Oct. 30, 1951 R. G. RIEDESEL ET AL 2,573,220

ABRADING THE INTERIOR SURFACE OF HOLLOW WARE

Filed May 31, 1947 2 SHEETS—SHEET 1

A

Fig. 1

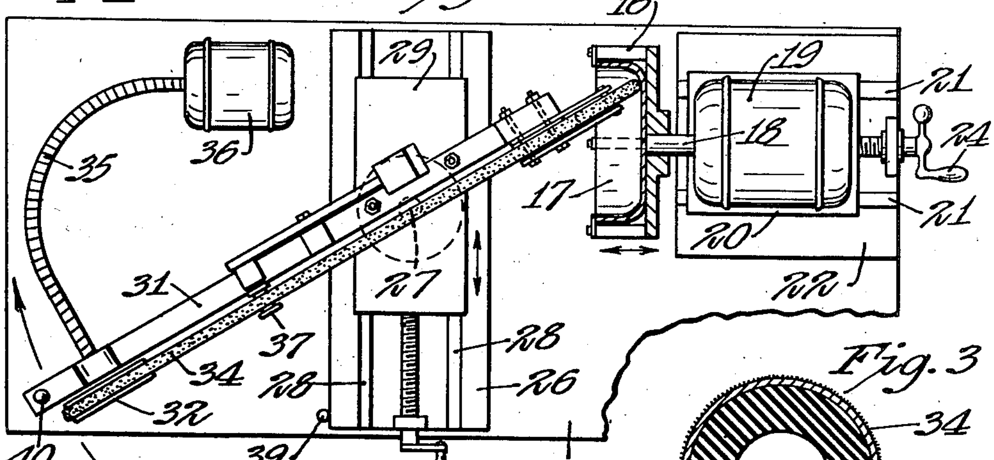


Fig. 3

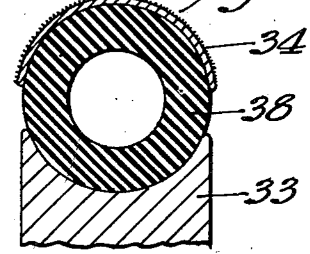


Fig. 2

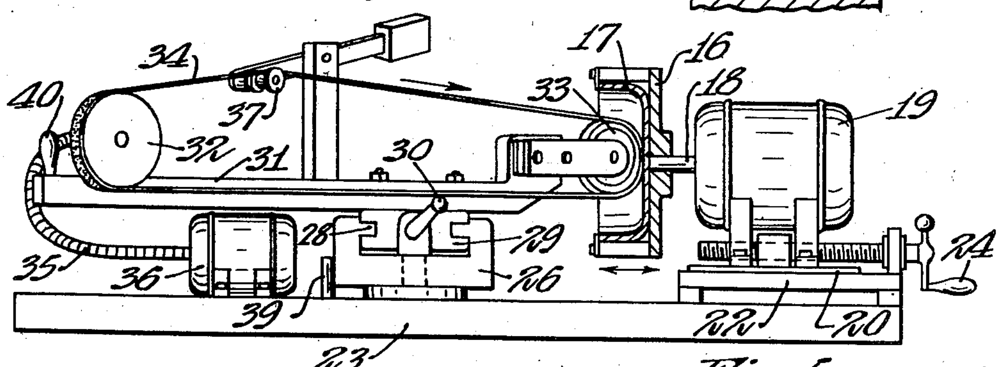


Fig. 4

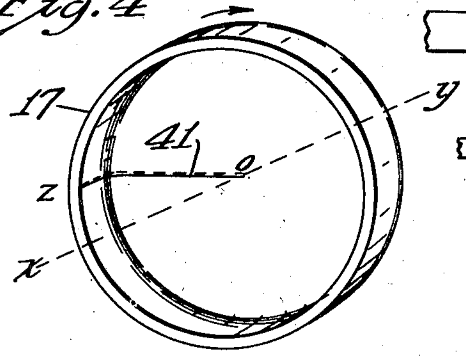
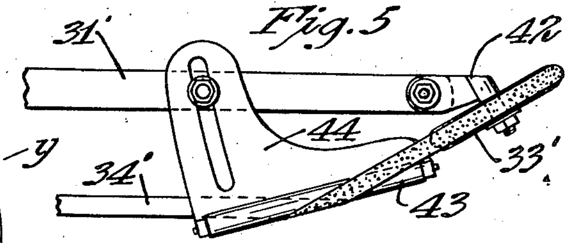


Fig. 5



Inventors
Richard G. Riedesel
Lawrence A. Martin

By Carpenter, Abbott, Coulter & Kinney
Attorneys

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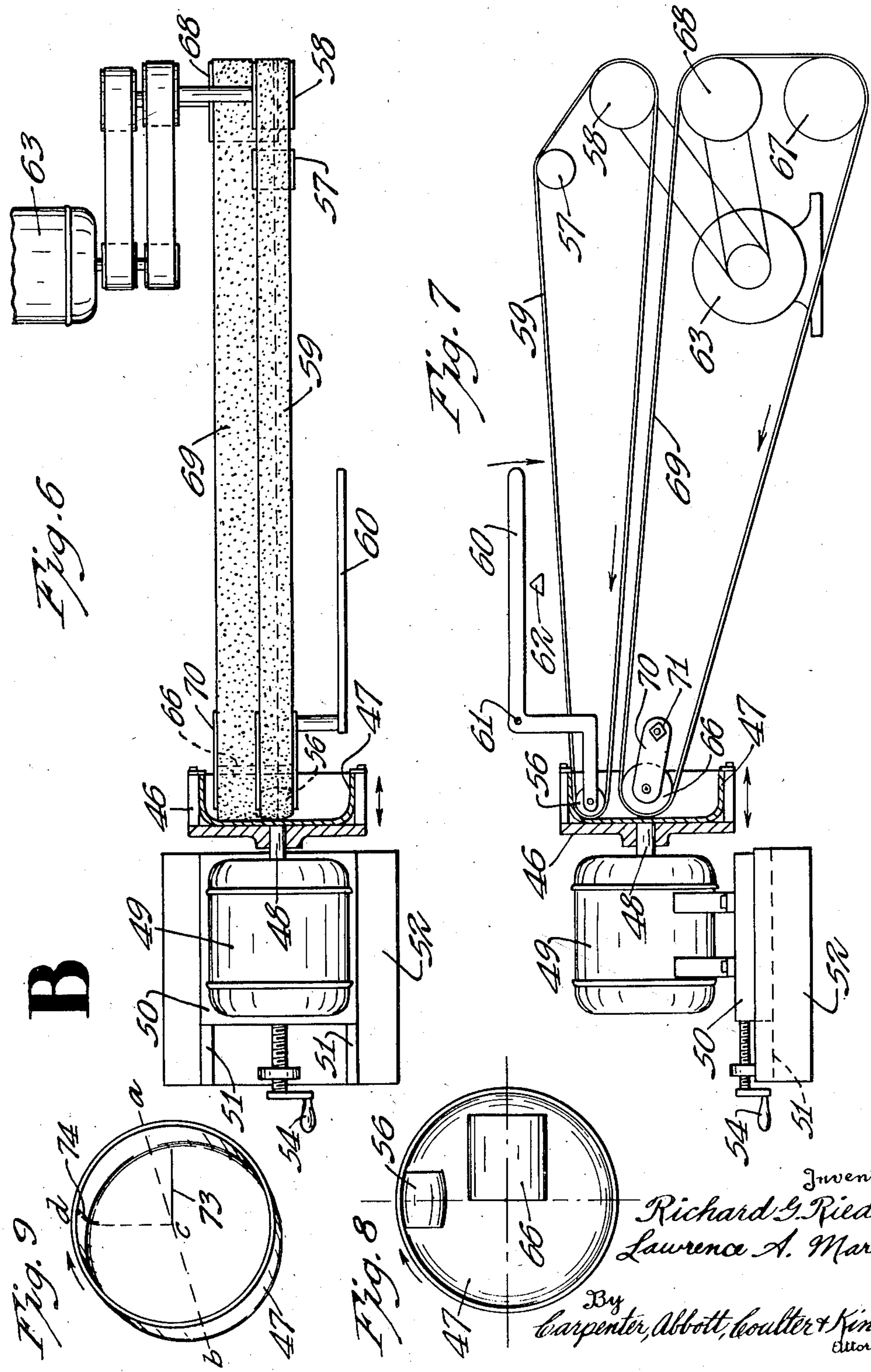
ABRADING THE INTERIOR SURFACE OF HOLLOW WARE

Filed May 31, 1947 2 SHEETS—SHEET 2



Inventors
Richard G. Riedesel
Lawrence A. Martin
By
Carpenter, Abbott, Coulter & Kinney
Attorneys

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UNITED STATES PATENT OFFICE

2,573,220

ABRADING THE INTERIOR SURFACES OF HOLLOW WARE

Richard G. Riedesel, St. Paul, and Lawrence A. Martin, White Bear, Minn., assignors to Minnesota Mining & Manufacturing Company, St. Paul, Minn., a corporation of Delaware

Application May 31, 1947, Serial No. 751,590

5 Claims. (Cl. 51—147)

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This invention relates to abrading, grinding and/or polishing the interior surfaces of hollow ware such, for example, as aluminum cookers, pans, kettles, etc., also vats, tanks and the like.

Methods previously used have been principally hand operations; and the few machines that have been tried have been crude and inadequate, necessitating much hand labor. All of the said methods and machines heretofore known have had numerous defects, including particularly the inability to produce true surfaces. The provision of means and methods for the production of such interior surfaces is accordingly one of the objectives of this invention.

The invention provides a method wherein a piece of hollow ware is rotated about its axis and a rotating abrasive wheel is thrust into the cavity into contact with the interior surface and then moved along a path complementary thereto.

In another aspect, the invention provides a method wherein a second rotating wheel, in addition to the first, is thrust into the cavity into contact with the surface. The second wheel may be held against the surface without movement other than its own rotation and the rotation of the surface.

The invention also provides novel apparatus for the performance of these operations, comprising a chuck mounted for axial movement and a rotatable abrasive element in front of the chuck mounted for transverse movement.

In the illustrated embodiments the abrasive wheels are in the form of pulleys or rolls carrying on their peripheries endless abrasive belts.

Illustrative embodiments are hereinafter described and are diagrammatically illustrated in the accompanying drawings in which:

Figures 1 and 2 are plan and side elevational views, respectively, of a single roll grinder (sometimes referred to herein as "machine A");

Figure 3 is an axial section of a portion of the contact roll or wheel;

Figure 4 is a perspective view of a pan;

Figure 5 is a plan view of an alternative form of belt supporting arm;

Figures 6 and 7 are plan and side elevational views, respectively, of a double roll grinder (sometimes referred to herein as "machine B");

Figure 8 is a front elevation of a pan and the contact wheels or rolls; and

Figure 9 is a perspective view of a pan.

A. *Single roll grinder*

Referring to Figures 1 to 5, a chuck 16 adapted to hold the workpiece that is to be abraded, such as the pan 17, is fixed on the shaft 18 of a motor 19. The motor is on a table 20 which is slidably mounted in ways 21 in a rack 22 that is fixed to a platform 23. This construction, together with the feed screw assembly 24, provides means for effecting reciprocal axial movement of the chuck, that is, reciprocal movement in the direction of the chuck's axis, as indicated by the arrows.

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A second rack 26 is pivotally mounted in front of the chuck on the platform 23 for rotation about the point 27 in a plane parallel with the chuck's axis. The rack 26 has ways 28 which slidably support a table 29, and a feed screw assembly 30 is provided to effect reciprocal movement of the table in the rack in a plane parallel with the chuck's axis.

A horizontal arm 31 is fixed to the table 29, with pulleys 32 and 33 rotatably mounted at either end to support an endless abrasive belt 34. The belt is driven by the pulley 32 which is rotated through a flexible power shaft 35 that leads from the motor 36. Belt tension is adjusted by an idler pulley 37. The pulley 33 serves as a contact wheel or roll for pressing the belt 34 into contact with the work. Its periphery is formed of a rubber tire 38 around which the belt 34 passes and which provides a cushioned back-up and pressing means. The wheel 33 is thus, in effect, an "abrasive surfaced wheel."

A pin or stop 39 is placed at a point such that when the rack 26 bears against it in response to a counter-clockwise rotating impulse, the ways 28 will occupy the directional position that is desired during an abrading operation, which, in the illustrated embodiment, is approximately parallel with the planar area of the surface being abraded, i. e., with the bottom of the inside of the pan 17 as it is held in the chuck 16. The arm 31 is positioned on the table 29 at an angle such that when the ways 28 are in the said operating position, the wheel 33 extends towards the chuck 16 to a point close to its face so as to extend into the interior of the pan 17 when the latter is held in the chuck. The centers of the wheel 33 and the chuck 16 are at approximately the same level.

From the above, it will be clear that the rotation of the arm 31 about the point 27 as well as its transverse movement in the ways 28, is in a plane determined by the chuck's axis, so that the entire transverse movement of the wheel 33 is also within the said plane.

In operation, the pan 17 is centered in the chuck 16 and fixed therein with its concave surface that is to be abraded, facing outwardly. The arm 31 is swung or turned about the pivot point

27 clockwise to the limit of its movement in that direction, i. e., until the rack 26 bears against the stop 39. The crank 30 is then turned until the point of contact of the wheel 33 is opposite the center of the pan. The motor 36 is started, driving the abrasive belt 34 in the direction shown by the arrow in Figure 2; the motor 19 is started, rotating the pan 17 clockwise as shown by the arrow in Figure 4; and the crank 24 is then turned to move the chuck assembly toward the belt assembly until the abrasive surfaced wheel 33 extends into the spinning pan and contacts the bottom surface of the inside of the pan so as to abrade it.

Upon contact of the wheel 33 with the center of the pan, the crank 30 is turned so as to move the table 29 and with it the belt assembly along the ways 28 in a direction away from the crank. This causes transverse movement of the wheel 33 across the surface of the pan from the center towards the edge, the point of contact describing a path that lies approximately in a plane determined by the axis of the pan, the said path being indicated by the dotted line *oz* in Figure 4. At the same time the wheel 33 is caused to continue to bear against the pan by holding the rack 26 against the stop 39. This is effected by manual pressure on the handle 40 in a direction to impel the belt assembly clockwise about the point 27.

When the wheel 33 has completed its straight line course across the flat or planar portion of the bottom of the pan and has reached the position shown in Figure 1, the turning of the crank 30 is stopped. The crank 24 is then turned so as to draw the pan back in a direction away from the wheel 33 and at the same time the manual pressure on the handle 40 is reversed so as to impel the belt assembly counterclockwise thereby causing the wheel 33 to bear laterally against the side of the pan and to follow its contour to the edge of the pan as indicated by the line *oz* in Figure 4.

The entire inside surface of the pan will then have been abraded.

Referring to Figure 4, the geometrical axis of the pan is represented by the dotted line *xy* which is, at the same time, the axis of rotation of the pan and of the chuck 16. The dotted line *oz* is complementary to an axial section of the inside surface of the pan and lies in a plane that is determined by the said axis.

In the above described operation of machine A, the path of the point of contact of the wheel 33 is the line *oz*, although in practice it is frequently desirable for the line to be slightly above or below *oz*. This is true particularly where, as in the described machine, the abrasion is by a belt carried by the periphery of the contact wheel, as contrasted with abrading by a solid abrasive wheel. In the described machine, if the pan rotates clockwise, the preferred path of the point of abrading contact is along a line slightly below the line *oz*, as indicated by the solid line 41. The two lines, however, are in practice interchangeable and are so very close together that, for the purposes of this invention as defined in the claims, they are regarded as equivalents and are both embraced in the phrase "a path complementary to an axial section of the surface" and in the phrase "in a plane that is determined by the axis of rotation of the surface," as those phrases are used herein.

There are numerous other variables in both the method and the apparatus, all of which are contemplated as coming within the scope of the claimed invention.

For example, the periphery of the contact roll or wheel 33, here shown as semi-circular in cross section, may be of other shapes in cross section, such as oval, pointed, etc., to suit the contour of the concave surface being abraded, the flexibility of the belt, etc. The periphery may be hard and rigid, although it is preferably of a resilient material such as solid or sponge rubber, either natural or synthetic. Synthetic rubber for example, is desirable when oil is being used as an abrading lubricant. The periphery may be in the form of a tire which is solid, or which has an interior bore as shown in Figure 3. The tire may be made of a length of rubber hose.

Sizes of the wheel 33 and the tire 38 may vary widely, depending primarily upon the size and shape of the concave surface being abraded. For example, wheels have been used in machine A having outside diameters of 2⅜'', 2½'', 2⅝'', 3¾'' and 4'', for example. On these the diameters of the tires were ¼'', ⅜'', 9/16'', ⅝'' and ⅞'', respectively; the walls 1/16'', ⅛'', 3/16'', 3/16'' and ¼'', respectively; and the bores ⅛'', ⅛'', 3/16'', ¼'' and ⅜'', respectively.

Widths of the belt may vary, a preferred width being such as to cover the periphery of the contact wheel approximately in the proportion shown in Figure 3. The belt length may also vary. For example, one model of machine A accommodates a belt length averaging 110 inches.

It is not always necessary to employ the sliding table 29. It is used in the above described operation to provide the transverse movement of the wheel 33 across the flat portion of the bottom of the pan 17, but where the bottom of a vessel is curved or rounded, the transverse movement of the wheel 33 outwardly from the center of the vessel towards its edge, may be secured by the rotary or pivotal movement of the arm 31 about the point 27 without using the slide 29 at all.

A form of belt supporting arm that is particularly useful for thrusting the contact wheel into vessels that are relatively deep in proportion to their diameter, is shown in Figure 5. The wheel 33' is positioned at an angle in respect to the arm by being rotatably mounted on an adjustable bracket 42, the course of the belt 34' which is normally parallel with its supporting arm 31', being turned or deflected toward the wheel and into alignment therewith, by two elongate cylindrical deflecting members 43 which are held at an angle to the arm by adjustable brackets 44. In such a construction, the belt is "inside out" except for the portion of it that passes over the deflectors 43 and the contact wheel 33'. The pulley that supports the other end of the belt may accordingly be rubber surfaced to accommodate the abrasive surface of the belt. However, the length of the belt flights usually permits a single half turn of the belt in each flight so that the belt is again abrasive side out when it passes over the said pulley at the other end, in which case an ordinary belt pulley may be used. The plan view of Figure 5 shows the upper flight of the belt, the upper bracket 44 and the upper deflector 43. The corresponding lower flight, lower bracket and lower deflector are the same and are directly below them, respectively. The deflecting members 43 may be smooth round fixed rods, as shown, or they may be rotatable sleeves or rollers. Alternatively, the edges of the brackets 44 may be rounded so as to function as deflecting members. The inside surfaces of vessels 10" high with diameters that taper from 5½" at the top to 4½" at the bottom, have been abraded on machine A using the belt supporting arm of Figure 5.

B. *Double roll grinder*

Referring now to Figures 6 to 9, a chuck 46 adapted to hold the workpiece that is to be abraded, such as the pan 47, is fixed on the shaft 48 of a motor 49. The motor is on a table 50 which is slidably mounted in ways 51 in a rack 52. This construction, together with the feed screw assembly 54, provides means for reciprocal axial movement of the chuck, that is, reciprocal movement in the direction of the chuck's axis, as indicated by the arrows.

An abrasive belt assembly, comprising rotatably mounted pulleys 56, 57 and 58 which carry an endless abrasive belt 59, is positioned in front of the chuck 46 with the pulley 56 adjacent the face of the chuck so as to extend into the interior of the pan 47 when the latter is held in the chuck. The pulley 56 has a resilient periphery and serves as a contact wheel or roll for pressing the belt 59 into contact with the work. The belt passes around the wheel's periphery so that the wheel 56 is, in effect, an "abrasive surfaced wheel."

The wheel 56 is rotatably mounted on the end of an arm or lever 60 which pivots around a shaft 61 in a plane determined by the chuck's axis. Downward movement of the lever, as indicated by the arrow in Figure 7, which is limited by the stop 62, raises the wheel 56 to bear upwardly against the inner surface of the side of the pan 47. The belt 59 is driven by the pulley 58 which is rotated by a motor 63.

Below the belt 59 is a second abrasive belt assembly comprising rotatably mounted pulleys 66, 67 and 68 which carry an endless abrasive belt 69, positioned with the pulley or roll 66 adjacent the face of the chuck 46 so as to extend into the interior of the pan 47 when the latter is held in the chuck. The roll or pulley 66 has a resilient periphery and serves as a contact wheel or roll for pressing the belt 69 into contact with the work, and is, in effect, an "abrasive surfaced wheel." The roll 66 is rotatably mounted on an adjustable arm 70. The arm is pivotally supported to permit positional adjustment (up and down) of the roll 66, a nut 71 being provided to lock the arm in desired position. The belt 69 is driven by the pulley 68 which is rotated by the motor 63.

In operation, the pan 47 is centered in the chuck 46 and fixed therein with its concave surface that is to be abraded, facing outwardly. The stop 62 is then adjusted so that when the lever 60 bears down against it, the periphery of the contact roll 56 will contact the inside edge of the pan, as indicated in Figure 8. The nut 71 is loosened, the arm 70 is raised or lowered until the center of the roll 66 is on a level with the center of the pan, and the nut 71 is then tightened.

The motor 63 is started, driving the abrasive belts 59 and 69 in the direction of the arrows in Figure 7; the motor 49 is started, rotating the pan 47 clockwise as shown in Figures 8 and 9; and the crank 54 is then turned to advance the chuck assembly toward the belt assemblies.

When the edge of the spinning pan comes within reach of the wheel 56, the lever 60 is held (manually) downwardly against the stop 62, and a downward pressure is maintained while the chuck advances, thereby continuously pressing the wheel 56 upwardly against the inside side of the pan. The said manual pressure, however, should be yieldable, so that as the chuck advances, the wheel 56 may move downwardly in response to the pressure of the converging sides of the pan and follow their contour. The net effect is to rotate the arm 60 about its pivot 61 and thereby to move the wheel downwardly (which is "transversely" in respect to the chuck and the pan) in a plane determined by the chuck's axis.

When the chuck has advanced until the wheel 56 extends into the pan so as to contact the bottom of the pan, as shown in Figure 7, the turning of the crank 54 is stopped. Movement of the bottom of the pan into contact with the wheel 56 will also have moved the bottom into contact with the wide contact roll 66, and the entire inside surface of the pan will then have been abraded, the curved side area by the wheel 56, the planar bottom area by the roll 66.

Referring to Figure 9, the geometrical axis of the pan 47 is represented by the dotted line *ab*, which is at the same time the axis of rotation of the pan and of the chuck 46. The dotted line *cd* is complementary to an axial section of the inside surface of the pan and lies in a plane that is determined by the said axis. The solid line 73 is complementary to an axial section of the inside surface of the pan and lies in a plane that is determined by the said axis.

In the above described operation of machine B, the path of the point of contact of the wheel 56 is the line *cd*, although in practice it is frequently desirable for the line to be slightly to the right or left of *cd*. This is true particularly where, as in the described machine, the abrasion is by a belt carried by the periphery of the contact wheel as contrasted with abrading by a solid abrasive wheel. In the described machine, if the pan rotates clockwise, the preferred path of the point of abrading contact is along a line slightly to the right of the line *cd*, as indicated by the solid line 74. The two lines, however, are in practice interchangeable and are so very close together that, for the purposes of this invention as defined in the claims, they are regarded as equivalents and are both embraced in the phrase "a path complementary to an axial section of the surface" and in the phrase "in a plane that is determined by the axis of rotation of the surface," as those phrases are used herein.

In the above described operation of machine B, the line of contact of the wheel or roll 66 is the line 73. This too may vary slightly above or below its described position, but since there is little or no lateral pressure on this roll, such variance renders little, if any, advantage.

There are numerous other variables in both the method and the apparatus, all of which are contemplated as coming within the scope of the claimed invention. For example, the size and shape of the contact rolls 56 and 66 may vary widely, such variance being governed largely by the size and shape of the concave surfaces being abraded. The width of the belts vary accordingly. The length of the belts may also vary. For example, one model of machine B accommodates an upper belt 59 averaging 110 inches in length, and a lower belt 69 of somewhat longer length.

The periphery of the contact roll of wheel 56 is preferably curved in cross section sufficiently to clear, or at least to complement, the circular side of the pan being abraded, as shown in Figure 8; and the wheel itself is preferably of a sufficiently small radius to enable it to clear, or at the most to complement, the curve between the side and bottom of the pan, as shown in Figure 7.

The lower contact roll **66**, being stationary, its periphery must be shaped to conform to or complement the surface which it abrades. Such surface being here illustrated as substantially flat or planar, the roll **66** is consequently cylindrical with substantially straight sides. If the bottom of the pan were curved, the sides of the cylinder (the periphery of the roll) would be curved accordingly. The width of the roll is preferably sufficient to support a belt whose width extends from the edge of the area that is abraded by the upper roll **56** to the center of the pan, preferably to a point slightly past the center; in fact, if desired, it may extend clear across the pan to the opposite edge so as to have approximately twice the width of the illustrated roll **66**.

Although the roll or wheel **56** is referred to herein as the "first" wheel and **66** as the "second," and **56** is described and illustrated as the first to contact the work, the construction may be altered so that **66** is the first to make contact, if desired. Insertion of the roll **66** may be before, during or after the operation of **56**.

Transverse movement of the wheel **56** in relation to the chuck or pan, in a plane determined by the chuck's axis is here shown as being accomplished by movement of the wheel, the wheel being raised and lowered by the lever **60**. It may also be accomplished by moving the chuck, e. g., the arm **60** may be fixed and the chuck assembly mounted in ways for reciprocal vertical movement; or it may be accomplished by movement of both the wheel and the chuck.

The axis of the wheel **33** in the single roll grinder (machine A; Figures 1 and 2) is shown as lying in the plane of its own transverse movement, whereas the axis of the wheel **56** in the double roll grinder (machine B; Figures 6 and 7) is perpendicular thereto. If desired, the construction of the single roll grinder may be altered so that the axis of the contact wheel will lie in a plane perpendicular to the plane of its transverse movement; similarly the construction of the double roll grinder may be altered so that the axis of the movable contact wheel will lie in the plane of its own transverse movement.

The peripheries of the contact rolls may vary from hard and unyielding metal or wood or other material to very soft and/or highly resilient rubber or other material, depending on the material being abraded, the speed of cut and the quality or type of finish that is desired.

The chuck and belt speeds of both machines may vary over a wide range. For example, ranges frequently employed in the illustrated machines are 600 to 2000 revolutions per minute for the chucks and 2000 to 3500 surface feet per minute for the belts. For finishing operations, the belt in machine A is frequently slowed to a range of 75 to 300 surface feet per minute. The chuck and belt speeds in their relation to each other may also vary. Generally, a belt speed that is slow in relation to the speed of the chuck or surface being ground, produces a slow cut and a smooth finish. A higher relative belt speed increases the cut but gives a rougher finish. A surface being abraded can be rotated so as to move with or against the movement of the belt. By the almost infinite number of possible combinations of relative speeds and directions of movement between the surface being abraded and the abrasive elements, a corresponding variety of kinds of finish may be obtained. For example, the bottom of a pan abraded by the transversely moving wheel of machine A has a different appearance from one abraded by the stationary contact roll **66** of machine B. Again, if the wheel of machine A turns faster than the pan, a cross-line pattern is formed; if it turns slower than the pan, a straight-line pattern is formed.

The sizes of vessels whose interior surfaces have been abraded by methods and machines that embody this invention vary from pans measuring 5″ in diameter and 3″ high to pressure cookers 12″ in diameter and 11″ high. Shapes have varied from skillets 14″ in diameter and ¾″ high to vessels 10″ high which taper in diameter from 5½″ at the top to 4½″ at the bottom, and cone shaped milk funnels which taper in diameter from 13″ at the top to 2″ at the bottom. Larger surfaces may also be handled such as milk vats 3′ to 4′ in diameter, and tanks 15′ to 18′ in diameter. Thus the size, shape and proportions may vary almost infinitely.

Although the illustrated machines are designed for manual operation of the feed mechanisms they could be equipped with mechanical feeds to make the machines partially or entirely automatic without departing from the claimed invention.

Claims to the double roll grinder (machine B; Figures 6, 7, 8 and 9) are contained in the application Serial No. 238,662 which was filed July 26, 1951, as a division of the present application.

What we claim is:

1. A machine for abrading the interior surfaces of hollow ware comprising a work holding chuck, means for rotating the chuck, means for effecting reciprocal axial movement of the chuck, a rack pivotally mounted in front of the chuck, a table slidably mounted in the rack for reciprocal movement of the table within the rack, an arm mounted on the table with one end adjacent the face of the chuck, pulleys on the arm for supporting an endless abrasive belt, one of the pulleys being at the end of the arm adjacent the chuck face to serve as a contact wheel to apply the belt to the work, and means for rotating one of the pulleys to drive the belt.

2. The device of claim 1 in which the rack turns in a plane parallel with the chuck's axis and the table moves within the rack in a plane parallel with the chuck's axis.

3. The device of claim 1 in which the peripheral portion of the contact wheel is a rubber tire.

4. The device of claim 1 including means for rotatably mounting the contact wheel on the arm at an angle to the normal course of the belt, and elongate cylindrical members positioned adjacent the belt at an angle thereto around which the belt may be partially wrapped to direct it toward the said angularly positioned wheel and into alignment therewith.

5. A machine for abrading the interior surfaces of hollow ware comprising a work holding chuck mounted for rotation about a horizontal axis and for reciprocal axial movement, means for rotating the chuck, means for effecting reciprocal axial movement of the chuck, a horizontal rack in front of the chuck and below the level of the chuck's axis, the rack being mounted for rotation in its own horizontal plane about a vertical axis, a table slidably mounted for reciprocal horizontal movement in the rack, a horizontal arm mounted on the table at a point between the two ends of the arm and at an acute angle to the direction of the rack's reciprocal movement with one end

of the arm adjacent the face of the chuck, pulleys on the arm for supporting an endless abrasive belt, one of the pulleys being at the end of the arm adjacent the face of the chuck with its axis at the approximate level of the chuck's axis to serve as a contact wheel to apply the belt to the work, and means for rotating one of the pulleys to drive the belt.

RICHARD G. RIEDESEL.
LAWRENCE A. MARTIN.

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