Sept. 1, 1959 A. KLUGE, JR 2,901,871

METHOD AND MACHINE FOR FINISHING THE INNER SURFACES OF HOLLOW WORKPIECES

Filed Feb. 7, 1957 7 Sheets-Sheet 1

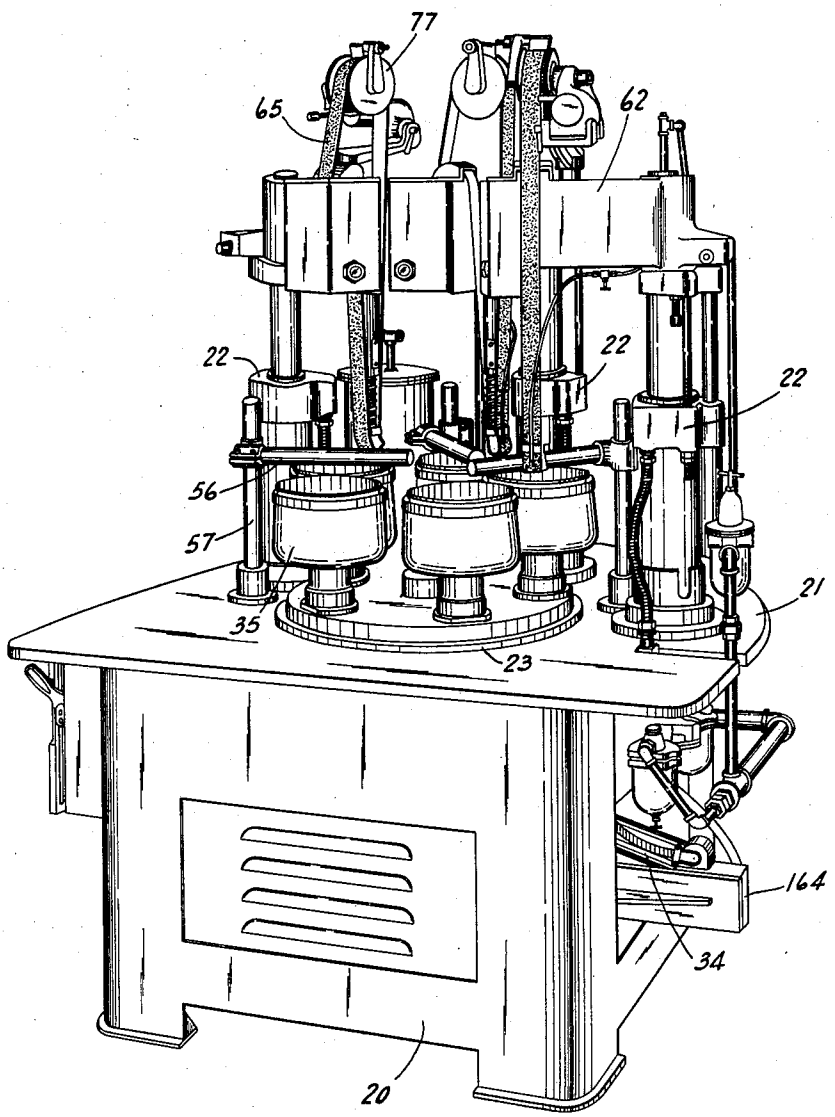

Fig. 1

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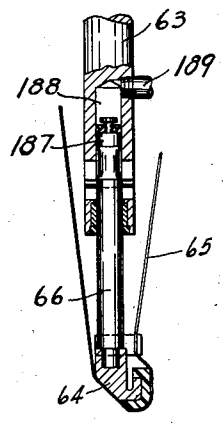

Fig. 5

Fig. 2

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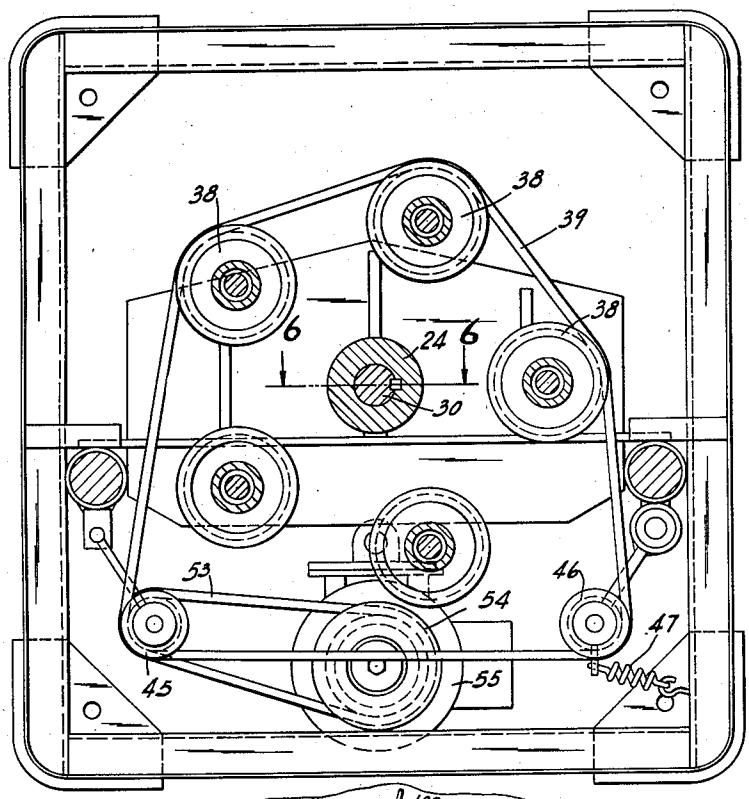

Fig. 3

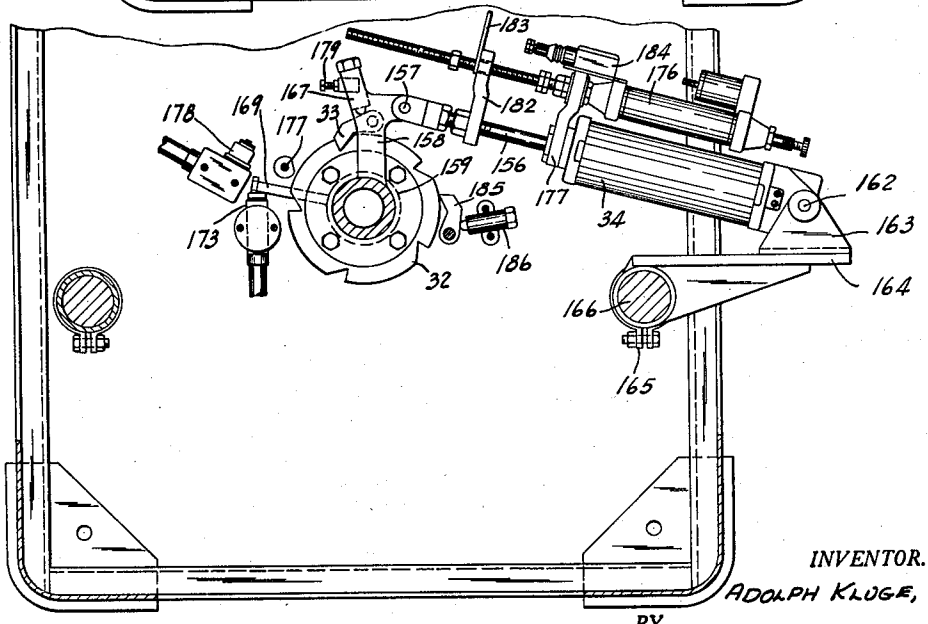

Fig. 4

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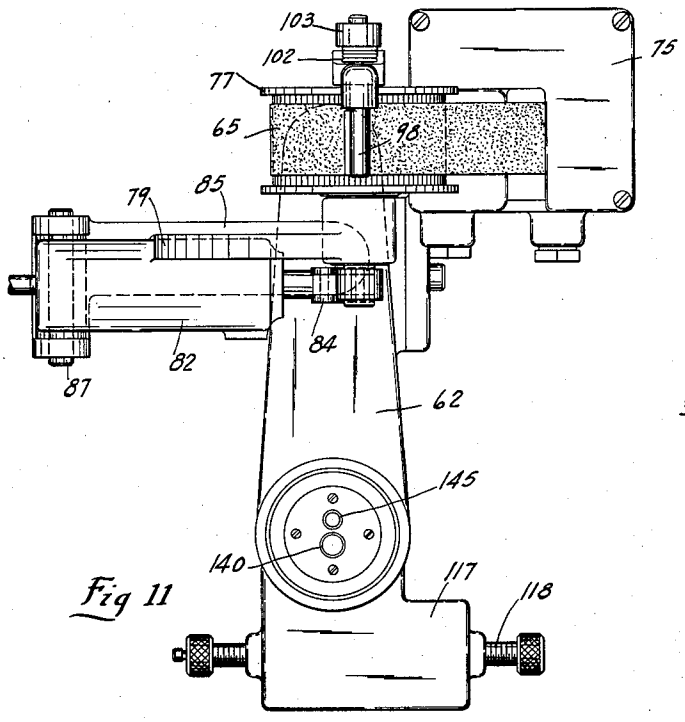

Fig 11

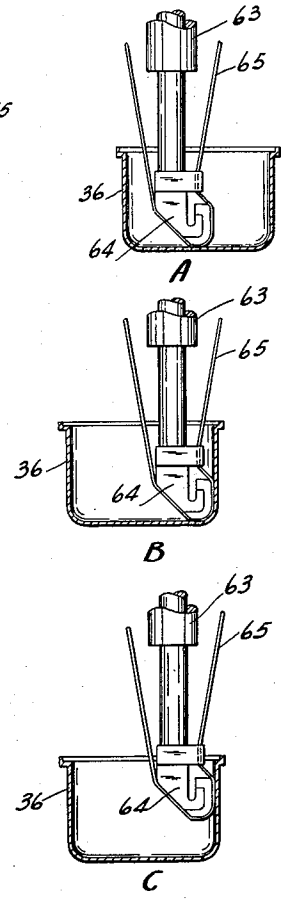

Fig. 14

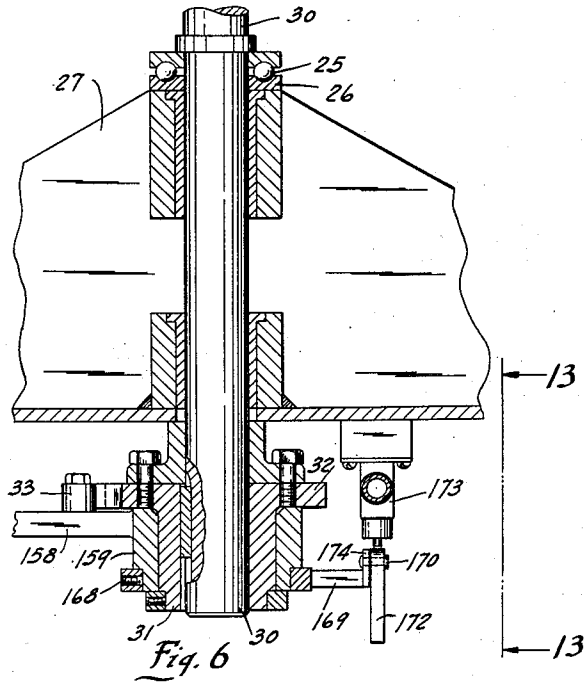

Fig. 6

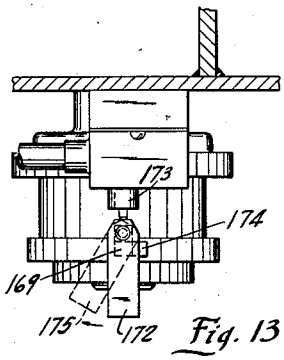

Fig. 13

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METHOD AND MACHINE FOR FINISHING THE INNER SURFACES OF HOLLOW WORKPIECES

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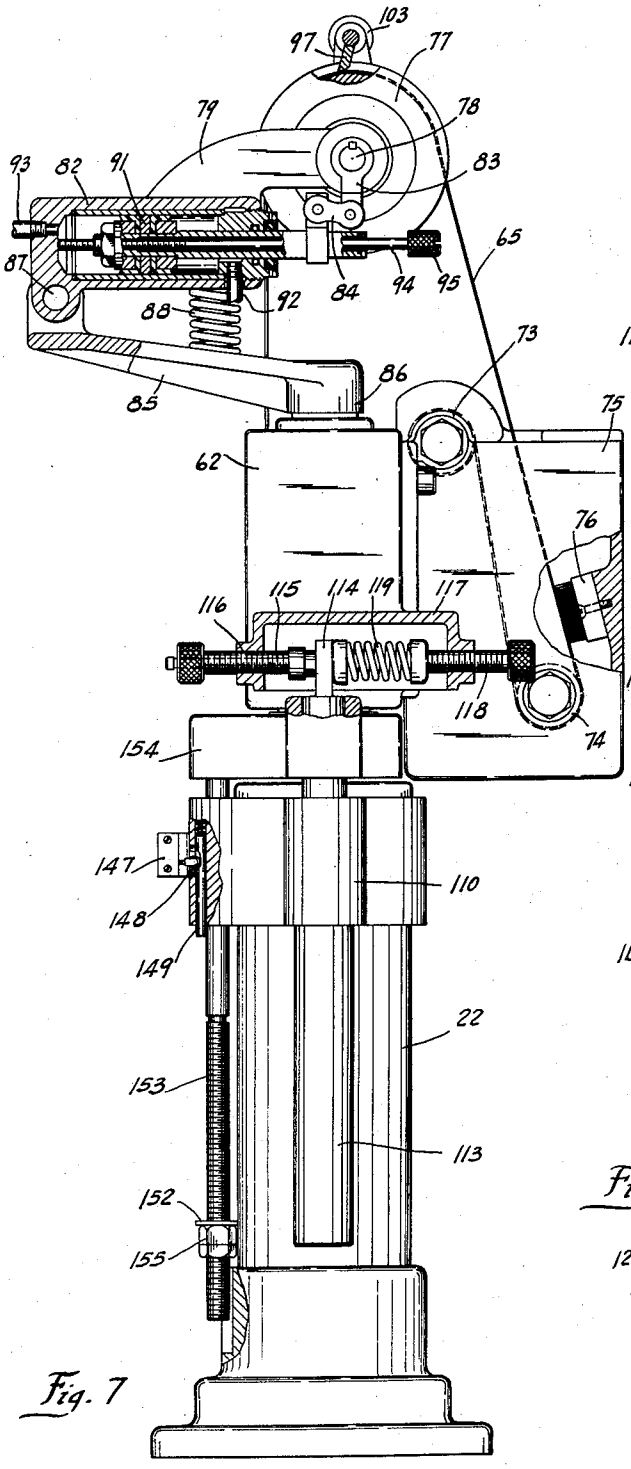

Fig. 7

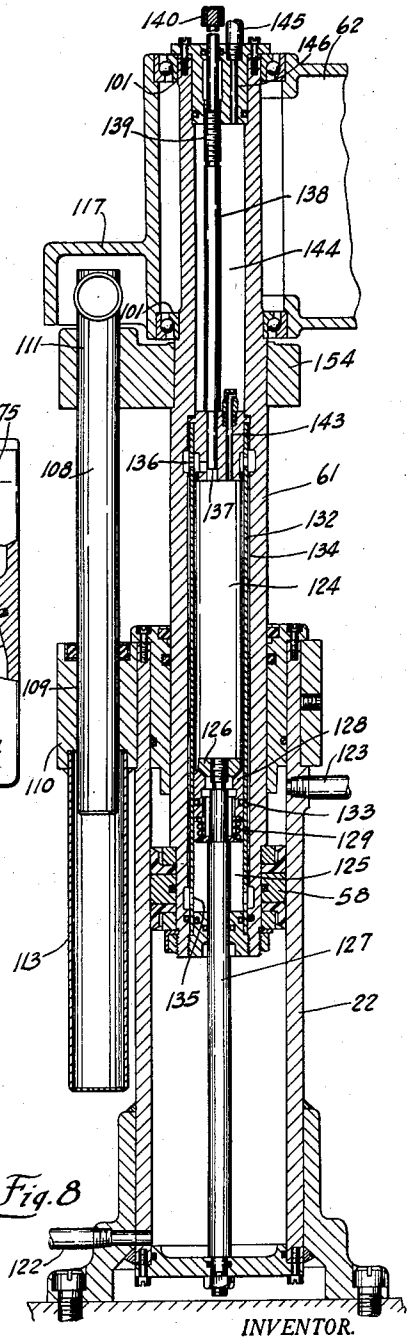

Fig. 8

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METHOD AND MACHINE FOR FINISHING THE INNER SURFACES OF HOLLOW WORKPIECES

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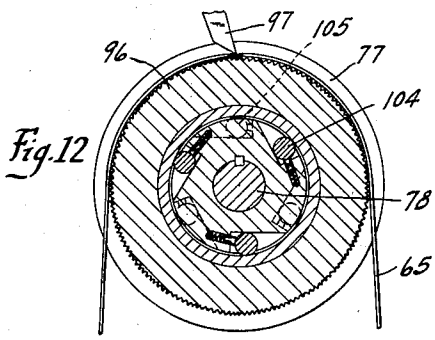
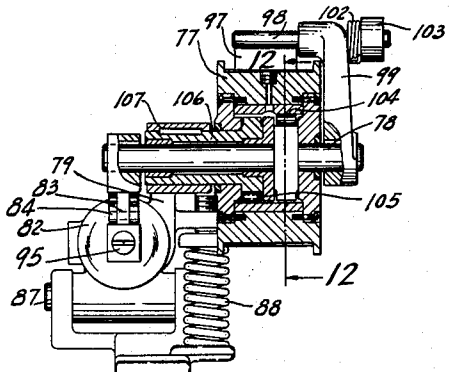


Fig. 12



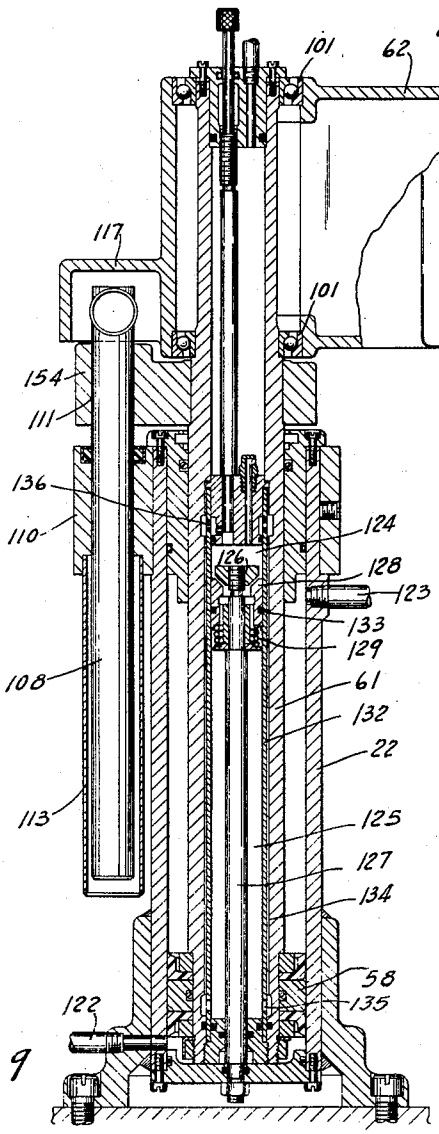


Fig. 9

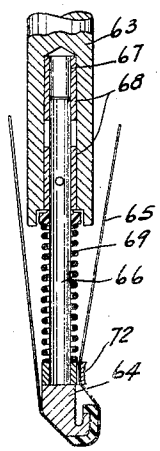
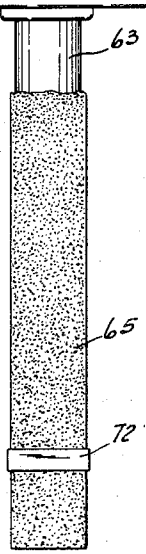


Fig. 10



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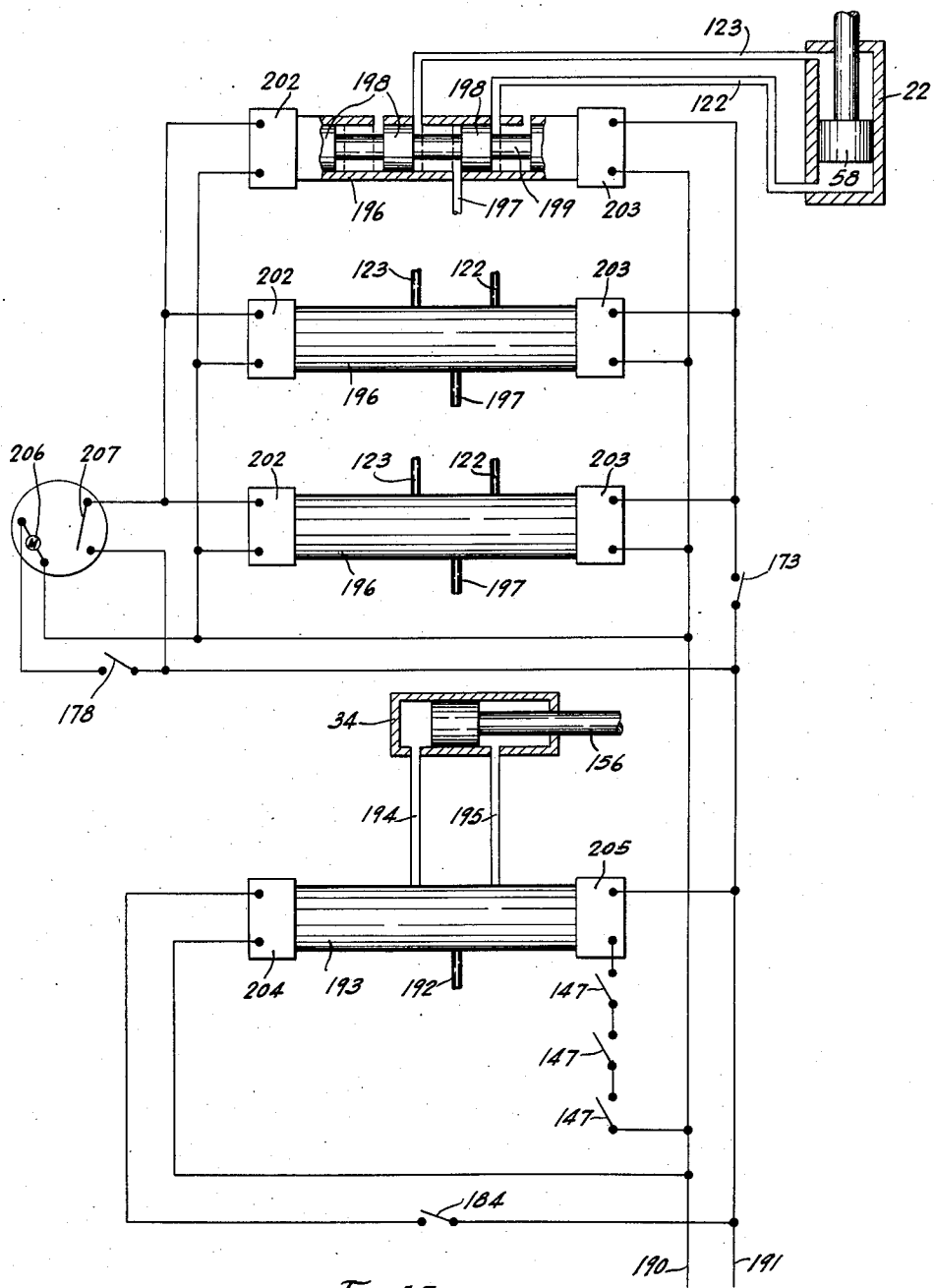

Fig. 15

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United States Patent Office

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METHOD AND MACHINE FOR FINISHING THE INNER SURFACES OF HOLLOW WORKPIECES

Adolph Kluge, Jr., Milwaukee, Wis., assignor to J. M. Nash Company, Milwaukee, Wis., a corporation of Wisconsin

Application February 7, 1957, Serial No. 638,747

23 Claims. (Cl. 51—145)

This invention relates to a method and machine for finishing the inner surfaces of hollow workpieces such as metal kitchen pots and pans.

The operation performed by the machine is known to the trade as "sun raying." The spinning, drawing or casting operations to which the workpieces were previously subject may leave random scratches which are difficult to remove. Heretofore these scratches are made inconspicuous by applying to the scratched surfaces a finished appearance by spinning the workpiece and manually holding thereagainst an abrasive such as emery cloth, sandpaper, etc. This operation leaves lines in a concentric pattern which abscure the random scratches aforesaid.

It is the purpose of the present invention to provide a machine which will automatically perform the finishing operation which heretofore has been successful only as a manual operation.

Attempts heretofore made to perfect machinery for this purpose have not found commercial acceptance. However, the device of the present invention has gone into commercial use and embodies novel features to which the commercial success of the machine is attributable.

An important feature of the present invention is to limit the movement of the abrading head to substantially a vertical path. A conveyor which preferably is in the form of a rotatable turret carries a plurality of chucks in which the workpieces are rotatably mounted. It is desirable to have a plurality of abrading stations. The abrading heads at each station are provided with abrasive belts of progressively finer grit size whereby the workpieces will be progressively more finely finished as it moves from station to station.

The movement of the turret and the movements of the respective abrading heads are so timed that the respective abrading heads descend into the rotating workpieces before the turret completes one intermittent indexing motion. The abrading heads engage the workpieces near their center of rotation and the relative movement between the abrading head and the turret during the completion of the indexing motion of the turret will cause the abrasive material to abrade the bottom surfaces of the workpiece from the center thereof outwardly to the sides thereof.

The abrading head is disposed in the corner of the workpiece during the initial period of dwell in the indexing movement of the turret and the abrading heads are then lifted vertically to abrade the side walls of the workpiece while the turret remains stationary. After all abrading heads are completely withdrawn from the workpieces the turret will again index forwardly and when it reaches an appropriate position prior to completion of the next indexing operation the respective heads will again descend thereinto to repeat the abrading operation.

The known prior art machines attempt too closely to simulate the manual arm movements of the operator. In

such machines the workpiece rotates on a fixed axis during the abrasive operation and the abrading head must move radially from the center of rotation of the workpiece outwardly to its side and then transversely along the side. In such machines the mounting for the abrading head must articulate in two planes.

In the device of the present invention, however, the movement of the turret into successive indexed positions is utilized in the process of abrading the workpiece bottom. Accordingly, when the indexing motion of the turret is completed, the abrading operation is also partially completed and all that remains to be done is to abrade the side of the workpiece. This is accomplished simply by withdrawing the abrading head along the side of the rotating workpiece. According to the present invention, movement of the abrading head may be conveniently limited to a single vertical path, thereby greatly simplifying the construction of the abrading head and its mounting and speeding the abrading operation.

Other novel features of the device of the present invention include the specific means for raising and lowering the abrading heads, the means for periodically shifting the position of the abrasive belts to expose fresh surfaces thereof to the workpiece, the pawl and ratchet mechanism for indexing the turret and the control mechanism for timing the movement of the turret to the actuation of the abrading heads to carry out the operational sequences aforesaid.

In the drawings:

Fig. 1 is a perspective view of a machine embodying the present invention.

Fig. 2 is a side elevation of the machine of Fig. 1, portions thereof being broken away and other portions being shown in cross section.

Fig. 3 is a cross sectional view taken along the line 3—3 of Fig. 2.

Fig. 4 is a cross sectional view taken along the line 4—4 of Fig. 2.

Fig. 5 is a fragmentary elevation of one embodiment of finishing platen.

Fig. 6 is a fragmentary cross sectional view taken along the line 6—6 of Fig. 3.

Fig. 7 is an enlarged side elevation of one of the mounting columns and associated parts upon which a finishing tool is mounted, portions of this view being broken away and other portions being shown in cross section.

Fig. 8 is a vertical axial cross section taken through the device of Fig. 7 and showing the parts in the position which they occupy with the finishing head in uppermost position.

Fig. 9 is a vertical axial cross section taken through the device of Fig. 7 and showing the parts in the relative position which they occupy when the finishing head is in lowermost position.

Fig. 10 is a fragmentary axial cross section taken through a typical finishing platen.

Fig. 11 is a plan view of a finishing tool assembly embodying the invention.

Fig. 12 is a cross sectional view taken along the line 12—12 of Fig. 9.

Fig. 13 is a view partly in cross section and partly in elevation taken along the line 13—13 of Fig. 6.

Figs. 14 A, B and C are diagrammatic views showing the relative position of the finishing tool and the workpiece in successive steps of machine operation.

Fig. 15 is a simplified circuit diagram of one embodiment of electrical and hydraulic control apparatus.

The general overall view of Fig. 1 shows the machine in its commercial embodiment which includes a substantially hollow base 20 which supports the table 21 upon which three substantially identical support columns 22 for

the finishing or abrading heads 62 are mounted in a semicircular pattern. At the center of this circular pattern is mounted a rotating turret 23 having a hub 24 borne on seat 26 by ball bearings 25. Seat 26 is supported on radial webs 27.

The turret 23 is keyed to a central shaft 30. As best shown in Fig. 6 the lower end of shaft 30 is keyed to sleeve 31 which has an annular flange provided with ratchet teeth 32 (see Fig. 4). The ratchet teeth 32 cooperate with a pawl 33 which is actuated by the fluid motor 34 to impart intermittent indexing rotative motion to the turret 23.

Turret 23 is provided with hollow workpiece chucks 35 in which the pan-shaped workpieces 36 are mounted. The workpieces 36 ordinarily consist of pots and pans used as kitchen utensils. It is desired to finish their inner surfaces to obscure the scratches left therein by the methods by which they are originally fabricated, as aforesaid. To adapt the machine to function on workpieces of various sizes and shapes, the chucks 35 are of interchangeable sizes.

The shaft 37 of each chuck 35 has a pulley 38 beneath the table 21. The shafts 37 may rotate freely in their bearings 42 which are seated in bushings 43 disposed in mutually arcuately spaced socket openings 44 in the turret 23. In the specific device shown in the drawings, the turret 23 has five equally spaced chucks 35.

As best shown in Fig. 3 the pulleys of the three chucks 35 in working position are concurrently engaged with the driving belt 39. The pulleys of the two chucks at the loading and unloading stations are free of the belt. For this purpose the belt 39 is trained about the three pulleys and also about idler pulleys 45, 46. Pulley 46 is biased by spring 47 to take up belt slack. Idler pulley 45 is mounted on shaft 48 which is supported in the bracket 49 and has thereon another pulley 52 about which the motor belt 53 is trained. Belt 53 passes about pulley 54 which is on the shaft of the motor 55.

The geometry of belt 39 is such that when the chucks 35 are proximate the respective finishing tool columns 22, the pulleys 38 thereon will engage the belt 39 to impart rotative movement to the workpieces 36 therein. However, when the chucks 35 and their contained workpieces are remote from the finishing tool pedestals 22 their pulleys 38 are released from engagement with the belt 39 to permit a workman to insert and remove workpieces from the respective chucks at the loading and unloading station of the machine.

As best shown in Fig. 1 bars 56 which are vertically adjustable on support posts 57 may be positioned to extend over the chucks and contain workpieces at their working stations. This is a safety feature which precludes the workpieces from being thrown out of the machine during their high speed rotation.

As best shown in Figs. 7 through 10, each pedestal 22 is hollow and constitutes a fluid cylinder having therewithin a piston 58 to which hollow piston rod 61 is secured. The top of piston rod 61 carries a laterally extending head 62 on which the finishing tool structure is carried. The finishing tool comprises a downwardly extending post 63 having a platen foot or shoe 64 about which belt 65 is trained. In the disclosed embodiment of the invention belt 65 has a surface coating of abrasive grit, whereby to score the workpieces in the manner aforesaid. Other finishing surfaces, for example buffing and polishing surfaces, can optionally be applied to the belt.

Platen 64 (Fig. 10) is desirably mounted on a stem 66 which is telescopically retractible in a socket 67 of post 63, suitable sleeve bearings 68 being provided. Platen 64 has a guide clip 72 through which the belt 65 is threaded to confine the belt thereon. Spring 69 biases platen 64 to extended position but the platen is free to yield against the bias of spring 69 in the course of machine operations whereby the belt will conform to the contour of the workpiece. In Fig. 5 an alternative embodiment of the invention is shown in which the spring 69 is replaced by an air cylinder on which the platen is resiliently mounted.

Belt indexing mechanism

In the preferred embodiment of the invention, belt 65 is endless and is provided with means for indexing or advancing it periodically about the platen 64 to expose fresh surfaces thereof to the workpiece. In the course of its indexing movement (Fig. 7) the used portions of the belt pass over suitable pulleys 73, 74 over which the belt is trained and through a reservoir 75 mounted on the head 62. The reservoir contains a cleaning solution. The reservoir is also provided with a brush 76 in the path of the belt 65. The cleaning solution and brush assist in the removal from the belt of portions of the workpiece material abraded therefrom.

Belt 65 is also trained over a feed drum 77 which is mounted on shaft 78 supported on arm 79. Arm 79 is mounted on the cylinder of a fluid motor 82 having a piston 91 in driving connection with shaft 78 through the crank 83 and link 84. Cylinder 82 is mounted on the bracket arm 85 connected at 86 to the head 62. Cylinder 82 is pivoted to the bracket 85 on the pintle 87 and is biased upwardly against the tension of belt 65 by the coil spring 88. Accordingly, the belt 65 is maintained in tension against the platen 64.

Intermittent and periodic movement is transmitted to belt 65 by the piston 91 in fluid cylinder 82. Fluid motor 82 is double acting and has input and exhaust fluid connections at 92, 93. The position of the piston 91 within cylinder 82 can initially be adjusted by the screw threaded stem 94 which has a knurled knob 95 for its manual adjustment.

Drum 77 is desirably provided with surface serations 96 (Fig. 12), the belt 65 intervening between the serated surface of the drum and a pawl 97 pivotally mounted on the stem shaft 98 (Fig. 9) which extends laterally from arm 99 which is keyed to shaft 78. Torsion spring 102 biases the pawl 97 toward engagement with the belt and underlying drum 77.

The inside surface of drum 77 is provided with a pair of overruning clutches 104, 105 shown respectively in full and dotted lines in Fig. 12 and in cross section in Fig. 2. Overrunning clutch 104 is keyed to shaft 78 and faces in the direction in which shaft 78 rotates to positively drive the drum 77 with the shaft 78 in the direction in which pawl 97 is advanced. Accordingly, belt 65 is positively held between the drum and the pawl in the course of its indexed advanced motion. During this time the overrunning clutch 105 slips. Overrunning clutch 105 is fixedly mounted on sleeve 106 which is keyed at 107 to arm 79. It faces in the same direction as clutch 104. As shaft 78 is rotated on the return stroke of fluid motor 82 to retract the pawl 97, overrunning clutch 105 positively holds the drum 77 against retractive movement while overruning clutch 104 slips. Accordingly, belt 65 is held by the friction of drum 77 in its advanced position and the apparatus is conditioned for the next indexing motion of the fluid motor 82.

Referring again to Figs. 7 through 9, head 62 is held against substantial rotation on its ball bearing connection 101 with piston rod 61 by reason of the slidable engagement of stabilizing stem 108 in elongated bore 109 formed in a lateral extension 110 of the column 22 and in elongated bore 111 in portion 154 of head 62. For safety reasons the path of stem 108 beyond extension 110 may be enclosed in a sleeve housing 113.

Stem 108 is provided at its upper end with an ear 114 engaged with the screw threaded stem 115 which is adjustable in the screw threaded tap 116 of the lateral hood portion 117 of head 62. The hood is provided with a second screw threaded stem 118 which bears against the

opposite side of ear 114 through the intervening compression spring 119. Accordingly, head 62 may have limited rotative movement with respect to column 22 against the bias of spring 119. The screws 116, 118 are normally set so that the spring must yield somewhat when the foot 64 of the abrading head contacts the side of the workpiece, thus placing the foot under transverse pressure against the workpiece side wall.

Finishing head raising and lowering mechanism

The pedestals 22 are adapted to receive through the pneumatic lines 122, 123 pneumatic pressure at opposite sides of their pistons 58. Accordingly, the head 62 will be raised and lowered according to the pressurization of the cylinder 22. In the device of the present invention means are provided whereby the respective heads will lower quickly into the workpieces in the course of their advance thereto and will withdraw slowly therefrom in the course of abrasive action between the belts 65 and the sides of the workpieces.

To produce this differential action each hollow piston 61 is provided with fluid chambers 124, 125 at opposite sides of a valve 126 mounted in fixed position within hollow piston 61 on the stem 127 which is fixed in the bottom end wall of the cylinder 22. Both chambers 124, 125 may ordinarily be filled with oil or other hydraulic fluid which must pass from one side of valve 126 to the other in the course of movement of the piston 58 in cyliner 22. Valve 126 is provided with a shiftable seat 128 which is normally biased toward closure with the valve 126 by the coil spring 129. The valve seat 128 includes a sleeve having frictional engagement with the cylindrical lining 132 of the hollow piston 61. This friction is augmented by a leather or like friction ring 133 interposed between the valve seat sleeve 128 and the lining 132. Accordingly, when air under pressure is admitted into cylinder 22 through line 123 above the piston 58, thereby causing the piston 58 to move downwardly in the cylinder and exhaust air from below the piston 58 through line 122, the friction between sleeve 132 and the valve seat sleeve 128 and friction ring 133 will move the valve seat sleeve 128 away from valve 126 against the bias of spring 129 to permit relatively free interchange of hydraulic fluid between chambers 124, 125. Accordingly, the hydraulic fluid will offer little resistance to piston movement and the finishing tool will descend relatively rapidly into the workpiece.

However, when the cylinder 22 is pressurized through line 122 beneath piston 58, air thereabove being exhausted through line 123, corresponding friction between the valve seat sleeve 128, friction ring 133 and the liner 132 of hollow piston 61 will close the valve seat sleeve against the valve 126 and block interchange of hydraulic fluid between the chambers 124, 125 except through a bypass channel 134 which desirably comprises an annular space between the cylinder liner 132 and the wall of hollow piston 61. Note the ports 135 in liner 132 near the bottom end of hollow piston 61 which communicate between channel 125 and the bypass channel 134 and the port 136 in liner 132 between bypass channel 134 and upper chamber 124. Passage of fluid through the bypass channel 134, however, is closely regulated by the needle valve 137 under control of the stem 138 which has an operating knob 140 and portion 139 threaded in closure plug 146. The valve 137 may be set to provide that size of orifice between bypass channel 134 and chamber 124 to require the piston rod 61 to raise relatively slowly and thus provide for a relatively long period of contact between the finishing tool and the workpiece side wall in the course of upward movement of the head 62.

Piston rod 61 is provided with an intermediate fixed partition 143 in which the needle valve 137 is housed. The space between partition 143 and closure plug 146 provides a make-up chamber 144 for hydraulic fluid. Additional make-up fluid may be admitted to the chamber 144 through the hydraulic fluid supply line 145.

As best shown in Fig. 7 the upper end of each cylinder 22 is provided with a microswitch 147 having a roller 148 actuated by the stem 149 on the path of movement of the striker 152 which is adjustably mounted on the threaded stem 153 which in turn is connected to the arm 154 which projects laterally from the piston rod 61. The relative position of the striker 152 is adjustably fixed by means of the set bolts 155. Microswitch 147 will be actuated when the piston rod 61 has risen to its upper extreme of movement for the control effects hereinafter explained.

Turret indexing mechanism

Referring again to Figs. 4, 6 and 13, pneumatic motor 34 has a piston rod 156 having a pivotal connection at 157 to an arm 158 which is connected to sleeve 159 which is rotatably mounted on the sleeve 31 which is otherwise provided with the ratchet teeth 32. Arm 158 carries the pawl 33 which engages the teeth 32 on the ratchet sleeve 31. Accordingly, the movement of the piston rod 156 outwardly from its cylinder 34 will engage the pawl 33 under the bias of spring 167 with the ratchet teeth 32 and index the turret 23. Cylinder 34 is pivotally connected at 162 to the bracket 163 mounted on plate 164, the plate in turn being adjustably fixed by the clamped strap 165 to the support post 166. The pivotal connections aforesaid permit the various parts to articulate to accommodate for the movement aforesaid.

Microswitch 173 is disposed in the path of arm 169 which is clamped by set screw 168 to sleeve 159. Arm 169 carries on pintle 170 a weighted actuator lever 172 adapted to actuate the microswitch 173 in one direction of movement of arm 169 and to by-pass the microswitch in the opposite direction of movement of arm 169. Arm 169 carries a back-up tab 174 positioned to restrain the weighted lever 172 against pivotal movement opposite the direction of arrow 175 from its full line position shown in Fig. 13, the lever being free, however, to move in the direction of arrow 175 toward its position shown in dotted lines in Fig. 13.

When the indexing movement of the turret is approximately half completed, arm 169 will reach a position in which the weighted lever 172 will engage and actuate the operating button for microswitch 173. The direction of movement of arm 169 is such that tab 174 acts as a positive stop for the lever 172. Actuation of microswitch 173 actuates the hydraulic circuit to start the abrading heads downwardly into the workpieces. The timing is such that the abrasive belt 65 contacts the workpiece bottoms near their respective centers of rotation.

At about the same time the indexing rotation of the turret is damped by hydraulic check cylinder 176 which is mounted by bracket arm 177 on pneumatic motor 34.

The indexing motion of the turret continues at reduced speed with the abrasive belts 65 working on the bottoms of the workpieces. The apparatus is so timed that when the sides of the workpieces approach the abrasive belt, pawl 33 strikes the positive stop 177 to positively stop the turret. Pawl 185 is then biased by spring 186 into engagement with ratchet teeth 32 to preclude reverse rotation of the turret during subsequent retraction of pawl 33. The relation of the parts is such that at the same time, microswitch 178 is actuated by the adjustable striker arm 179 on pivot arm 158 to start a timing motor 206 (Fig. 15) which controls the time that the abrasive belts remain in contact with the corners of the workpieces. When the timing motor 206 completes its cycle, the pneumatic motors 22 which raise the abrasive heads are actuated and the abrasive heads move upwardly out of the workpieces. In this motion the belts 65 are biased by springs 119 against the sides of the workpieces.

When each of the three abrasive heads reach their topmost position, as controlled by the stop nuts **155**, and each of the interlocked microswitches **147** are actuated, a circuit is closed to reverse the solenoid controlled air valve **193** (Fig. 15) to reverse the action of pneumatic motor **34** and return the indexing pawl **33** to its starting position.

In the course of return of pawl **33**, the weighted lever **172** will swing to its dotted line position as shown in Fig. 13 under the pressure of the internal spring in the microswitch **173** and bypass the microswitch so as not to reclose the switch **173** in this return movement.

The piston rod **156** for the cylinder **34** carries a laterally extending bracket arm **182** having a striker portion **183** which engages the actuating button for microswitch **184** when piston rod **156** is fully retracted. Switch **184** energizes solenoid **204** (Fig. 15) of air valve **193** to reverse the air connections to pneumatic motor **34** to cause piston rod **156** to reverse direction and re-engage pawl **133** with the ratchet teeth **32** and repeat the indexing operation.

The sequence of relative position of a finishing tool and a workpiece is diagrammatically illustrated in Fig. 14. At position A the turret **23** is still indexing and the finishing platen **64** has entered the workpiece **36** to engage its bottom near its center of rotation. At position B the indexing movement of the turret **23** has concluded and the timer aforesaid holds the finishing platen in the corner of the workpiece. In position C the pneumatic motor **22** has been energized to withdraw the tool from the workpiece and in the course of such withdrawal to finish the side thereof.

It is clear that according to the method of the present invention the bottom of the workpiece is finished during the completion of the indexing movement of the turret and the side of the workpiece is abraded after the completion of the indexing movement of the turret and during the withdrawal of the finishing tool therefrom. Accordingly, the finishing tool need move only on a vertical path with the aforesaid advantages.

Fig. 5 shows an alternative embodiment of yieldable structure for the platen over which the abrasive belt **65** is trained. In this embodiment the stem **66** of platen **64** is connected to the piston **187** of air cylinder **188** in post **63**. Cylinder **188** is supplied with air under constant pressure through port **189**. The air in chamber **188** provides a resilient cushion against which the platen **64** may yield to permit it to closely follow any irregularity in the workpiece.

A combined diagrammatic electrical and hydraulic circuit is shown in Fig. 15. The circuit is simplified for purposes of illustration. Electric power is provided by feed lines **190, 191**. The supply of air to pneumatic motor **34** comes from air line **192** through the solenoid controlled air valve **193** and through intake and exhaust air lines **194, 195** between the valve **193** and cylinder **34**.

Substantially identical air valves **196** are shown, one for each of the pneumatic cylinders **22** to operate the vertical movement of the finishing heads. A supply of air pressure leads to each valve **196** through the air pressure line **197**. Air lines **122, 123** lead from the respective valves **196** to the respective cylinders **22**. The respective valves **196** may consist of axially spaced spools **198** mounted on a common valve stem **199** actuated by solenoids **202, 203** at the respective ends of the valve. Valve **193** has similar solenoids **204, 205** at its respective ends.

The air valves **193, 196** are conventional and may conveniently be of a type in which the spool valves thereof will remain impositively in any position to which they are moved by actuation of either of the solenoids connected to the valve stem.

When microswitch **184** is closed by retraction of the piston **156** of fluid motor **134**, as shown in Fig. 4, solenoid **204** of valve **193** will be actuated to shift the valve to position to pressurize cylinder **34** to expel piston **156** in turret indexing direction. The turret will then index as aforesaid. At about the midpoint of turret indexing movement switch **173** will be closed, as aforesaid, to close the circuit to the respective solenoids **203** at corresponding ends of valves **196** whereby to move the spool valves **198** to their full line position shown in the topmost valve **196** in Fig. 15. Accordingly, the space above pistons **58** in the respective cylinders **22** will be pressurized to cause rapid descent of the finishing tools into the respective workpieces.

When microswitch **178** is closed, as aforesaid, the timing motor **206** will be energized and the finishing shoes **64** will dwell in the corners of the work-pieces for a predetermined time. At the completion of the dwell period the timing motor **206** will close switch **207** to energize solenoids **202** of valves **196** and to throw the spool valves therein to their dotted line positions shown in the upper valve **196** in Fig. 15. Accordingly, lines **122** will be pressurized and lines **123** will be opened to the atmosphere, thereby causing the pistons **58** to move up slowly subject to the retarding effect of the hydraulic damping action aforesaid. As each piston **58** reaches its uppermost position, the series connected interlocked switches **147** associated therewith will close. When each of said switches is closed, solenoid **205** for valve **193** will be energized to reverse valve **193** to reverse the pressure in pneumatic motor **34** and cause piston **156** to retract into the motor. At the conclusion of such retractive movement, striker arm **183** will reengage switch **184** to recommence the cycle as aforesaid.

What is claimed is:

1. A machine for finishing the inside surface of a pan-shaped workpiece having a bottom and a side wall and comprising a finishing tool, a conveyor movable with respect thereto, actuating means for advancing and retracting the tool transversely with respect to conveyor movement, power driven chuck means for rotatably mounting said workpiece on said conveyor, means for the intermittent movement in steps with intervening dwell of said conveyor in a direction transverse to the axis of workpiece rotation, the finishing tool actuating means comprising means for advancing the tool toward the conveyor and on a path transverse to conveyor movement to frictionally engage the tool with the bottom of the workpiece in the course of intermittent movement of the conveyor whereby such movement of the conveyor will finish said bottom, said tool actuating means further comprising means for frictionally engaging the tool with the side wall of the workpiece in the dwell position of the conveyor.

2. The device of claim 1 in which the conveyor comprises a rotatable turret, said turret having a shaft and a ratchet, the means for moving the turret including a pawl coacting with the ratchet for indexing the turret in the intermittent motion thereof.

3. A machine for finishing the inside surface of a pan-shaped workpiece having a bottom and a side wall and comprising a finishing tool, a conveyor movable with respect thereto, actuating means for advancing and retracting the tool transversely with respect to conveyor movement, power driven chuck means for rotatably mounting said workpiece on said conveyor, means for the intermittent movement of said conveyor in steps with intervening dwell, the tool being disposed with respect to the conveyor in such a position that the tool is frictionally engaged with the bottom of the workpiece in the course of intermittent movement of the conveyor and is frictionally engaged with the side wall of the workpiece in the dwell position of the conveyor, the finishing tool actuating means comprising a double-acting fluid motor and speed control means therefor including differential valve means for causing the tool to lift at a slower rate of speed than it descends.

4. The device of claim 1 in further combination with an additional finishing tool spaced laterally from the tool first mentioned and aligned for corresponding coaction with a workpiece previously finished by the tool first mentioned, the said tools comprising abrading surfaces of different grit size.

5. The device of claim 1, in which the finishing tool comprises a platen, a finishing belt trained over said platen, and means for periodically shifting the belt about the platen to expose a fresh surface thereof to the workpiece.

6. A machine for finishing the inside surface of a pan-shaped workpiece having a bottom and a side wall and comprising a finishing tool, a conveyor movable with respect thereto, actuating means for advancing and retracting the tool transversely with respect to conveyor movement, power driven chuck means for rotatably mounting said workpiece on said conveyor, means for the intermittent movement of said conveyor in steps with intervening dwell, the tool being disposed with respect to the conveyor in such a position that the tool is frictionally engaged with the bottom of the workpiece in the course of intermittent movement of the conveyor and is frictionally engaged with the side wall of the workpiece in the dwell position of the conveyor, said finishing tool comprising a platen, an endless finishing belt trained over said platen, means for periodically shifting the belt about the platen to expose a fresh surface thereof to the workpiece, in further combination with a liquid reservoir through which said belt passes for cleaning from said belt workpiece material removed by said belt from the workpiece and condition the cleaned portions of said belt for re-use.

7. A machine for finishing the inside surface of a pan-shaped workpiece having a bottom and a side wall and comprising a finishing tool, a conveyor movable with respect thereto, actuating means for advancing and retracting the tool transversely with respect to conveyor movement, power driven chuck means for rotatably mounting said workpiece on said conveyor, means for the intermittent movement of said conveyor in steps with intervening dwell, the tool being disposed with respect to the conveyor in such a position that the tool is frictionally engaged with the bottom of the workpiece in the course of intermittent movement of the conveyor and is frictionally engaged with the side wall of the workpiece in the dwell position of the conveyor, said finishing tool comprising a platen, a finishing belt trained over said platen, and means for periodically shifting the belt about the platen to expose a fresh surface thereof to the workpiece, the means last mentioned comprises a clamp engaging the belt at both sides thereof.

8. The device of claim 7 in which said clamp comprises a drum over which said belt is trained and a coacting pawl, and belt driving means including an overrunning clutch interconnecting the drum and pawl for imparting intermittent motion to said belt.

9. A machine for abrading the inside surfaces of pan-shaped workpieces having bottoms and side walls and comprising a conveyor having multiple chucks for said workpieces, means for rotating said chucks and the workpieces therein, means for indexing said turret in a direction transverse to the axis of workpiece rotation to intermittently advance the workpieces to and from an abrading station, an abrading tool at said station, means for actuating said tool to advance said tool into a workpiece in the course of its intermittent advance to said station and to retract said tool out of the workpiece to permit further intermittent workpiece advance, and control means for the conveyor indexing means and the tool actuating means including means whereby the tool is advanced to frictionally engage the bottom of the workpiece at substantially its center of rotation for abrasion of the workpiece bottom from the center of the bottom to the side of the workpiece in the course of continued workpiece advance to said station, means for completing one intermittent advance of the conveyor when the tool is in the corner of workpiece between its bottom and side wall, and means for retracting the tool at the termination of intermittent advance of said conveyor for abrasion of the side wall of the workpiece.

10. The device of claim 9 in further combination with means for causing the tool to dwell in the corner of the side and bottom of the workpiece.

11. In a device of the character described, a double-acting fluid motor for raising and lowering a finishing tool, said motor comprising a cylinder, a piston in said cylinder, fluid connections to said cylinder at opposite sides of the piston, a hollow piston rod connected to the piston and comprising therewithin a fluid cylinder, a valve within the cylinder last mentioned, means substantially fixing said valve against movement with the piston and a fluid within the cylinder last mentioned and port means for transferring said fluid from one side of the valve to the other, said means including means whereby the rate of transfer of fluid is higher in one direction of piston movement than in the other direction of piston movement whereby the piston will move in one direction at a rate of speed which is different from its movement in the opposite direction.

12. The device of claim 11 in which said port means includes a seat for the valve, means for closing said seat in one direction of piston movement whereby to preclude flow of fluid therethrough in said direction but which will open said valve in the opposite direction of piston movement to pass fluid therethrough, and a fluid bypass channel formed in the wall of said piston around said valve and means for regulating flow of fluid through said bypass channel whereby to regulate the flow of fluid through said bypass channel during the movement of the piston in the direction in which the valve is closed.

13. In a device of the character described including a conveyor having a plurality of chucks mounted thereon for the reception of pan-shaped workpieces, a finishing tool adapted for movement into and out of said pan-shaped workpieces for the finishing of the inner surfaces thereof, means for mounting said tool for said movement and comprising a hollow column mounted adjacent the path of conveyor travel, said column comprising a cylinder for a piston telescopically received therein, fluid connections to said cylinder for advancing and retractting said piston with respect to the conveyor, said tool being connected to the said piston for its actuation, yieldable means biasing said tool toward one position of relative rotation with respect to the column whereby to bias the tool against the side of the pan-shaped workpiece in the course of finishing operation.

14. The device of claim 13 in which said tool comprises a platen and a belt trained over said platen, and means for periodically indexing said belt about said platen whereby to periodically expose a fresh surface thereof to the workpiece in the course of machine operation.

15. The device of claim 14 in which said belt is endless, in further combination with a liquid reservoir mounted on said piston and through which said belt passes for cleaning from said belt workpiece material removed by said belt from the workpiece and condition the cleaned portions of said belt for re-use.

16. In a device of the character described, an endless finishing belt, a platen over which said belt is trained, belt feeding means whereby to periodically shift the position of the belt with respect to said platen to periodically expose fresh portions thereof, said feeding means comprising a drum over which said belt is trained, a pawl opposite said drum and cooperating therewith to clamp said belt between the drum and pawl and power means for concurrently rotating the drum and pawl through a predetermined arcuate extent.

17. The device of claim 16 in which said power means includes a fluid operated motor, linkage connections from said motor to said drum and said pawl, said linkage connections including a first overruning clutch between the linkage and drum whereby to drive the drum positively in one direction and slip in the opposite direction, and a second overrunning clutch between the drum and a fixed part of the machine to hold the drum against retraction while the first overrunning clutch slips.

18. The method of finishing transversely disposed surfaces of a workpiece mounted for rotation on a conveyor and comprising the steps of moving the conveyor past a finishing tool which has a path of movement which is transverse with respect to the path of movement of said conveyor, intermittently advancing said conveyor on its path, advancing the finishing tool on its path to contact one surface of said workpiece prior to the completion of the indexed movement of the conveyor whereby the surface of the workpiece contacted by the finishing tool will be finished in the course of continued indexing movement of the conveyor, the travel of the conveyor being in timed relation to the position of the tool so that said surface is substantially completely finished at the end of said indexing movement and the finishing tool contacts the other said surface, and thereafter retracting the tool on its path during continued rotation of the workpiece to finish the said other surface.

19. The method of claim 18 plus the intermediate step of causing the finishing tool to dwell at the intersection of said surfaces prior to retraction of the finishing tool.

20. The method of claim 18 in which the conveyor is mounted for movement on a substantially horizontal path, the tool being mounted for movement on a substantially vertical path, said workpiece being pan-shaped with a bottom and side wall substantially at a right angle, said tool being advanced on its path into said workpiece to contact the workpiece at substantially the center of its rotation and to finish said bottom from the center radially outwardly to its side in the course of completion of the indexing movement of the conveyor, the tool being withdrawn from the workpiece in the course of finishing the side of the workpiece.

21. The method of claim 18 in which said conveyor is mounted for rotation on a circular path, there being multiple finishing tools arranged concentrically with said circular path to apply successively different degrees of finishing to said workpiece.

22. In a device of the character described including a conveyor for workpieces having bottoms and sides, means for the indexed advance of said conveyor in steps with intervening dwell, a finishing tool and means to advance and retract said tool with respect to said conveyor for sequential action of the tool on the bottoms and sides of the workpieces, and automatic control means therefor comprising means for sequentially advancing the tool against a workpiece bottom during the movement of the conveyor, means for completing the indexed advance of the conveyor when the bottom has been finished and the tool is proximate the side of the workpiece, and means for withdrawing the tool from the workpiece while maintaining it in pressure contact with the side of the workpiece to finish the workpiece side in the course of said withdrawal and during the dwell period in conveyor movement.

23. The device of claim 22 in which said control means includes an electrical circuit, interlocked switches in said circuit and means actuating said switches pursuant to the movement of said conveyor and finishing tool.

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