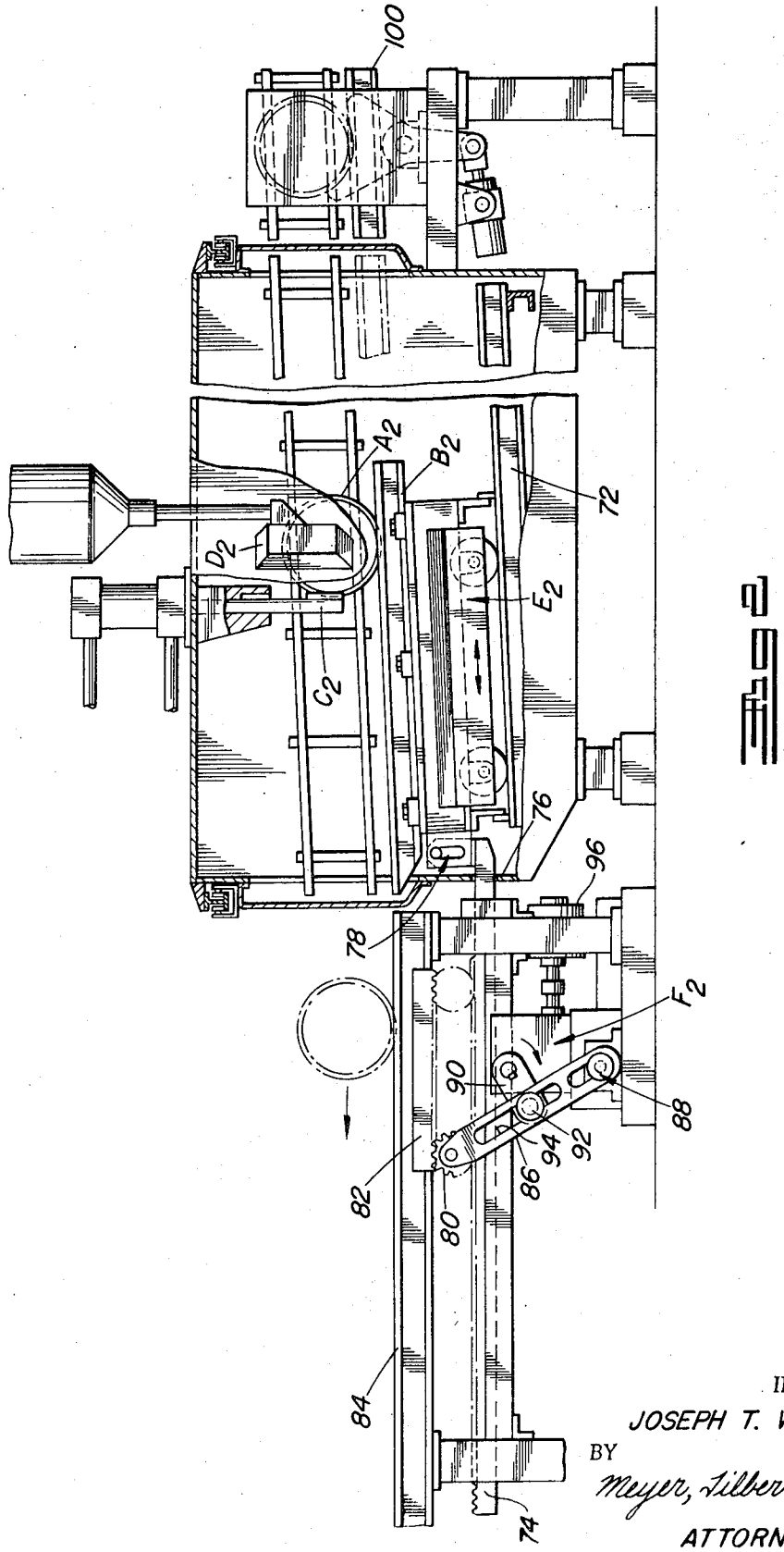

FIG 2

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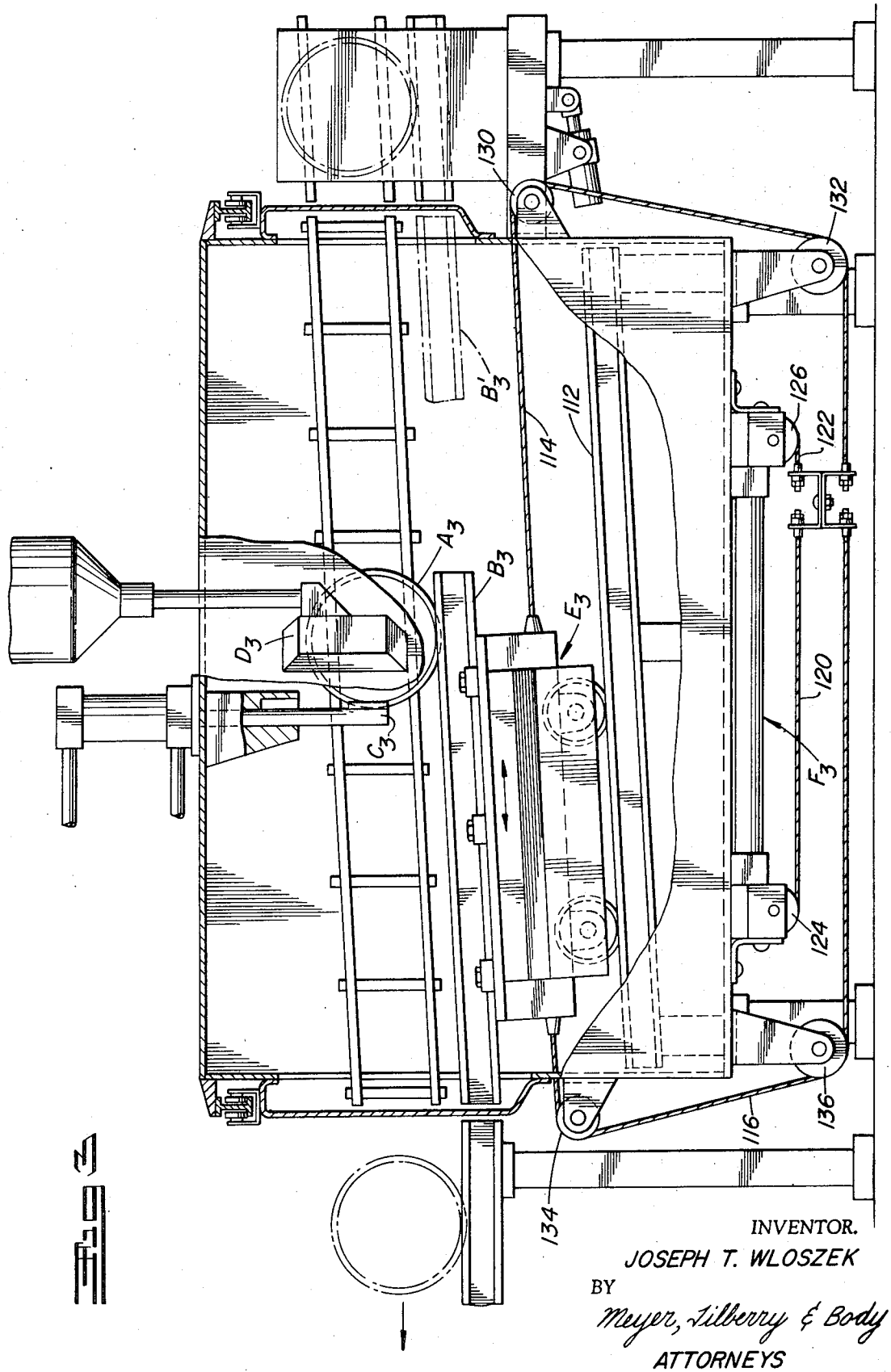

Fig. 3

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APPARATUS FOR SUPPORTING AND ROTATING A CIRCULAR WORKPIECE

The invention lies in the field of rotating a circular workpiece that is to be treated.

The invention is particularly applicable to supporting and rotating a railroad wheel while being shot blasted and will be described with particular reference thereto. However, it will be appreciated that the invention has broader applications such as supporting and rotating any cylindrical workpiece which must be treated by a process which imposes no or a minimum of force on the workpiece opposing rotation.

Prior art devices for turning a wheel during a shotblast treatment have included power driven rollers and the like which are complex and are exposed to the blast to such an extent that the shot causes excessive wear and erosion of the holding and turning mechanism, such that the machine must be shut down for the repair or replacement of working parts. Such shutdown periods occur so frequently as to make the shotblast treatment very expensive.

SUMMARY OF THE INVENTION

In accordance with the invention, an elongated member is positioned on a slope such that a cylindrical untreated workpiece rolls downhill to a stop where it is in position to be treated in combination with means for moving the member in such a way that the workpiece is continuously rotated. In a preferred embodiment, the member is vibrated on a line of movement lying between a vertical line and the uphill slope of the rail. The amplitude and frequency of vibration are such that, considering the inertia of the workpiece, the workpiece on the upward movement of the member will be moved away from the stop and on the downward movement, the member will move away from the workpiece such that the wheel is pulled back to the member momentarily under the force of gravity and then rolls downhill on the member and comes to rest against the stop.

In another embodiment the member is reciprocated on a line of movement parallel to its slope, slowly enough on the uphill stroke that the wheel rotates due to friction and fast enough on the downhill stroke that the member slips under the wheel due to the inertia of the wheel. The amplitude and frequency may be as desired to effect the necessary rotation.

In another embodiment, the member is moved on a line of movement parallel to its length continuously in one direction for a distance such that the wheel is rotated through the desired arc.

Preferably when shot blasting railroad wheels, the member is a used railroad rail which is relatively inexpensive and easily and quickly replaced when it wears out.

It is accordingly an object of this invention to provide for rotating a circular workpiece mechanism which avoids expensive and sophisticated holding and turning devices.

Another object is a support which is inexpensive and can be quickly and easily replaced.

It is a further object of the invention to provide means for turning a workpiece having a circular periphery through substantially 360° to permit treatment of either face, or both faces, or of the peripheral surface, or of all of these, without exposing the holding and turning mechanism unnecessarily to the material treating the wheel such as the erosive effect of the blast of shot in a shotblasting operation.

Other objects and advantages will be apparent to these skilled in the art.

THE DRAWINGS

The invention may take physical form in certain parts and arrangements of parts preferred embodiments of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof and wherein:

FIG. 1 shows an embodiment of the invention as referred to above wherein the wheel supporting rail is vibrated through a relatively short stroke at a relatively high frequency.

FIG. 2 is a view generally similar to that of FIG. 1, but showing another embodiment of the invention.

FIG. 3 is a view also generally similar to that of FIG. 1, but showing still another embodiment of the invention.

DESCRIPTION

Referring now to the drawings wherein the showings are for the purpose of illustrating preferred embodiments of the invention only and not for the purpose of limiting same, the figures show a circular workpiece A mounted on a support in the form of a sloping rail B, a stop C positioned to prevent downhill roll of the wheel away from the work station, a shotblast device D for directing metallic shot upon the wheel, means E mounting supporting rail B for movement, and means F to provide the force to move wheel support B.

Referring now specifically to FIG. 1 for a more detailed description of the embodiment shown in FIG. 1, workpiece A could be any one of a number of workpieces having a periphery with a substantially circular cross section. The workpiece shown in FIG. 1 is intended to be a piece such as a railway car wheel having a flange 4 and a rolling contact surface 2 resting at 7 on the upper surface 5 of the support B which surface slopes downwardly to the left as viewed in FIG. 1 at an angle 'a' with the horizontal. This angle 'a' must be such that the wheel will roll downhill thereon against stop C. 3° is believed to be the minimum. 6°–10° is preferred. The maximum angle will be discussed hereinafter. Means not shown may be provided for varying the angle 'a' within limits.

In the embodiment shown in FIG. 1, the support B is mounted so that it can be vibrated on a short arc or line of movement between a vertical line and the uphill slope of the support surface 5. Preferably this line of movement forms an angle *b* from 10°–15° relative to surface 5. Other angles may be employed.

While various mountings will suffice, in the preferred embodiment the rail B is mounted on a pair of spaced leaf springs E preferably formed of fiberglass. As shown in FIG. 1, leaf springs E are mounted on the basic frame structure 6 by suitable pedestals 8 and 10 to which angle irons 12, 14 respectively are secured by any suitable securing means. The leaf springs E are bolted or otherwise secured to the angle irons so as to be inclined slightly toward the downhill side of the support B, and are secured to support B by suitable angle brackets 16, 18. It will be noted that the angle of the leaf springs E

relative to support B is such that the leaf springs E are not perpendicular to support B. Moreover, the inclination of leaf springs E is on the downhill side of an imaginary line passing through the base support **12** or **14** of the leaf springs E and perpendicular to the support B. Workpiece A is mounted on the rail B in such a way as to lie in substantially a vertical plane. Wheel A can be mounted in any one of a number of ways, but in the embodiment shown a rail B is provided which has a groove in which flange **4** can ride. Wheel A is supported with a slight "lean" away from the plane of the paper of FIG. **1** by a pair of parallel rub rails **20**, **22** having spacer braces **24** secured to the sides.

Unrestrained, wheel A would roll downhill from its treatment station shown in FIG. **1**, and to prevent such downhill roll, the stop C is located on the downhill side of wheel A, here shown as bearing against the rolling contact surface **2**. Stop C preferably includes any suitable physical block of metal such as the pad shown at **26**. The rod forming part of the stop member C is an extension of a piston rod **28** of a pneumatic operating cylinder **30** which has an operating stroke long enough to pull the stop C and its pad **26** up into a recess **32** provided in the mounting boss **34** on the underside of upper frame member **36**, pneumatic cylinder **30** being mounted on the top side of upper frame **36** and in alignment with the mounting boss **34**.

The shotblast mechanism per se forms no part of this invention, and it will suffice to point out that the shotblast gun or nozzle D receives shot pellets from a hopper **38** through a suitable duct or conduit **40**.

Reference is made above to basic frame structures **6** and **36**; these form part of a housing which surrounds the treatment area to shield personnel and other items of equipment from stray shot pellets which might emanate from the work area. The housing thus constituted is provided with openings **42** and **44** in its uphill and downhill end walls **46** and **48** respectively. The opening **42** is adapted to be closed by a sliding door **50** mounted on a suitable track indicated generally at **52**, while the opening **44** is closeable by a door **54** mounted on a suitable track indicated generally at **56**.

Just outside the sliding door **50**, there is disposed a station **58** for untreated wheels to be held in readiness for admission to the treatment space as soon as that space is cleared of a piece on which treatment has been completed. A retainer element **60** is shown as being in engagement with the untreated wheel waiting in the station **58**, and retainer **60** is connected for movement by a suitable indexing device indicated generally at **62** and actuable to release the untreated wheel in the station **58** so that it may roll downhill onto rail B and against stop C. Meanwhile, the treated wheel A has rolled out of the treatment space by retraction of the stop mechanism into the recess **32**, treated wheel A rolling downhill along the rail B, out through the opening **44** with sliding door **54** having been previously moved aside. The completed wheel rolls onto an exit rail shown at **66** and to an assembly or collection point.

Movement of supporting rail B must be such that the point of contact P of surface **2** on surface **5** will first rise slightly, i.e., lift away from the ground and on a line of movement between the vertical and the uphill slope of surface **5** and then downwardly along the same or another path. In the embodiment shown contact point P moves on a short arcuate path.

In accordance with the invention the amplitude and frequency (and wave shape if the velocity of movement is other than a sine wave) of the movement of rail B are such that taking into account the angle 'a' and angle 'b', the wheel on he upward movement of the rail B, will be both: driven in a counterclockwise direction by the friction of the surface **5** on surface **2**; and, due to the inertia of the wheel against being rotated, away from the stop C. On the downward movement of the rail, the acceleration of the surface **5** in a downward direction must exceed, at least momentarily, the acceleration of gravity, i.e. 32.2 feet per second per second. As such the surface **2** will be spaced, at least momentarily, from surface **5** and the wheel spaced from stop C, falls vertically into engagement with surface **5** and then still under the force of gravity rolls downhill due to the slope of surface **5** until it again strikes stop C. The process is then repeated. While the arc of rotation on each cycle is relatively small, the net result is that the wheel A continuously rotates in a counterclockwise direction.

The downward acceleration is a function of frequency and amplitude of the movement and the shape of the velocity curve. In any event in the embodiment shown the wheel rotates at a speed which is a function of the frequency and amplitude of vibration and the angles a and b. A sine wave movement at a frequency of 500 to 2,000 cycles per second and an amplitude of 0.002 to .010 inches are preferred.

Angle 'a' must be great enough so that the wheel will roll downhill considering rolling friction and/or dirt on the surface **5**. 3° is considered minimum. However as angle 'a' is increased, the wheel exerts a greater and greater force on stop C such that more and more power is required to drive it away from stop C. 20° is considered to be the maximum for angle 'a' for effective operation. Also as the angle 'a' is increased, the weight of the wheel supported on surface **5** goes down and thus the frictional force which can be developed by the movement of surface **5** in its plane goes down.

Angle b determines the line of force of the surface **5** on surface **2**. It may be divided into two components, component C parallel to the surface **5** and component *d* which is vertical. On the upward movement of surface **5** component *d* raises the wheel against gravity while component C acting through friction on surface **2** drives the wheel in a counterclockwise direction and because of the inertia of the wheel, drives it away from stop C. Angle *b* may vary from something other than vertical to angle *a*. Preferably angle *b* is such that the line of movement bisects this included angle. Thus if angle *a* is 10°, angle *b* will be 40°.

The means for moving the rail B may take a number of different forms but in the preferred embodiment is a commercially available power vibrator having a variable frequency and amplitude.

Thus the vibrator device shown at F in FIG. **1** can operate on any of a number of different principles, such as an impact device. The angle of the force provided by the device F is preferably directed at the support B in such a way that it will fall somewhere between the vertical and the uphill slope of rail B. An angle of approximately 45° from the vertical is preferred.

By varying the frequency and amplitude of the movement and/or the angle a the rate of rotation can be readily controlled.

In the embodiment of the invention shown in FIG. 2, the workpiece A_2 is shown as resting on a support B_2, support B_2 in this case being mounted on a carriage E_2. Carriage E_2 is mounted to travel on one or more rails 72 mounted to be parallel to the rail forming the support B_2. Carriage E_2 is reciprocated by mechanism shown generally at F_2, and to that end, the left end of carriage E_2 has secured thereto a rack 74 extending through an opening in the end wall 76 of the enclosure for the treatment device. Because rack 74 reciprocates substantially on a horizontal line, and carriage E_2 travels at a slope relative to the horizontal, the right end of rack 74 is connected with the left end of carriage E_2 by a suitable pin and slot connection indicated generally at 78, the pin being carried by rack 74.

Rack 74 is engaged by a pinion 80 which also engages a stationary rack 82 secured to a receiving rail 84 for finished work-pieces.

Pinion 80 is mounted on an arm 86, arm 86 having a pin and slot connection indicated generally at 88 to provide a fixed pivot for the arm 86, the slotted connection being necessary because of the outer end of arm 86 being limited in its movement by the engagement of pinion 80 with the stationary rack 82. Arm 86 has another pin and slot connection with a crank 90, the pin being provided at 92 in crank 90 to cooperate with a slot 94 in arm 86. Crank 90 is connected to be rotated through any suitable gear train by an electric motor 96, the geometry of the drive being such that clockwise rotation of crank 90 as seen in FIG. 2 moves carriage E_2 to the right sufficiently slowly to rotate workpiece A_2 on the rolling surface of support B_2, rather than sliding the workpiece A_2 on the surface of support B_2. On the return stroke, carriage E_2 moves much more quickly and, in fact, moves rapidly enough to slide the support B_2 under the workpiece A_2 so that a succession of such strokes rotates the workpiece through the required angle necessary to expose the entire workpiece to the shot pellets which emanate from the gun D_2.

The other features of the embodiment shown in FIG. 2 will be similar to or the same as the corresponding elements shown in FIG. 1 and described above, including the means at the right side of FIG. 2 for holding an untreated workpiece in readiness. A difference between the two embodiments of FIGS. 1 and 2 which will be apparent is the fact that the stroke through which the support B of FIG. 1 vibrates is very short, being of the order of magnitude of a view thousandths of an inch, while the stroke through which the support B_2 moves in the FIG. 2 embodiment is substantial, being of the order of magnitude of several inches, this value being one which can vary. Nevertheless, because the stroke is substantial, means are provided in the mechanism for driving the arm 86 such that the arm 86 can be shut down for discharge of a finished workpiece with the carriage E_2 sufficiently close to the receiving rail 84 to permit the workpiece A_2 after it is finished to move between the left end of support B_2 and receiving rail 84. This leaves a gap between the right end of support B_2 and the rail shown at 100 on which an untreated workpiece rests while it awaits release to be admitted into the treatment space. The mechanism is provided with a slow motion rotation drive for crank 90 such that the carriage can be moved very slowly to its extreme position as seen in FIG. 2 and can be stopped by the operator in sufficiently close proximity to the left end of rail 100 to allow transfer of the untreated workpiece from that rail to the support B_2, with the untreated workpiece then rolling downhill into engagement with the stop C_2 while the crank 90 returns itself and carriage E_2 back to the starting point, whereupon the treatment cycle begins again. Alternatively, rails 84 and 100 can be provided with telescoping extensions capable of reaching movable rail B_2 whenever it may have stopped, for the movement of workpiece A_2 onto and off rail B_2 as necessary.

Passing now to a consideration of the embodiment shown in FIG. 3, workpiece A_3 is there shown as resting on a support B_3, support B_3 being a rail mounted on a carriage indicated generally at E_3 which is adapted to move along a slope provided by one or more rails 112. Carriage E_3 is connected by cables 114 and 116 with a traversing cylinder indicated generally at F_3. Traversing cylinder F_3 is one of a type having cables 120 and 122 passing around pulleys 124 and 126 respectively, and passing through suitably packed ends in the cylinder element of device F_3. Cables 120 and 122 are suitably coated, as with a substance known commercially as Teflon, providing the cables with a surface that is smooth enough and consistent enough to permit packing of the openings through which the cables pass. Devices of this type are commercially available, and an example is such a device furnished for industry by the manufacturer known as Tol-O-Matic, Inc., at 246 Tenth Avenue South, Minneapolis, Minnesota 55415.

Cables 114 and 116 are threaded over numerous pulleys 130, 132, 134, and 136. The stroke of the actuating device F_3 is such that the carriage E_3 moves support B_3 through a distance that is great enough to rotate the workpiece A_3 through the arc required for treatment of the entire circle which makes up the workpiece A_3. It will, of course, be apparent to those skilled in the art that the working stroke of support B_3 will very according to the size of the workpiece A_3. It will,

The rail B, B_2, B_3 to support wheel A, A_2, A_3 is an important part of the invention. Pieces of rail too worn for normal road use are available at bargain prices, and such rails are ideally suited to the role of wheel support in this invention. The rails can be mounted for easy and quick replacement when too worn for further use, whereupon they still have the usual scrap value.

OPERATION

Referring to the embodiment shown in FIG. 1, the vibrator device F which applies the vibrating force to support B operates at a relatively high frequency, on the order of magnitude of 1500 to 2000 cycles per minute. The direction of the force, is such that workpiece A is lifted a very short distance from its support B, and tends to drop back onto support B while rolling counterclockwise as seen in FIG. 1. As the workpiece A rotates, it is subjected to a blast of shot from the gun or nozzle B throughout its entire 360° arc, and when the treatment is completed, the workpiece is permitted to roll downhill to the receiving rail 66, whereupon an untreated workpiece is discharged from the waiting station 58, rolling into the treatment station and held there by the stop C.

In the embodiment shown in FIG. 2, the support B_2 moves through a perceptible stroke, which is of the order of magnitude of several inches, such as a 6 inch stroke. The device for moving the support B_2 and the carriage E_2 is such that support B_2 moves uphill or to the right as seen in FIG. 2 at a relatively slow speed, namely slow enough so that workpiece A_2 by virtue of its frictional engagement on its support B_2 is rotated in a counterclockwise direction. However, when the crank 90 rotates through the return portion of the stroke, the geometry of the drive is such that movement of support B_2 from its right extremity to the left as seen in FIG. 2 is quite rapid, sufficiently rapid to exceed the inertia of the workpiece thus the support B_2 slides under the workpiece A_2. A succession of such strokes serves to rotate the workpiece A_2 while it is being shot-blasted.

In the embodiment shown in FIG. 3, the working cycle begins with the support B_3 and carriage E_3 at the extreme right end of its travel, that position being shown in phantom in FIG. 3 at B'3. With the support in the position shown in phantom lines, the sliding door at the right end is opened and the untreated workpiece is released from the waiting station, rolling off the rail in the waiting station and into the treatment area onto the supporting rail B_3, as it rests in the position shown in sold lines, held in place on the support by stop mechanism C_3. With both end doors closed, the shot-blasting treatment is started, and movement of carriage E_3 to the left is begun by energization of the actuator F_3. As support B_3 moves slowly to the left, it moves under the rotating workpiece A_3 which is continuously subjected to the blast of metallic shot coming from the nozzle B_3 as wheel A_3 rotates clockwise. The length of the working stroke is such that the wheel rotates through a sufficient arc to permit shotblasting of the full circle made up by the wheel A_3. At the end of the working stroke, the workpiece A_3 has been treated throughout its circular span, and the support B_3 comes to rest in the position shown in solid lines in FIG. 3, whereupon the sliding door at the left end is opened, stop C_3 is moved out of the way, and the fully treated workpiece A_3 rolls downhill, out of the treatment space, and onto the receiving rail, and the cycle starts over again.

The invention has been described with reference to three preferred embodiments. Obviously, modifications and alterations will occur to others upon the reading and understanding of this specification. As an example, it may be pointed out that support B_2 in FIG. 2 may be moved quickly to the right so as to slide under wheel A_2, and then more slowly to the left to rotate the wheel. It is my intention to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalence thereof.

What is claimed is:

1. Mechanism to rotate a workpiece having a circular periphery, comprising a sloping surface in contact with the workpiece at a point on the bottom portion of said periphery, a stop adapted to prevent downhill roll of the workpiece on said surface in contact with the downhill side of said workpiece at a second point located on a peripheral arc extending from the middle to the bottom of the workpiece, and means to reciprocate the sloping surface in a direction having at least a component parallel to said surface.

2. Mechanism as in claim 1, wherein said surface has a slope of from 3°–20°, and means to render ineffective said means.

3. Mechanism as in claim 1, wherein said surface is supported for movement on a line of movement extending between the vertical and the uphill slope of said surface and means to apply a vibratory force to the surface sufficient to move said workpiece away from said stop in one direction of movement and to move said surface downwardly away from said bottom point of contact in the other direction of movement.

4. Mechanism as in claim 1, wherein the reciprocating means moves the support in one direction at a speed slow enough to roll the workpiece on the surface and moves the surface in the opposite direction at a speed fast enough to slide the surface relative to the workpiece.

5. Mechanism as in claim 1, wherein the surface reciprocating means includes means to move the surface a distance at least equal to the circumference of the workpiece periphery.

6. In a device to support and rotate a workpiece having a circular periphery at a work station, the improvement comprising an elongated workpiece supporting surface sloping downwardly from a loading station to the work station and in contact with the workpiece at a point on the bottom portion of said periphery, stop means to hold the piece at said work station in contact with the downhill side of said workpiece at a second point located on a peripheral arc extending from the middle to the bottom of the workpiece, and means to move the surface relative to the workpiece on a line of movement and at velocities and amplitudes sufficient to rotate the workpiece.

7. A device as in claim 6, wherein said stop means includes a removable stop member preventing downhill roll of the workpiece.

8. A device as in claim 6, wherein the workpiece support surface is on a linear element mounted for vibration on a line of movement between the vertical and the uphill slope of said surface.

9. Mechanism as in claim 1, wherein the workpiece support means is a linear element mounted for reciprocation parallel to said surface.

10. Mechanism as in claim 1, wherein said reciprocating means includes at least one leaf spring secured to said workpiece support means at such an angle that as said spring is flexed said support moves on a line of movement between the vertical and its uphill slope and means to apply a vibratory force to the piece support means of an amplitude and frequency as to move said workpiece upwardly and away from said stop means and said workpiece surface away from said workpiece periphery whereby said workpiece drops to said surface under the force of gravity and rolls to said stop means.

11. Mechanism to rotate a cylindrical workpiece having a circular periphery through a desired arc comprising an elongated supporting member in contact with the workpiece at a point on the bottom portion of said periphery, means to support the member on a slope, stop means to hold the workpiece against downhill roll on the member in contact with the

downhill side of said workpiece at a second point located on a peripheral arc extending from the middle to the bottom of the workpiece, and means to reciprocate the member in one direction in rolling contact with the workpiece and in the opposite direction without reversing the direction of rotation of the workpiece.

12. Mechanism as in claim 11, wherein the member reciprocating means comprises a vibrating device operating at a frequency and amplitude such that said workpiece is periodically moved away from said stop means and said member.

13. Mechanism as in claim 11, wherein the member reciprocating means has a stroke of at least several inches and moves the member in one direction of a complete cycle in rolling contact with the workpiece and in the opposite direction of the cycle in sliding contact with the workpiece.

14. Mechanism as in claim 11, wherein the member reciprocating means is in rolling contact with the workpiece throughout one direction of reciprocation of the cycle and rotates the workpiece through the desired arc in one continuous movement.

15. Mechanism of claim 12 wherein the device has a frequency of from 500 – 2,000 cycles per second and an amplitude of from 0.002 to 0.010 inches.

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