April 8, 1969 B. O. KALOCSAI ETAL 3,436,865

EDGE FORM GRINDING

Original Filed May 11, 1964

Sheet 1 of 3

FIG. 2

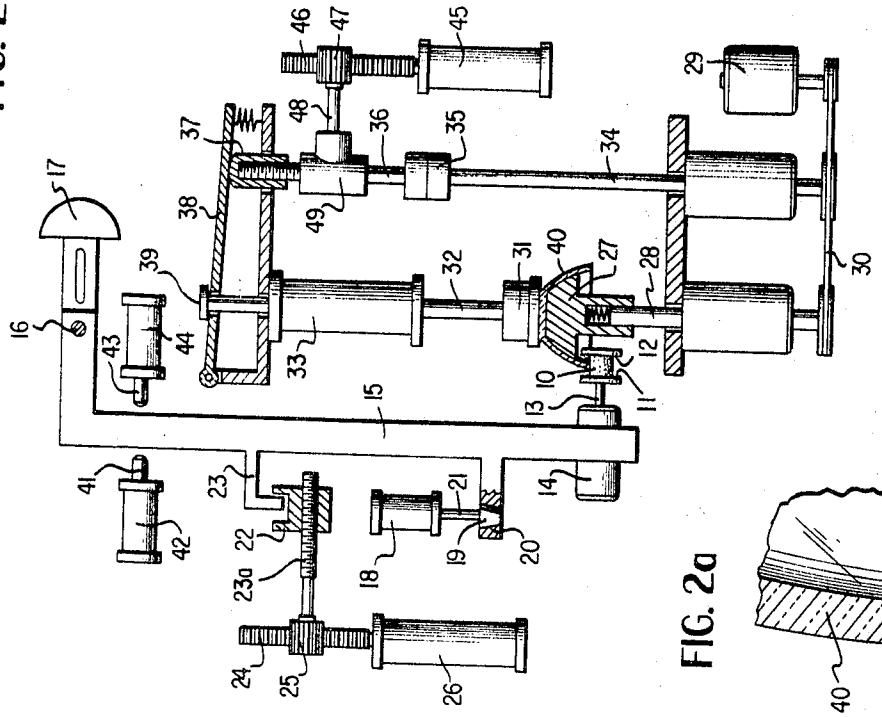
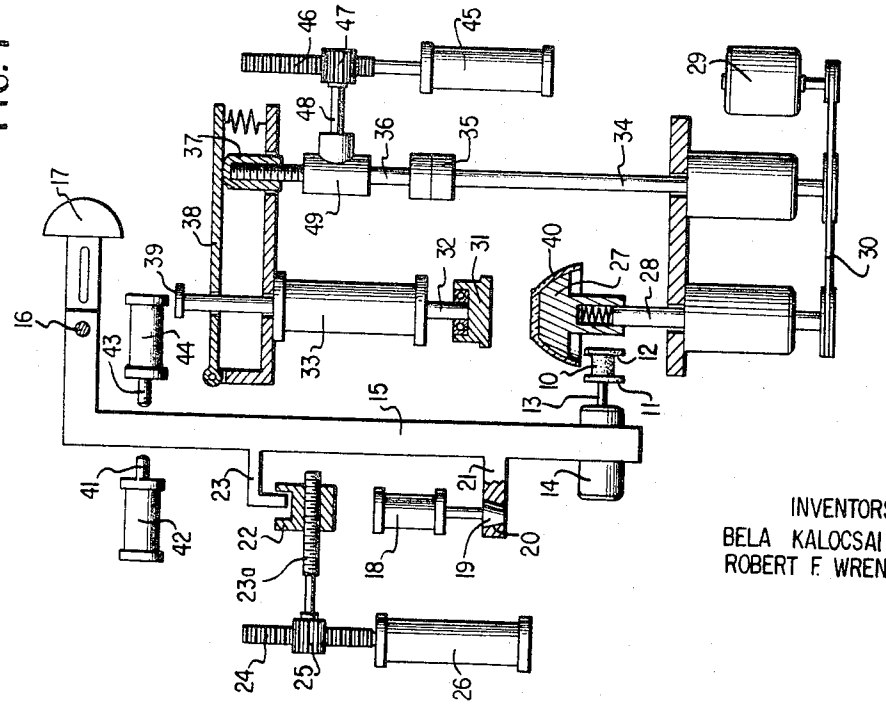


FIG. 2a

FIG. 1



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Sheet 2 of 3

FIG. 4

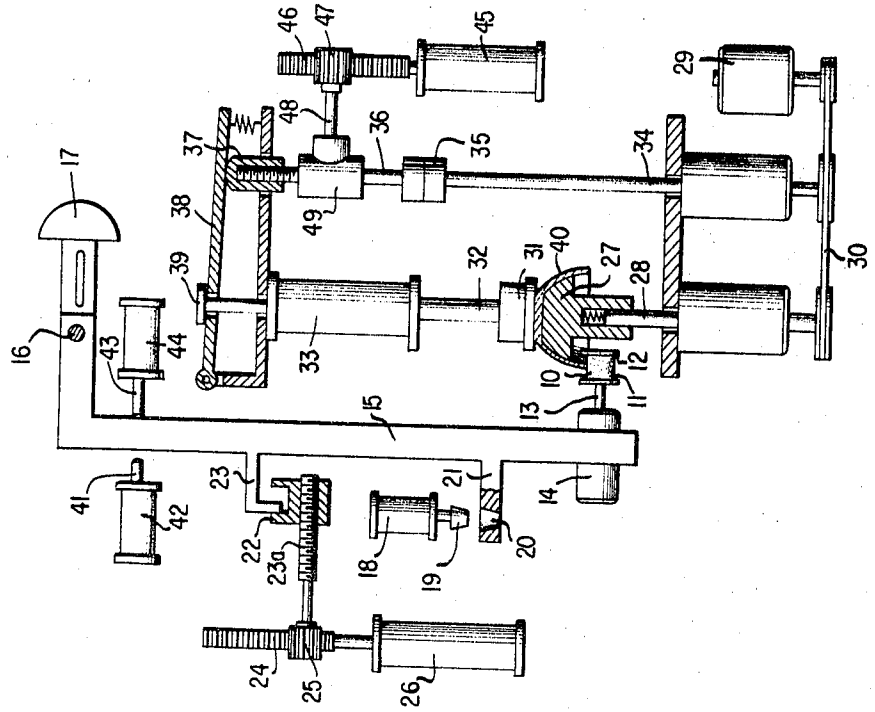
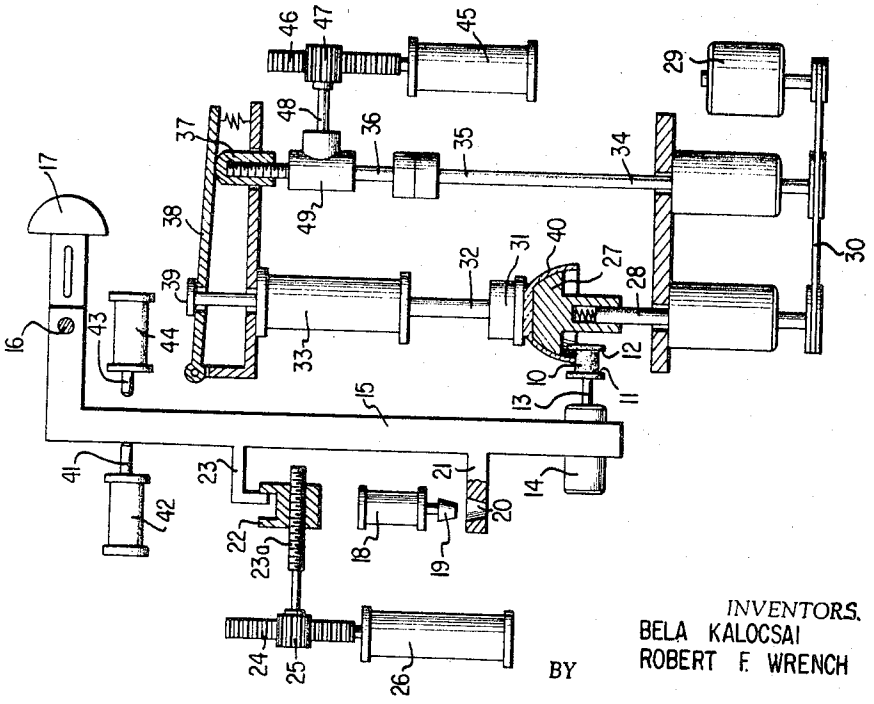


FIG 3



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April 8, 1969 B. O. KALOCSAI ET AL 3,436,865

EDGE FORM GRINDING

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Sheet 3 of 3

FIG. 4a

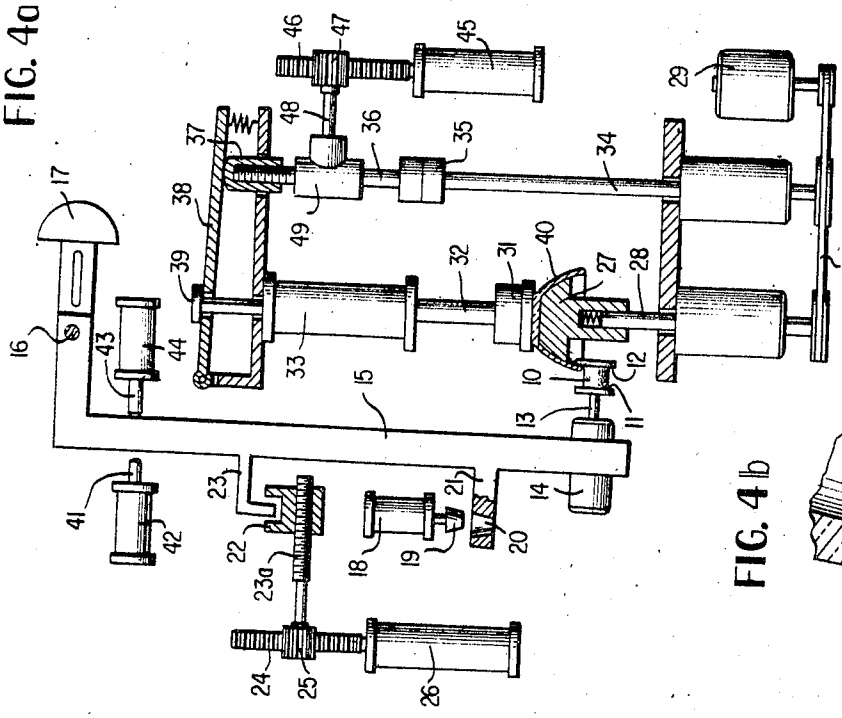


FIG. 4b

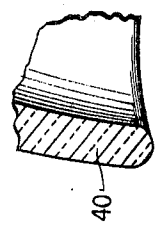


FIG. 3a

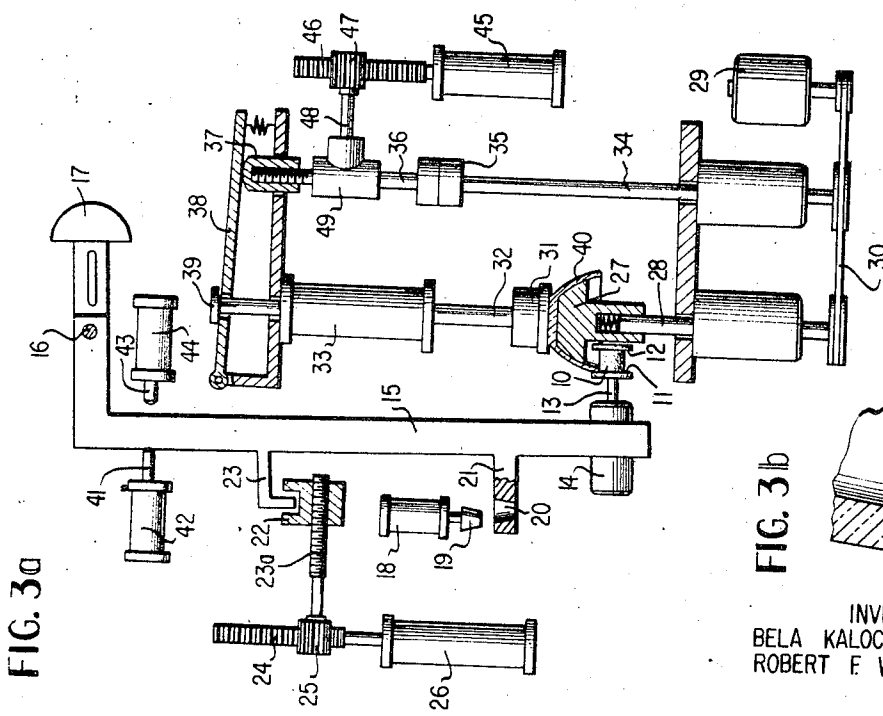
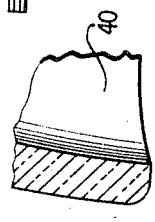


FIG. 3b



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3,436,865

EDGE FORM GRINDING

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Original application May 11, 1964, Ser. No. 366,261, now patent No. 3,313,066, dated Apr. 11, 1967. Divided and this application Oct. 5, 1966, Ser. No. 608,467
Int. Cl. B24b 7/00, 9/00 49/00
U.S. Cl. 51—3 7 Claims

ABSTRACT OF THE DISCLOSURE

A grinding machine used to finish edges of a workpiece, which includes an abrasive element movable longitudinally along and rotatably about a single axis and in correlation to movement of a workholder carrying a workpiece which moves longitudinally along and rotatably about a second axis. The abrasive member is mounted on a pivoted arm which, when biased in either of two opposed directions, causes longitudinal movement of the abrasive member into engagement with the workpiece carried by the vertically movable and rotatable workholder. The abrasive element has a peripheral face which is first positioned relative to the workholder so as to form a planar annular surface on the surface to be finished of the workpiece. The abrasive element also has two radial faces which are subsequently positioned relative to the workholder to form filleted surfaces along the inner and outer radial edges of the workpiece.

This application is a division of our application Ser. No. 366,261, filed May 11, 1964, now Patent No. 3,313,066, dated Apr. 11, 1967.

This invention relates to grinding, and more particularly to finishing the edges of pressed or molded ware by abrasive grinding.

Pressed or molded ware has long been used for dinner ware, and large numbers of cups and bowls are presently formed from glass or other suitable materials by processes of this type. A typical indication that a piece of ware was produced by molding or pressing is the existence of mold, ring, or plunger joints or "parting" lines on the finished ware. Such lines appear as ridges along the portions of the finished articles engaged by the tools used in forming the article, and due to the practical requirements of manufacturing, may often appear on surfaces where the roughness of the lines create unaesthetic or dangerous conditions. One example of the location of such a parting line which may become dangerous is a lip surface of a cup or bowl, which may engage the lips or mouth area of a user of the ware. While the prior art has proposed various apparatus and methods for removing parting lines from finished ware, practice of the prior art methods requires considerable hand work to avoid the production of a sharp edge which may prove as unsatisfactory as the parting line originally existing on the ware.

It is an object of this invention to provide an improved finishing apparatus to remove parting lines from molded or pressed ware.

Another object of this invention is to provide an apparatus for removing parting lines from glassware resulting in safe and aesthetically pleasing final products.

Another object of this invention is to perform a finishing operation by machine, yielding a fully rounded or controlled contoured edge for a pressed or molded cup or bowl.

Other objects of the invention will be pointed out in the following description and claims and illustrated by the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode

which has been contemplated of applying that principle.

In the drawings:

FIG. 1 is a somewhat schematic representation of an apparatus, constructed and operating in accordance with the present invention, in a starting position;

FIG. 2 is a somewhat schematic representation of the apparatus during the performance of a first grinding step;

FIG. 2*a* is a part section view of the product of a first grinding step;

FIG. 3 is a somewhat schematic representation of the apparatus during the first step of the second grinding operation;

FIG. 3*a* is a somewhat schematic representation of the apparatus during the performance of the second step of the second grinding operation;

FIG. 3*b* is a part sectional view of the product of the second grinding operation;

FIG. 4 is a somewhat schematic representation of the apparatus during the first step of the third grinding operation;

FIG. 4*a* is a somewhat schematic representation of the apparatus during the performance of the second step of the third grinding operation; and

FIG 4*b* is a part sectional view of the product of the third grinding operation.

Briefly, the present invention employs a spool abrasive tool having a peripheral abrading face and two radial abrading faces. The abrasive tool is mounted for floating axial movement and may engage a glassware workpiece edge to create first a planar annular surface, then an outer filleted surface, and finally an inner filleted surface.

The construction of an apparatus embodying the present invention and the method of operation of the present invention may be better understood from a more complete discussion. As noted from FIG. 1, the abrasive working tool used in the apparatus takes approximately the form of a spool, having a first peripheral abrasive face **10** and two radial abrasive faces **11**, **12**. The abrasive element may be formed in any manner suitable for grinding glass articles, as widely known in the prior art, but diamond-type elements have been found to be most effective. The abrasive element is mounted for rotation by a shaft **13**, and the shaft is driven by any suitable power source, such as a pneumatic or electric motor **14**.

The motor **14** is carried by a pivot arm **15** which is mounted for movement about a pivot axis **16**. The weight of the grinding motor **14** is compensated for by a counterbalance **17** so that in a normal state of rest the grinding shaft **13** is approximately level.

When the apparatus is in the starting position, illustrated in FIG. 1, two stop or locking systems operate to prevent swinging movement of the pivot arm **15**. The first of these systems, serving a locking function, employs a pneumatic actuator or solenoid actuator **18** to insert a taper locking piston **19** into a taper bore **20** provided through an arm **21** extending from the pivot arm **15**. The locking piston **19** prevents lateral movement of the pivot arm **15** and thus holds it stationary. The second system operates as a payout stop to prevent sudden counterclockwise rotation of the pivot arm **15**, and has other functions as will appear from subsequent discussion. This system employs a stop element **22** to engage a hook arm **23** extending laterally from the pivot arm **15**. The position of the stop element **22** is controlled by a lead screw **23A** extending through a threaded opening in the stop element **22**. When desired, the lead screw **23** is driven by a rack **24** and pinion **25** in which the rack is positioned by a pneumatic or other suitable payout actuator **26**. In the starting position of FIG. 1, the stop element **22** is to the left but not touching hook arm **23**.

In FIG. 3, hook arm 23 strikes stop element 22 and prevents sudden counterclockwise rotation of the pivot arm 15 until payout by actuator 26.

Adjacent the position of the abrasive element is a lower ware chuck 27, mounted for rotation about a vertical axis on a shaft 28, and drivingly engaged by the shaft while capable of axial movement relative to the shaft. The lower ware chuck shaft 28 is driven from a suitable power source, such as an electric motor 29, by a belt transmission 30. An upper ware chuck 31 is mounted vertically over the lower ware chuck 27, and may rotate relative to its mounting shaft 32. The relative vertical position of the upper ware chuck shaft 32 may be controlled by a system to be described more fully subsequently, including a pneumatic cylinder 33 or other similar actuator.

The power transmission belt 30 driving the lower ware chuck shaft 28 also engages a downfeed drive shaft 34. The rotation of this shaft 34 is applied, through an electric clutch 35, to a downfeed feedscrew 36. Rotation of the downfeed feedscrew 36 controls the downfeed rate and position of a stop cap 37, which in turn controls the downfeed and position of an upper ware chuck stop 38. A stop element 39, carried by the upper extremity of the upper ware chuck shaft 32, engages the chuck stop 38 to limit the rate of downward movement of the upper ware chuck. Position of chuck stop 38 is controlled by timing the disengagement of clutch 35.

In preparing the apparatus for operation, a suitable piece of molded or pressed glassware 40 from which parting lines are to be removed or which is to receive a smoothed lip is placed in position on the lower ware chuck 27. The distance between the upper ware chuck 31 and the lower ware chuck 27 is sufficient to permit ease in positioning the glassware 40 in the desired manner, and the weight of the glassware 40 should not be sufficient to force the lower ware chuck 27 downwardly on the shaft 28 a distance sufficient to bring the lip of the glassware 40 into engagement of the abrasive element.

In order to remove any parting lines which may exist on the lip surface of the glassware 40, the upper ware chuck 31 is driven downwardly by the actuator 33 to engage the upper surface of the inverted glassware workpiece 40. As the upper ware chuck 31 engages the workpiece, the stop element 39 at the extreme upper end of the shaft 32 engages the chuck stop 38, preventing movement of the workpiece downwardly relative to the lower ware chuck shaft 28. The drive motors 14, 29 are then started to rotate the abrasive element, the lower ware chuck shaft 28, and the downfeed drive shaft 34. Actuation of the clutch 35 causes the downfeed shaft 34 to drive the downfeed feedscrew 36. Relative rotation between the feedscrew 36 and the stop cap 37 causes downward movement of the cap and the chuck stop 38 engaging the stop cap. This further downward movement of the upper ware chuck 31 forces the workpiece 40 downwardly so as to engage the lip of the workpiece with the peripheral surface 10 of the abrasive element. The use of the feedscrew to control grinding in accordance with the revolution of the workpiece 40 assures careful control over the removal rates in grinding a planar annular surface at the lip of the workpiece, avoiding edge chipping or other undesirable effects. The downward movement is completed with the stopping of chuck stop 38 by the disengagement of clutch 35, thus completing the grinding on surface 10.

The product of the grinding operation accomplished by the downward movement of the upper ware chuck is illustrated in FIG. 2*a*, while the positions of the elements of the apparatus during the grinding process are illustrated in FIG. 2. As may be seen, a substantially planar annular surface is ground at the lip edge of the workpiece 40, thus entirely removing any parting line that might otherwise appear on this portion of the ware. In order to remove any dangers occasioned by use of glassware having a sharp edge, and in order to improve the aesthetic appeal of glassware having parting lines removed by grinding, the present invention fillets the corners of the substantially planar annular surface, by grinding rounded or desired contoured corners. The unique abrasive element and the floating spindle operation now to be described make this result readily possible. At the conclusion of the grinding operation described above, at which time the workpiece 40 has been given a planar annular surface, the locking piston 19 is withdrawn from the taper bore 20 by operation of the actuator 18. The outer filleted surface is first formed by plunger 41 of urge cylinder 42 which is a pneumatic cylinder or other suitable actuator, engaging pivot arm 15 causing the arm to pivot counterclockwise with hook arm 23 striking element 22 as shown in FIG. 3. The payout actuator 26 is operated to move the rack and pinion 24, 25 so as to rotate the lead screw and move the element 22 toward the right. The arm 15 is thus payed out toward the right. This movement carries the abrasive element to the right as shown in FIG. 3*a* engaging the outer surface of workpiece 40. Block 22 continues movement to the right so that arm 15 is thus released to a free pivotal condition so that the abrasive face 11 may effectively follow workpiece 40.

The use of payout block 22 assures careful control over abrasive face 11 in contacting gently workpiece 40 avoiding edge chipping or other undesirable effects if arm 15 was not payed out at a controlled rate. As the pivot arm 15 is relatively long and pivotal motion very small a resulting approximate straight line following movement results in the outer corner of the workpiece 40 engaging one radial abrasive face 11 and the peripheral abrasive face 10 simultaneously, at the point of junction of the abrasive faces. This double engagement results in a smoothly blended or rounded outside corner, as illustrated in FIG. 3*b*.

During the course of the grinding operation, the payout lead screw mechanism is not in contact with the pivot arm 15. The relatively free pivotal movement of the swing arm and the relatively resilient urging force developed by the actuator 42 permit the pivot arm 15 to be floatingly held against workpiece 40. As a result, the abrasive element may effectively move in and out relative to the workpiece 40, to accommodate the inherent radial runout or waviness of a molded or pressed glass article.

While transverse movement of the abrasive element has been here described as obtained by use of the pivot arm 15, an alternative structure might use any axially movable shaft known in the prior art which would permit moving the abrasive element so as to engage both radial and peripheral faces simultaneously. The relatively higher costs of such structures makes the pivot arm structure here described more economically attractive, but the pattern of movement obtained from the axially movable shaft would be for all practical purposes identical.

In order to complete the finishing operation, and provide a fully rounded edge for the workpiece 40, the pivot arm 15, on completion of the outer filleted surface, is resiliently urged in clockwise relation by a plunger 43 and actuator 44 similar to the counterclockwise actuator 42. When moved in this direction, as in FIGS. 4 and 4*a* the abrasive element is moved to the left relative to the workpiece 40, and the inner corner of the planar annular surface is engaged by a second radial abrasive face 12 and the peripheral abrasive face 10. In a manner similar to that described above, as producing the outer filleted surface, an inner filleted surface is ground as illustrated in the finished article of FIG. 4*b*. During the course of this operation the payout stop mechanism is operated to move the stop element to the left thus moving pivot arm 15 to the left, engaging abrasive face 12 gently with workpiece 40. Block 22 continues overrun movement to the

left so that hook 23 of arm 15 is released so that the abrasive face is effectively free to follow workpiece 40.

On the completion of the grinding operation, and when the final product is satisfactorily finished, the apparatus returns to the starting position in order to accommodate the next workpiece. The resilient urge force of the clockwise actuator 44 is removed, so that the pivot arm 15 again seeks a normal balance position. In so doing, the lock actuator 18 projects the locking piston 19 into the tapered bore 20 to hold the pivot arm 15 stationary. To release the finished workpiece, the clutch 35 is disengaged, and pneumatic cylinder 33 lifts the upper ware chuck 31. A quick rewind system comprises a pneumatic or other suitable actuator 45, operates a rack 46 and pinton 47 to rotate a drive shaft 48. The drive shaft, through a rigid angle gearing mechanism 49, revolves the lead screw 36 causing a relatively upward movement of the cap 37. This movement raises the chuck stop 38. Once the workpiece 40 is moved out of any possible contact with the abrasive element, the actuator 33 for the upper ware chuck lifts it out of engagement with the workpiece to permit removal of the workpiece. At this time, the next workpiece may properly be positioned, and the cycle initiated again.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to the preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. A machine for grinding the end surface of a workpiece comprising, a workholder adapted to move longitudinally along a first axis and to rotate about said first axis, an abrasive element mounted to move longitudinally along a second axis and to rotate about said second axis, said abrasive element having a peripheral face and a radial face, means for correlating the movement of said workholder along said first axis with the movement of said abrasive element along said axis to move said peripheral face of said abrasive element into engagement with a workpiece carried by said workholder to form a planar annular surface and to move said radial face of said abrasive element into engagement with a radial edge of said planar annular surface to form a filleted surface.

2. A machine as claimed in claim 1, in which said first and second axes are perpendicular.

3. A machine for grinding the end surface of a workpiece comprising, a workholder adapted to move longitudinally along a fixed axis and to rotate about said axis, an abrasive element mounted to rotate about a second axis, said abrasive element having a peripheral face and first and second radial faces, and means for moving said abrasive element in correlation to movement of said workholder to first engage said peripheral faces with a workpiece to form a planar annular surface and to move said first radial face of said abrasive element to subsequently engage the outer radial edge of said planar annular surface to form a filleted surface and to then move said second radial face of said abrasive element to engage the inner radial edge of said planar annular surface to form a filleted surface.

4. A machine in accordance with claim 3, in which said second axis is perpendicular to said first axis when said peripheral face engages a workpiece.

5. A glassware finishing machine for grinding the end surface of a workpiece comprising, a workholder adapted to move longitudinally along a first axis and to rotate about said first axis, an abrasive element mounted to rotate about a second axis defined by a drive shaft, said abrasive element having a peripheral face and first and second radial faces, means for mounting said drive shaft on a frame to releasably pivot about a third axis remote from said second axis and mutually perpendicular to both said first and second axes, and means for correlating the movement of said workholder on said first axis, said abrasive element on said second axis and said frame on said third axis to cause said peripheral face of said abrasive element to first engage the workpiece to form a planar annular surface, said first radial surface of said abrasive element to subsequently engage the outer radial edge of said planar annular surface to form a filleted surface, and said second radial face of said abrasive element to subsequently engage the inner radial edge of said planar annular surface to form a filleted surface.

6. A glassware finishing machine as in claim 5, further including means for resiliently urging said pivotal frame about said third axis.

7. A glassware finishing machine as in claim 6, in which the means correlating the movement along said first, second and third axes includes means for achieving resilient engagement of a workpiece and said abrasive element, and means for allowing said abrasive element and workpiece to move relatively in accommodation to normal manufacturing variation of said workpiece.

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LESTER M. SWINGLE, *Primary Examiner.*

U.S. Cl. X.R.

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