

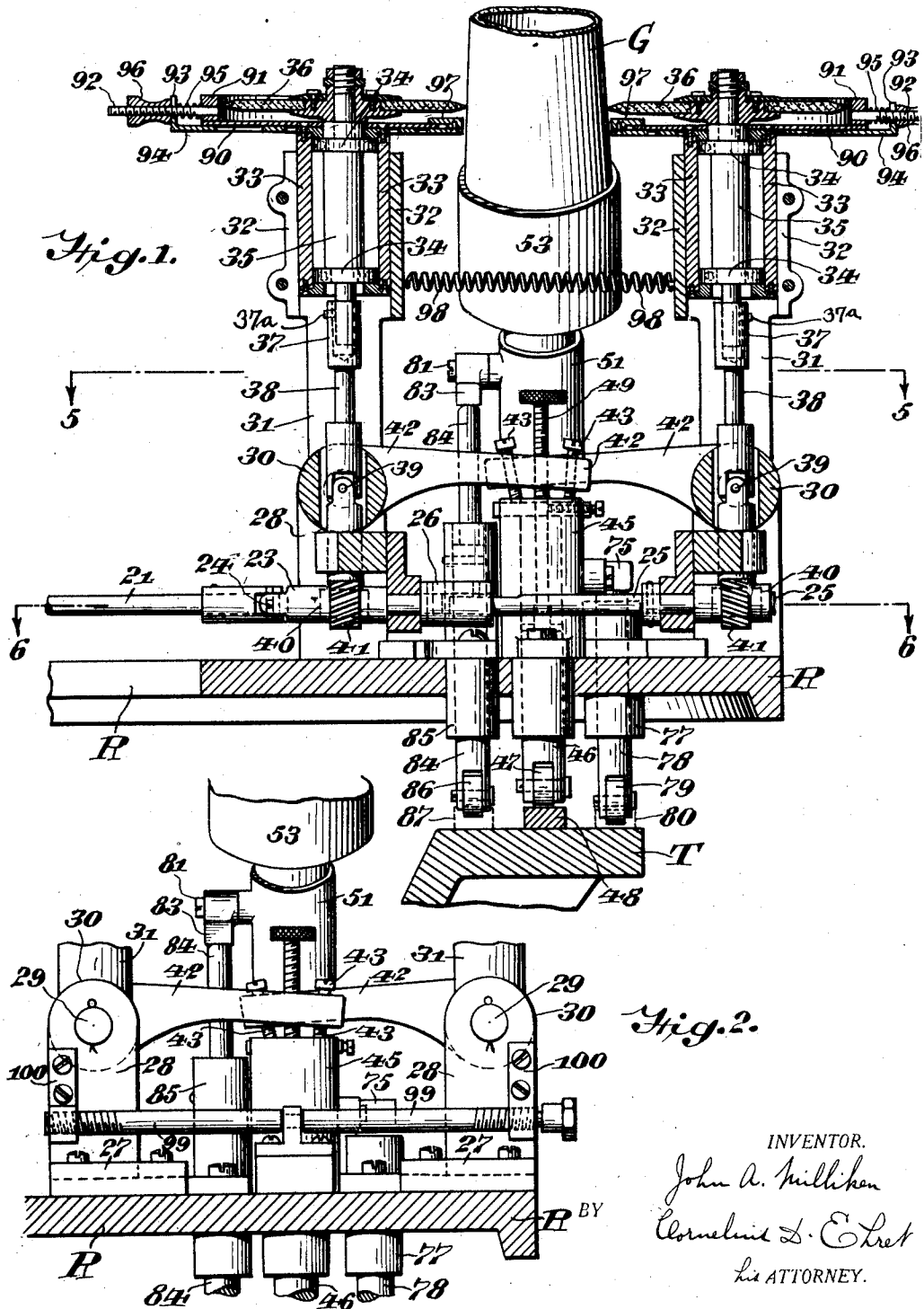
July 17, 1928.

1,677,484

J. A. MILLIKEN
GRINDING APPARATUS

Filed April 17, 1923

4 Sheets-Sheet 1



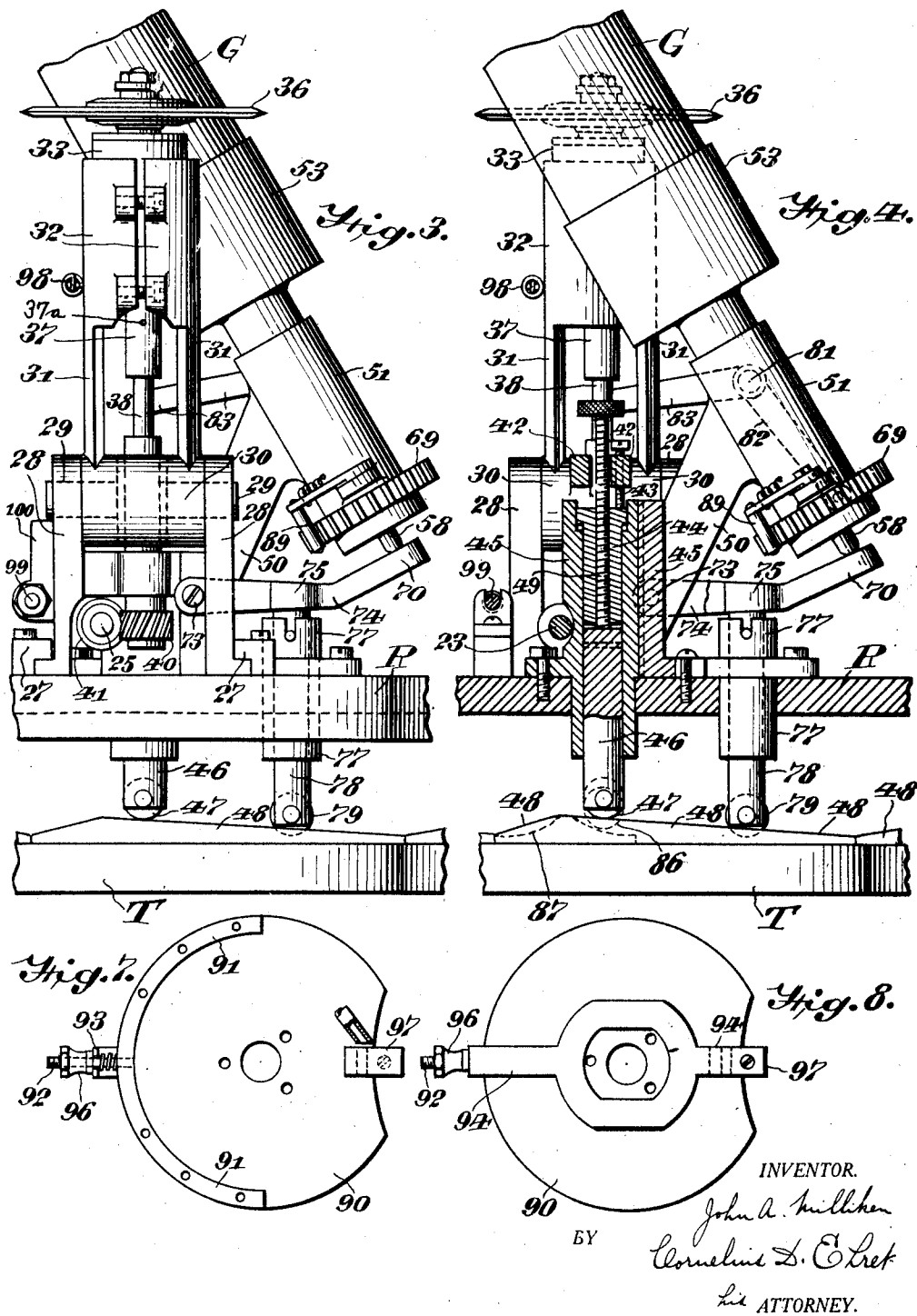
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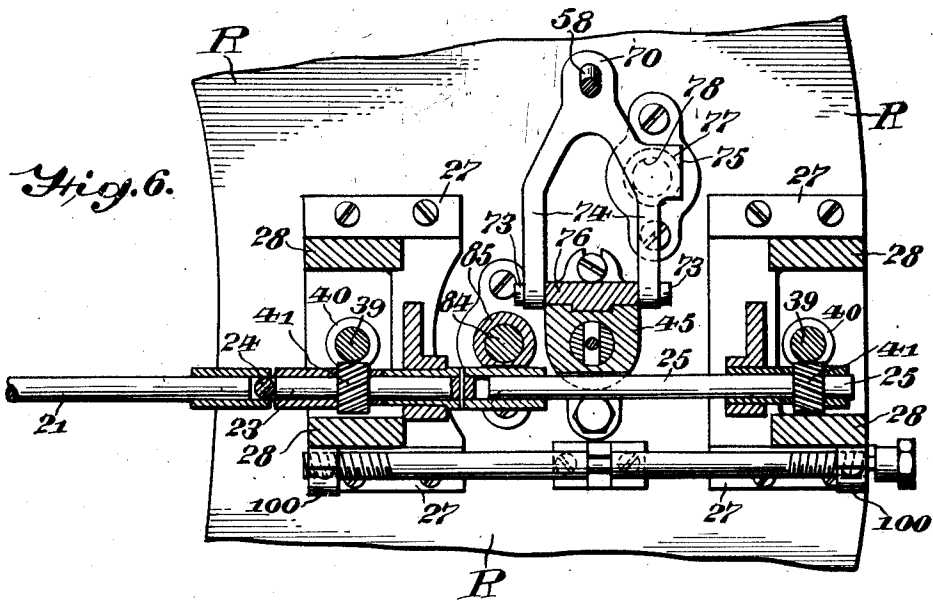
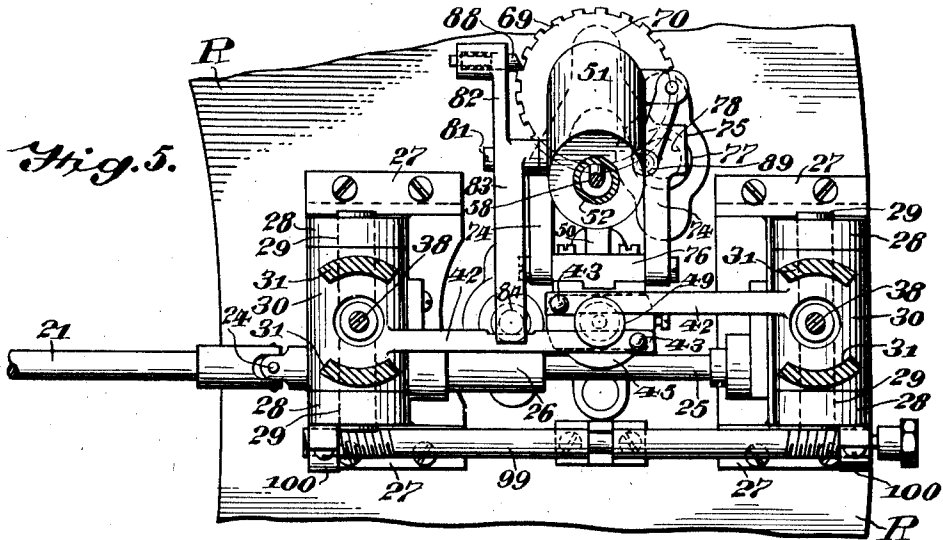
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GRINDING APPARATUS

Filed April 17, 1923

4 Sheets-Sheet 3



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July 17, 1928.

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GRINDING APPARATUS

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Fig. 9.

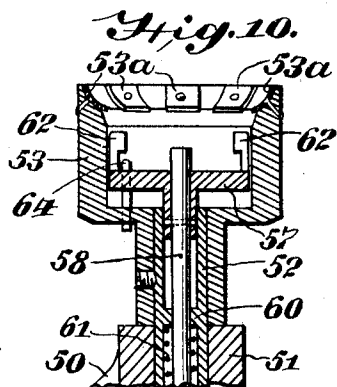
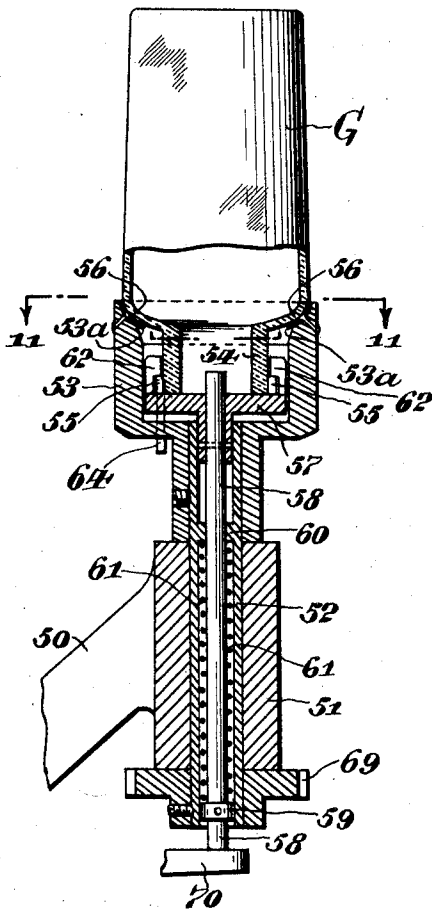


Fig. 11.

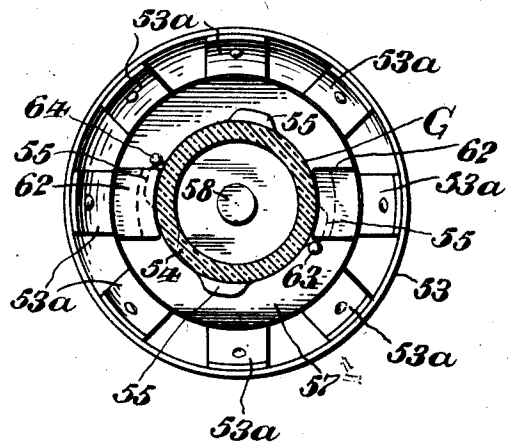
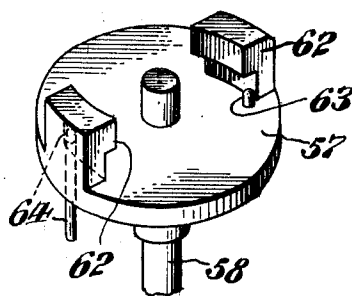


Fig. 12.



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GRINDING APPARATUS.

Application filed April 17, 1923. Serial No. 632,749.

My invention relates to grinding apparatus and particularly to apparatus for cutting or ornamenting glass ware, such as drinking glasses, tumblers, and the like.

5 This application is in part a division of my application Serial Number 481,501, filed June 30, 1921 and entitled Glass working apparatus.

My invention has for its objects the provision of an improved and simplified form of apparatus for cutting or decorating glassware and the like and for holding the articles while being operated upon.

One form of apparatus embodying my invention is shown in the accompanying drawing wherein:

Fig. 1 is a view, partially in section and partially in rear elevation, of a device embodying my invention.

20 Fig. 2 is a view, on an enlarged scale, of a portion of the apparatus shown in Fig. 1.

Fig. 3 is a view of the apparatus of Fig. 1, in side elevation.

Fig. 4 is a view partially in side elevation and partially in section of a portion of the apparatus shown in Fig. 1.

Fig. 5 is a horizontal sectional view, partially in plane, taken on the line 5—5 of Fig. 1.

30 Fig. 6 is a view, partially in plane and partially in section, taken on the line 6—6 of Fig. 1.

Figs. 7 and 8 are top and bottom plan views, respectively, of the combined guard plate and gage device which I employ.

Fig. 9 is a view, partially in elevation and partially in section, of the chuck for holding a glass article.

Fig. 10 is an enlarged detail view of a portion of the apparatus of Fig. 9.

Fig. 11 is a view taken on the line 11—11 of Fig. 9.

Fig. 12 is an enlarged detail view of the gripping member of the chuck.

45 My invention is shown in the drawings as adapted for use in connection with a rotatable table, driving mechanism therefor, and stationary cam members, such as shown for example in my application for patent above referred to. In the present case, the movable table or structure is represented at R, said table serving as a carrier for the mechanism to be hereinafter described. T represents a base, or other stationary member, provided

with cam members to be hereinafter described, and along which the table R moves. It will be understood that instead of moving the table R such member could be made stationary and the cam members moved relatively to the table R.

60 Secured upon the table R are the guides 27, by which are held the vertical standards 28 carrying the horizontal pivot shafts 29. Movably mounted on said shafts 29 are the cylindrical members 30 which are provided with upwardly extending standards or arms 31 carrying at their upper ends the sleeve members 32. Bearing sleeves 33 are supported by the members 32 and longitudinally adjustable with respect thereto, said sleeves supporting the bearings 34 for a rotary shaft 35, upon whose upper end is secured the cutter or grinding wheel 36. The shaft 35 is connected with a driving shaft 38 by means of a sleeve 37 and a set screw 37^a so as to permit of relative longitudinal adjustment of said shaft 35 with respect to the driving shaft 38. Said driving shaft is actuated by the shaft 38, in turn driven through the universal joint 39, driven by the gear 40, in turn driven by the gear 41, said gears 41 being secured, respectively, upon the sections 23 and 25 of a power shaft 21, through a universal joint 24.

85 Secured to or integral with each member 30 is a laterally extending arm 42 carrying at its end an adjusting screw 43 bearing upon the upper end of the adjustable abutment member 44 (Fig. 4) slidable vertically in the guide member 45 secured upon the table R. Vertically slidable in the member 45 is the plunger or cam follower 46 in whose lower end is pivoted a roller 47 engaging cams 48 disposed in a circumferential series upon the stationary member T. An adjusting screw 49 threaded in the member 44 (Fig. 4) abuts against the upper end of the member 46, rotation of the screw 49 serving to adjust the vertical throw of the member 44 by the cam 48.

100 Disposed between the two cutter structures of a pair is an arm 50 having a sleeve like guide portion 51. The arm 50 is carried by a member 76 (Fig. 6) carried on the table R.

105 The tumbler or other article G is supported by a chuck 53 that may be of any desired form, such for example as the form shown in Figs. 9 to 12 to be hereinafter de-

scribed. A rod 58 extends into chuck body 53 and serves to operate the gripping members (not shown) of the chuck to engage and release the article G.

- 5 The chuck is rotatably supported by the sleeve 51, rotative movement thereof being effected by means of a notched or indexing wheel 69 that is actuated in a manner to be hereinafter described.
- 10 Located contiguously to the member 45 is a member 76 provided with pivot lugs 73 which movably engage the arms of a bifurcated lever 74 (see Figures 4 and 6). Said lever is provided with a chuck operating portion 70 and a lug 75. The member 76 also supports or carries the arm or bracket 50. The lug 75 enters a sleeve 77 located beneath it on the table R and engages a cam follower 78 which is provided at its lower end with the roller positioned to engage a cam 80 carried by the table T. In operation, the follower 78 is moved upwardly by the cam 80 once during each revolution of the table R thereby actuating the lever 74, which in turn moves the rod 58 upwardly to actuate the chuck to free the article G. Said article may then be removed and replaced by another, the holder or chuck gripping an article as the roller 79 again passes off of the cam 80.

- Pivoted to the member 51 at 81 is a bell crank lever having the arms 82 and 83. Co-acting with the arm 83 is the plunger or cam follower 84 movable vertically in the sleeve 85 carried by the table R. The plunger 84 carries at its lower end a roller 86 adapted to ride upon cams 87 disposed in a circumferential series upon the stationary member T. When the roller 86 rolls up the cam 87, the plunger 84 is raised, thereby rotating the bell crank lever upon its pivot 81 and causing the pawl 88 (Fig. 5) resiliently mounted in the lower end of the bell crank arm 82, to step the aforesaid notched or indexing wheel 69 around one notch. The wheel 69 is locked after each actuation in the position to which actuated, by a pin or dog 89 (Fig. 4), suitably mounted and biased by a spring or equivalent means to the locking position.

- Referring to Figs. 1, 7 and 8, there is secured upon the upper end of each sleeve 33 a plate 90 having the arcuate upstanding member 91 partially surrounding the cutter wheel 36 as a guard or shield. Secured to and extending radially outward from the member 91 is a threaded rod 92 extended through a slotted lug 93 carried by a member 94, a spring 95 surrounding the rod 92 and disposed between the lug 93 and the member 91. Threaded upon the rod 92 is the thumb nut 96, which when turned causes radial movement of the member 94 to suitably adjust or position a stop 97 carried at the end of the member 94 and embracing the

edge of the plate 90. A spring 98 biases the cutters 36 into engagement with the article G. The stop 97 serves to limit the movement of the cutter wheel 36 toward the article G when such stop or depth gage member 97 engages said article.

The chuck which I employ has its body portion 53 rotatably supported within the cylindrical bearing 51 of the arm 50 as above explained. A sleeve-like member 52 is rigidly secured to the body 53 and serves as a shaft for supporting the chuck within the bearing block 51, the notched wheel 69 being secured to the lower end of the hollow shaft 52.

A rod 58, which is provided with a collar or flange 59, extends through the sleeve shaft 52 and is engaged at its lower end by the pivoted arm 70. At its upper end, the rod 58 has secured thereto a gripping member 57 that is provided with two hooks or overhanging lugs 62. The glass article G is provided with a neck 54 upon which are formed two pairs of lugs 55 either pair of which may be engaged by the hook members 62, in the manner of a bayonet joint, the rotative movement of the tumbler G, when placed within the gripping member 57 being limited by pins 63 and 64 that serve as stop members, in the manner shown in Fig. 11. These pins are rigidly secured to the member 57. The pin 64 extends through a hole in the bottom of the body 53, to prevent rotative movement of the gripping member 57 with respect to said body.

The upper end of the chuck body 53 is bevelled or cupped and provided with rubber pads 53^a riveted thereto, these pads serving as seats for the shoulder portion 56 of the tumbler G.

A compression spring 61 is inserted between the flange 60 of the sleeve shaft 52 and the collar 59, to normally bias the rod 58 downwardly and hold the tumbler yieldingly against the seat members 53^a. Upon engagement of the cam roller 79 with the cam lug 80 as above explained, the lever 70 is raised, thus raising the rod 58 and gripping member 57 to the position shown in Fig. 10, against the compression of the spring 61, thereby moving the tumbler G from its seat and permitting removal thereof from the gripping member 57.

The operation of the apparatus is as follows:

With the cutters or grinders 36 driven by the shaft 21 as above explained, and the glass article G supported in the chuck 53, relative movement, in a horizontal direction, is imparted to the table R and the cam supporting member T. A series of cam lugs 48, only one of which is shown, are spaced sufficiently apart that the period occupied by the table R in carrying the roller 47 from one to the other will be sufficient to enable the grinders 36 to each make a cut of the

desired depth in the article G. Upon encountering a cam lug 48 the plunger 46 is raised to lift the arms 42 and thereby move the cutters out of engagement with the article being ground. At this stage, the roller 86 encounters a cam lug 87, thereby effecting movement of the lever 83 (Fig. 4) to impart a slight rotative movement to the chuck 53 and present unground areas of the article G to the cutters 36. The roller 46 then passes out of engagement with the cam 48 and permits the grinders 36 to be moved into engagement with the article G by the spring 98. Stepped rotative movements as just described are imparted to the chuck 53 until it has made a complete revolution about its axis, the cutters 36 being moved out of engagement with said article during each step of rotative movement thereof. At this time, and with two complete annular rows of circumferential cuts upon the article G, the roller 79 encounters a cam member 80, to effect upward movement of the arm 70 and the chucks controlling rod 58, to thereby permit removal of the article G and the insertion of another article in the chuck. At this period the roller 47 is raised by one of the cam members 48, to hold the grinders 36 in retracted position.

It will be understood that vertical movements of the plungers 84, 46 and 78 will be effected in any desired manner, it being necessary only that they be actuated in proper sequence to effect the desired rotative movement of the chuck, retractive and advanced movement of the grinders, and release of the article.

Various changes in detail and general arrangement may be made without departing from the spirit and scope of the invention as defined in the accompanying claims.

What I claim is:

1. A grinding apparatus of the character described comprising relatively spaced rotatable grinders, a rotatable work holder interposed between said grinders, a power shaft for actuating said grinders, and means whereby the grinders may be adjusted with respect to the power shaft and axially of said work shaft.

2. A grinding apparatus of the character described comprising rotatably mounted grinders, a work holder, a power shaft, and driving connections between said grinders and said power shaft, said driving connections being extensible so that the grinders may be adjusted axially of the work holders without breaking the driving connections with said power shaft.

3. A grinding apparatus of the character described comprising a grinder, a work holder, a power shaft, a driving connection between the holder and the power shaft, and means for oscillating the grinder toward and from the work holder, said driving con-

nection having means for maintaining its driving engagement with the power shaft during oscillation of the grinder.

4. A grinding apparatus of the character described comprising a grinder, a work holder, a power shaft, a driving connection between the holder and the power shaft, means for oscillating the grinder toward and from the work holder, means for maintaining driving connection with the power shaft during oscillation of the grinder, and means whereby the grinder may be adjusted with respect to the power shaft and axially with respect to the work holder.

5. A grinding apparatus of the character described comprising a work holder, a slidable support movable toward and from said work holder, a grinder carrier pivotally mounted on said support, and means for periodically oscillating said grinder carrier on its pivot.

6. A grinding apparatus of the character described comprising a work holder, a pair of spaced apart slidably mounted supports capable of relative adjustment with respect to the work holder and to each other, grinder carriers pivotally mounted on the respective supports, and means for periodically oscillating said carriers in unison upon their respective pivots.

7. A grinding apparatus of the character described comprising a work holder, a slidable support movable toward and from said work holder, a grinder carrier pivotally mounted on said support, a grinder rotatably mounted on said carrier, means for periodically oscillating said grinder carrier on its pivot, a power shaft having a driving connection with said grinder, and means maintaining said driving connection irrespective of the position of said slidable support.

8. A grinding apparatus of the character described comprising a work holder, a slidable support movable toward and from said work holder, a grinder carrier pivotally mounted on said support, a grinder rotatably mounted on said carrier, means for periodically oscillating said grinder carrier on its pivot, a power shaft having a driving connection with said grinder, said driving connection including means for maintaining its engagement with said drive shaft irrespective of the position of said slidable support, and means maintaining said driving connection during oscillation of said grinder carrier.

9. A grinding apparatus of the character described comprising a work holder, a slidable support movable toward and from said work holder, a grinder pivotally mounted on said support, means for periodically oscillating said grinder upon its pivot toward and from said work holder, a power shaft having a driving connection with said

grinder, and means maintaining said driving connection irrespective of the position of said slidable support.

10. A grinding apparatus of the character described comprising a work holder, a slidable support movable toward and from said work holder, a grinder pivotally mounted on said support means for periodically oscillating said grinder on its pivot toward and from said work holder, and a power shaft having a driving connection with said grinder, said driving connection including a universal joint so that driving engagement with the drive shaft may be maintained irrespective of the position of said slidable support, and during oscillation of said grinder.

11. Grinding apparatus comprising a pair of spaced supports, grinders pivotally mounted in said supports and rotatable about individual axes, a work holder between said grinders, means for adjusting the relative positions of said supports, and means for adjusting one of said grinders parallel of its axis and independently of the adjustment of said supports.

12. Grinding apparatus comprising a work holder, pivoted supports, a rotary cutter carried by each of said supports, a spring biasing said supports toward each other and toward said work holder, means for imparting step-by-step movements to said holder, and means for actuating said supports to move the cutters away from said holder in opposition to said spring during said movements of the holder.

13. A grinding apparatus of the character described comprising a pair of pivoted supports, each provided with a cutting tool, a work holder, an actuating member for periodically oscillating the supports to move the cutting tool toward and from the work holder, adjusting means interposed between the actuating member and the supports to limit said oscillating movement, and gages carried by the respective supports, said gages being positioned to engage an article carried by the work holder to limit the depth of the cuts made by said tools.

14. Grinding apparatus comprising a pair of pivoted supports, cutting tools mounted on said supports, a work holder disposed between said tools, means for oscillating said supports to move said tools toward and away from said work holder, means for adjusting the operative relation of said last named means and said support, and an adjustable gage device mounted upon each of said supports in position to engage an article carried by said work holder, to limit the depth to which the article will be cut by said tools.

15. Grinding apparatus comprising a pair of pivoted supports, a cutting tool car-

ried by each of said supports, a work holder disposed between said cutting tools, a crank arm carried by each of said supports, a movable member engaging said crank arms to oscillate said supports and move said tools toward and away from said work holder, an adjusting device for positioning said arms with respect to said movable member to limit the movement of said supports relative to said work holder, and a gage device carried by each of said supports in position to engage an article carried by said work holder, to limit the depth of cuts to be made by said tools.

16. Grinding apparatus comprising a pair of pivoted supports, a cutting tool carried by each of said supports, a work holder disposed between said cutting tools, means for oscillating said supports to cause said tools to move toward and away from said work holder, and an adjustable connection between said supports and said means for holding said tools in spaced relation to said work holder after an article has been removed from said holder.

17. Grinding apparatus comprising a pivoted support, a cutting tool carried by said support, a work holder mounted in position to be engaged by said cutting tool, plunger for oscillating said support, and an adjustable connection between said plunger and said support adapted to serve as a stop member for limiting the movement of said cutting tool toward said work holder after an article has been removed from said holder.

18. Grinding apparatus comprising a pivoted support, a cutting tool carried by said support, a work holder mounted in position to be engaged by said cutting tool, means for oscillating said support, an adjustable connection between said means and said support adapted to serve as a stop member to limit the movement of said cutting tool toward said work holder after an article has been removed from said holder, and a gage device carried by said support in position to engage an article held by said holder to limit the depth of cut therein made by said tool.

19. Grinding apparatus comprising a pivotally mounted support, a cutting tool carried thereby, a work holder mounted in position to co-operate with said cutting tool, means for oscillating said support, means independent of said work holder for limiting the movement of said support toward said holder, and means for engaging an article carried by said holder to limit the depth of cut made by said tool.

20. Grinding apparatus comprising a pivotally mounted support, a cutting tool carried thereby, a work holder mounted in position to co-operate with said cutting tool, means for oscillating said support, means independent of said work holder for limiting the movement of said support toward said

holder, means for engaging an article carried by said holder to limit the depth of cut made by said tool, and means for shifting the pivot point of said support toward
5 and away from said work holders.

21. Grinding apparatus comprising a pivoted support, a cutting tool carried by said support, a work holder mounted in position to co-operate with said cutting tool, means
10 for oscillating said support about its pivot and means for shifting the pivot point of said support toward and away from said work holder.

22. Grinding apparatus comprising a
15 table, a grinder support pivotally mounted upon said table for oscillation in a plane at right angles to the plane of said table, a rotatable work holder supported by said table, a reciprocatory member for rotating said
20 work holder about its axis, reciprocable members disposed vertically of the table and respectively engaging said grinder support and said reciprocable member, and means for operating said vertical members in predetermined
25 relation.

23. Grinding apparatus comprising a table, a grinder pivotally supported by said table, a work holder supported by said table, means for rotating said work holder about
30 its axis, releasing mechanism for disengaging an article from said holder, reciprocable disposed vertically of the table and respectively associated with said grinder support, rotating means and releasing mechanism, and
35 means for operating said reciprocable members in predetermined relation to effect the cutting of a pattern circumferentially of the article, to move the cutter out of engagement with the article, and to actuate said releasing
40 mechanism.

24. Grinding apparatus comprising a table, a work holder, a grinder movable relatively to said holder, means for rotating said holder, and members reciprocable vertically
45 of the table for respectively shifting the axial angularity of said holder, rotating said holder about its axis, and moving said grinder.

25. In a grinding apparatus, the combination with a grinding wheel, of a guard member therefor, a movable depth gage extending
50 diametrically across one face of said guard member, and adjusting means for imparting rectilinear movement to said gage.

26. In a grinding apparatus, the combination with a grinding wheel, of a guard member therefor, said guard member having a curved portion concentric with and partially encircling said grinding wheel, a movable
60 depth gage extending diametrically across said guard member, and adjusting means co-operating with said curved portion for moving said gage.

27. In a grinding apparatus, the combina-

tion with a grinding wheel, of a guard member therefor having a rearwardly extended
65 projection, a movable depth gage extending diametrically across one face of said gage member, and means cooperating with said projection for moving said gage.
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28. In a grinding apparatus, the combination with a grinding wheel, of a guard member therefor, said guard member having a curved portion concentric with and partially encircling the grinding wheel, said curved
75 portion having a rearwardly extended projection, a movable depth gage having a lug engaging said projection, and means cooperating with said lug and said projection for moving said gage.
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29. In a grinding apparatus, the combination with a grinding wheel, of a guard member having an abutment provided with a rearwardly extended threaded projection, a
85 movable depth gauge having a lug engaging said projection, a spring interposed between said lug, and a contiguous portion of said guard member, and an adjusting nut engaging said threaded projection and bearing
90 against said lug.

30. A chuck for an article of glass having an extension provided with a seating surface and with a circumferentially incomplete lug, comprising a body portion, a seat,
95 a gripping member movable axially of said body, and a circumferentially incomplete lug on said gripping member for engaging the rear side of said first named lug to hold said article against said seat.

31. A chuck for an article of glass having
100 an extension provided with a seating surface and with a circumferentially incomplete lug, comprising a body portion, a seat, a gripping member movable axially of said
105 body, a circumferentially incomplete lug on said gripping member for engaging the rear side of said first named lug when said article is moved against said gripping member and turned about its axis, and stop members
110 for limiting the said turning movement.

32. A chuck for an article of glass having an extension provided with a seating surface and with a plurality of circumferentially incomplete lugs, comprising a body
115 portion, a seat, a gripping member movable axially of said body, a plurality of circumferentially incomplete lugs on said gripping member for engaging the rear side of said first named lug when said article is
120 moved against gripping member and turned about its axis, and stop members for limiting the said turning movement.

33. A chuck comprising a body having a seating surface adapted to engage an external surface of an article intermediate the
125 ends thereof, a gripping member movable axially of said body and adapted to engage the article to hold it against said seat, and

means for preventing rotative movement of said gripping member with respect to said body in one direction.

34. Apparatus for operating on an article of glass having a seating surface and a lug, comprising a chuck body, a seat, holding structure movable axially of said body, and a lug rigidly secured to said structure and adapted to engage the lug of said article to hold the article against said seat.

35. A chuck comprising a body portion having a seating surface, a gripping member movable axially thereof and having a circumferentially incomplete lug provided with a circumferentially disposed open-ended slot to effect a releasable connection with an article of complementary form, and means for moving said gripping member axially to hold the article against said seat.

36. A chunk for holding an article provided with circumferentially spaced lugs and with a seating surface disposed circumferentially thereof, comprising a body member, a seat on said body member for said seating surface, a gripping member movable axially of said body, and lugs on said gripping member for engaging the lugs on said article to hold said article against said seat.

37. A chuck for holding an article provided with circumferentially spaced lugs and with a seating surface disposed circumferentially thereof, comprising a body member, a seat on said body member for said seating surface, a gripping member movable axially of said body, and lugs on said gripping member for engaging the lugs on said article, and means for biasing said gripping member in a direction to yieldingly hold said article against said seat.

38. A holder for an article provided with circumferentially spaced lugs and with a circumferentially disposed seating surface, comprising a chuck body provided with a seat for said seating surface, a gripping member provided with over-hanging lugs adapted to engage the rear sides of said first named lugs, and means for moving the said gripping member axially of said body to control the position of said article with respect to said seat.

39. A holder for an article provided with an extension having a lug and with a seating surface, comprising a chuck body, a seat for said seating surface, a gripping member provided with an over-hanging lug adapted to engage the rear side of said first named lug when said extension is moved into engagement with said gripping member and rotated to bring said lugs opposite one another, and means for imparting relative movement to said gripping member and said seat to control the position of said article with respect to said seat.

40. A holder for an article provided with an extension having a lug and with a seating

surface, comprising a chuck body, a seat for said seating surface, a gripping member provided with an over-hanging lug adapted to engage the rear side of said first named lug when said extension is moved into engagement with said gripping member and rotated to bring said lugs opposite one another, and means for imparting relative movement to said gripping member and said seat to control the position of said article with respect to said seat, the said seating surface and extension of said article being spaced axially thereof.

41. A holder for an article provided with circumferentially spaced lugs and with a circumferentially disposed seating surface, comprising a chuck body provided with a seat for said seating surface, a gripping member provided with over-hanging lugs adapted to engage the rear sides of said first named lugs, and means for moving the said gripping member axially of said body to control the position of said article with respect to said seat, the said seating surface and lugs of said article being spaced axially thereof.

42. A holder for an article provided with circumferentially spaced lugs and with a circumferentially disposed seating surface, comprising a chuck body provided with a seat for said seating surface, a gripping member provided with overhanging lugs adapted to engage the rear sides of said first named lugs, and means for moving the said gripping member axially of said body to control the position of said article with respect to said seat, the said seating surface being located at a position intermediate the bottom of said article and the said lugs.

43. A chuck comprising a body portion having a seating surface, a gripping member movable axially thereof and having its front end of a form adapted to effect a bayonet joint connection with an article complementary thereto, and means for moving said gripping member axially to hold said article against said seat.

44. A chuck comprising a rotatable body portion provided with a seat, a gripping member movable axially thereof and adapted to engage an article to hold it against the said seat, and means for preventing rotative movement of said gripping member with respect to said body.

45. A chuck comprising a seat, a yieldable article-engaging surface on said seat, and means for holding an article in position against said surface.

46. A chuck comprising a seat, resilient pads on said seat, and means for holding an article in position against said pads.

47. A chuck comprising a seat, circumferentially spaced pads on said seat, and means for holding an article in position against said pads.

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48. Grinding apparatus comprising a pair of pivoted supports, a cutting tool carried by each of said supports, a work holder mounted in position to co-operate with said cutting tools, means for oscillating said supports, and an adjustable connection between each of said supports and said means for independently adjusting said supports.

49. Grinding apparatus comprising a pair of pivoted supports, a cutting tool carried by each of said supports, a work holder mounted in position to co-operate with said tools, means for oscillating said supports to cause said tools to move toward and away from said work holder, and an adjustable connection between said supports and said means for simultaneously adjusting said tools with respect to said work holder.

50. Grinding apparatus comprising a pair of pivoted supports, a cutting tool carried by each of said supports, a work holder mounted in position to co-operate with said tools, means for oscillating said supports to cause said tools to move toward and away from said work holder, and adjustable connections between said supports and said means for, respectively, independently and simultaneously adjusting said tools with respect to said means.

51. Grinding apparatus comprising a pair of pivoted supports, a rotatable cutting tool carried by each of said supports, a work holder mounted in position to co-operate with said tools, means for oscillating said supports to cause said tools to move toward and away from said work holder, adjustable connections between said supports and said means for independently adjusting said supports, and means for independently adjusting said cutting tools longitudinally of their axes.

52. Grinding apparatus comprising a rotatable shaft, a cutting tool mounted thereon, an oscillatory support for said shaft, a driving member for said shaft, mounted independently of said support, and a universal joint between said shaft and said driving member.

53. Grinding apparatus comprising a pair of rotatable shafts, a cutter carried by each

of said shafts, an oscillatory support for each of said shafts, a common driving shaft for said first named shafts, and a universal joint between said driving shaft and each of said first named shafts.

54. Grinding apparatus comprising a rotatable cutter, a rotatable holder whose axis is inclined with respect to the axis of said cutter, an oscillatory support for said cutter, an arm secured to said support, and means for actuating said arms to oscillate said support.

55. Grinding apparatus comprising a pair of oscillatory supports, a rotatable cutter mounted upon each of said supports, a work holder disposed between said supports and having its axis inclined with respect to the axes of said cutters, an arm carried by each of said supports, and means for actuating said arms to oscillate said supports.

56. The combination with a grinding tool, of a work holder mounted in position to co-operate therewith, a support for said work holder, and means for rotating said work holder in said support, comprising a pawl pivoted upon said support, a toothed member secured to said work holder, and means for oscillating said pawl to impart a rotative movement to said toothed member.

57. A chuck comprising a supporting member, a holding device rotatably mounted in said supporting member, a toothed member carried by said holding device, a pawl pivotally mounted upon said supporting member, and means for oscillating said pawl to impart relative movement to said toothed member.

58. A chuck structure comprising a supporting member, a holding device rotatably supported in said supporting member, and provided with teeth, and a bell crank pivotally mounted upon said supporting member, one arm of said crank being adapted to engage said teeth and the other arm thereof serving as an actuating lever.

In testimony whereof, I have hereunto affixed my signature this 9th day of April, 1923.

JOHN A. MILLIKEN.