

July 12, 1927.

J. A. MILLIKEN

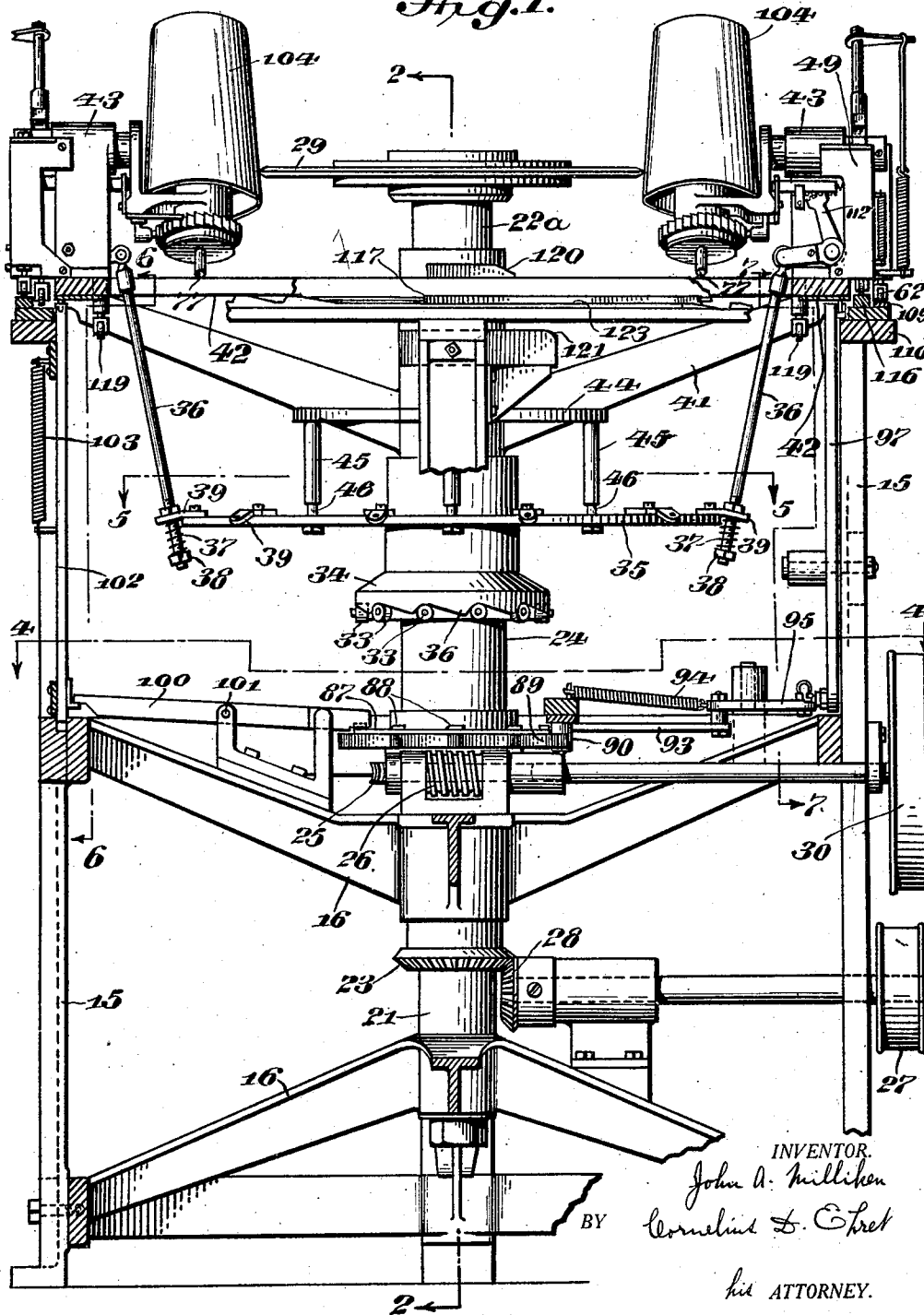
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GLASS GRINDING MACHINE

Filed Nov. 1, 1922

7 Sheets-Sheet 1

Fig. 1.



July 12, 1927.

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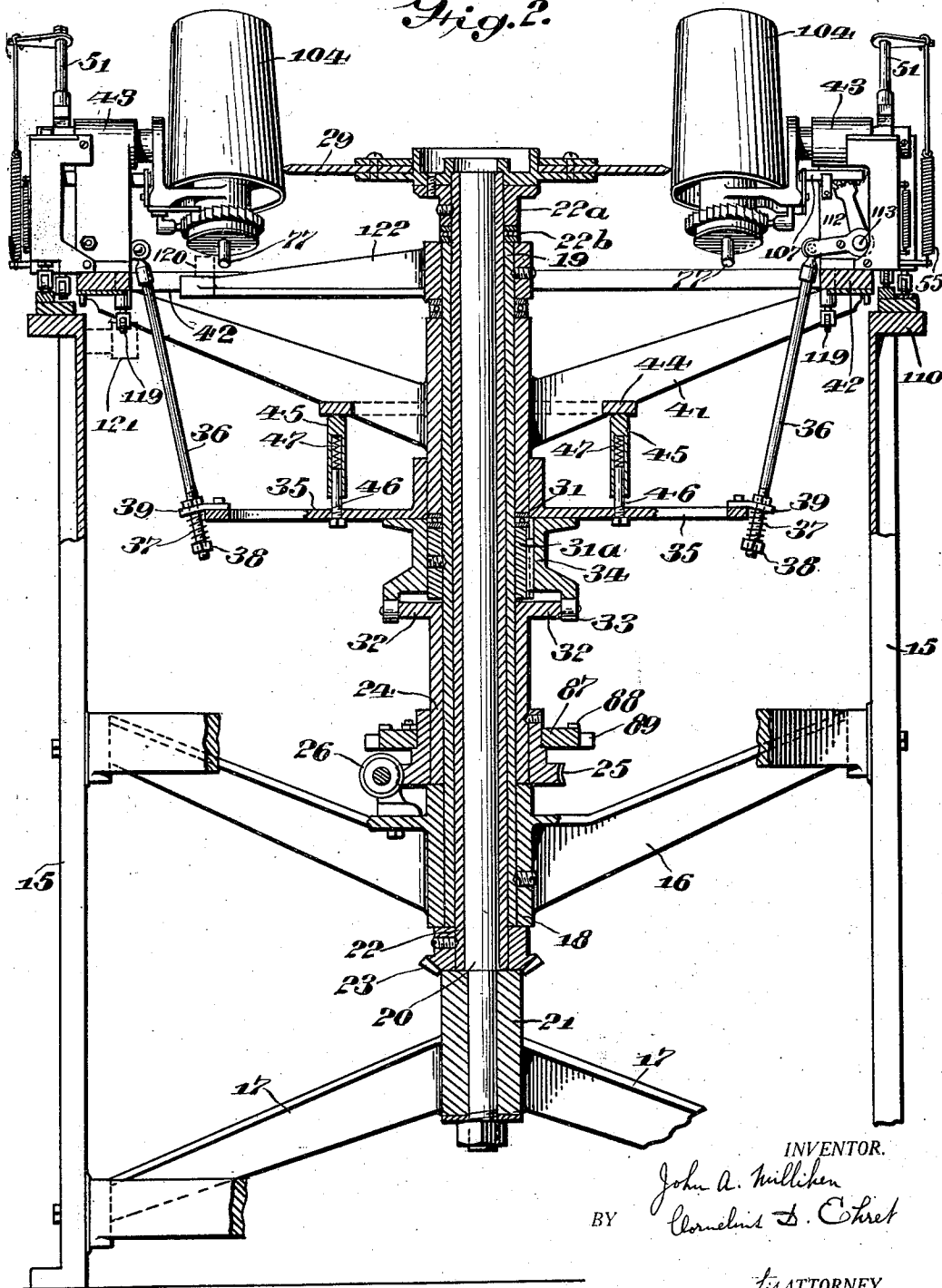
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7 Sheets-Sheet 2

Fig. 2.



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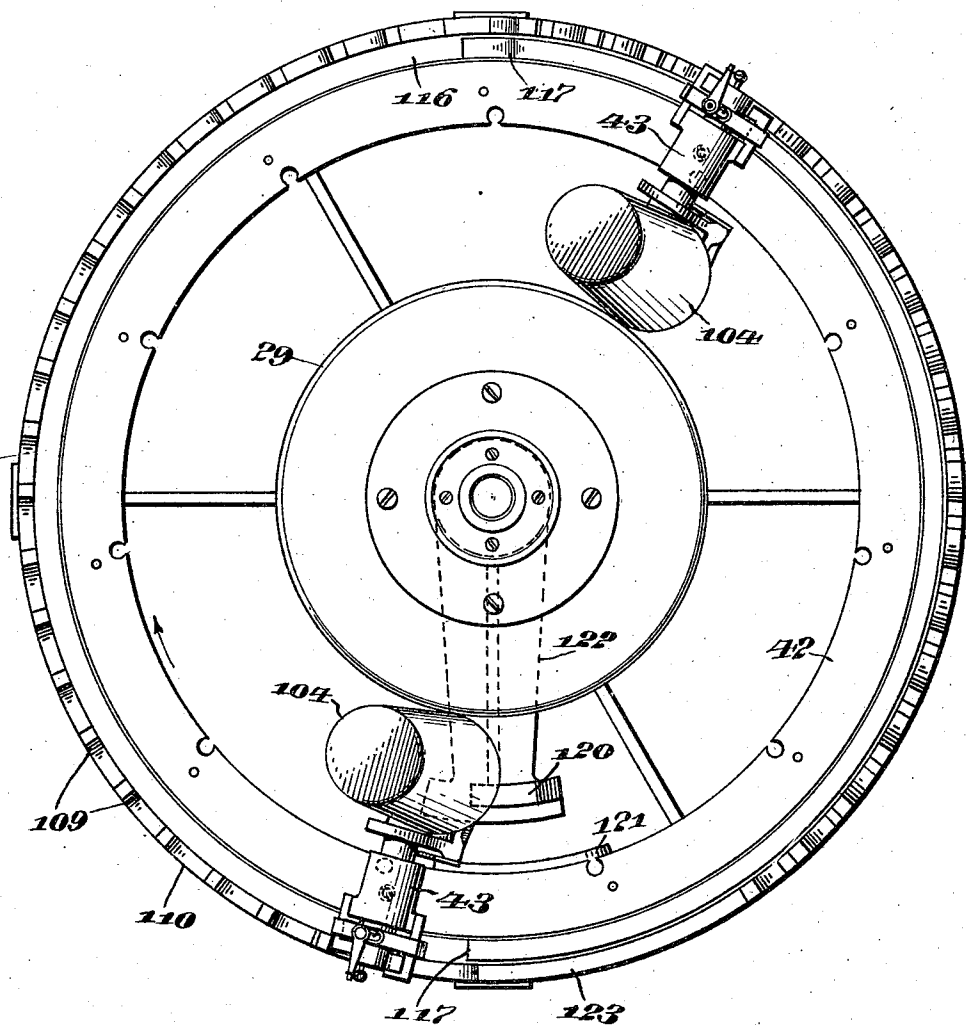
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1,635,491

7 Sheets-Sheet 3

Fig. 3.



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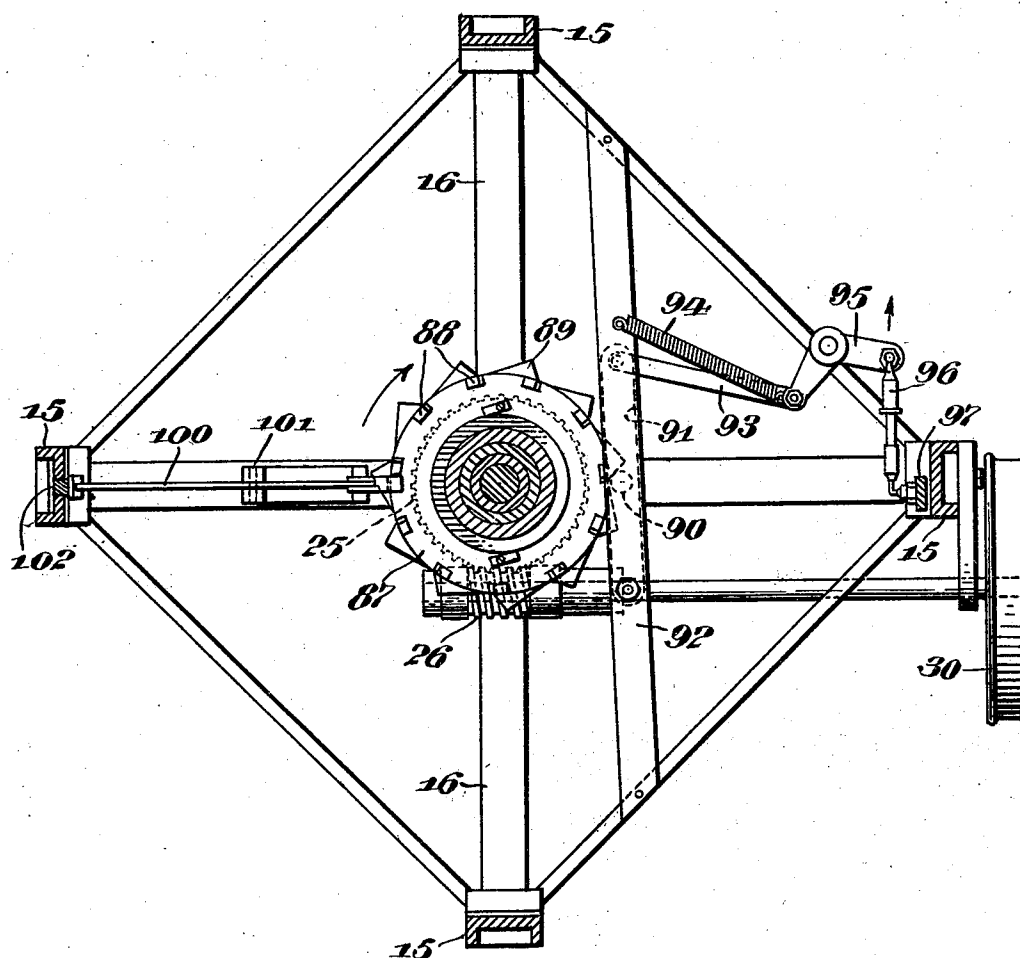
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GLASS GRINDING MACHINE

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7 Sheets-Sheet 4

Fig. 4.



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1,635,491

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7 Sheets-Sheet 5

Fig. 5.

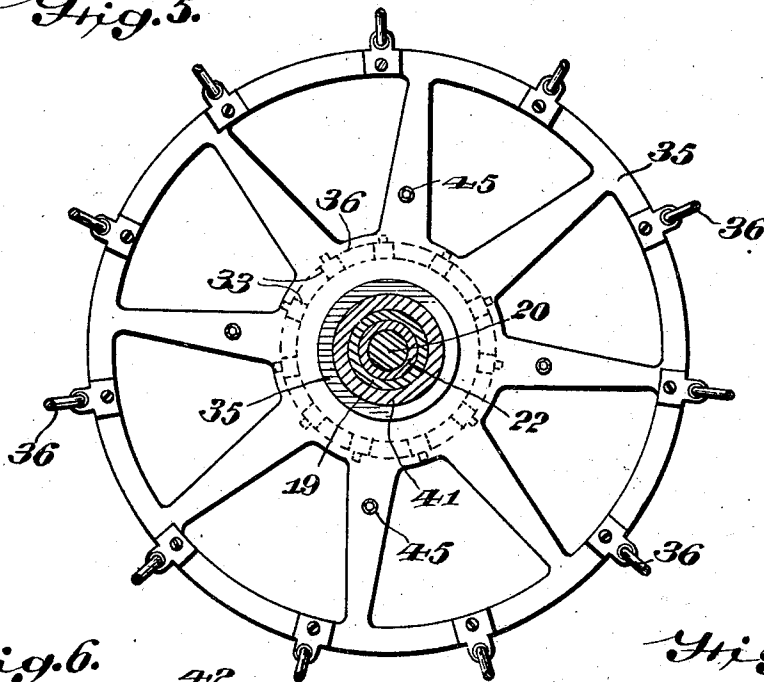


Fig. 6.

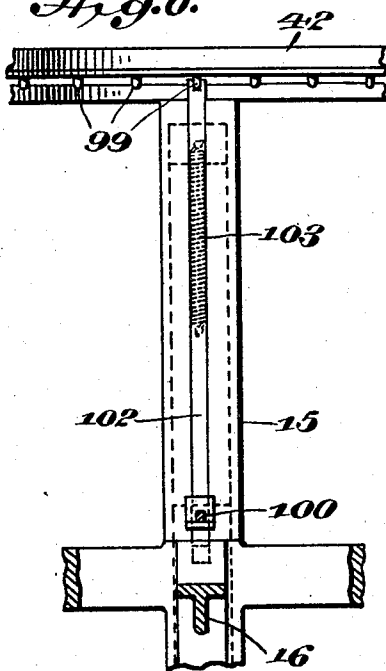
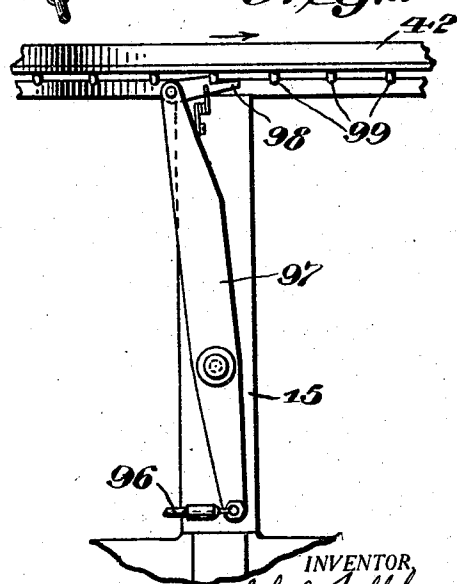


Fig. 7.



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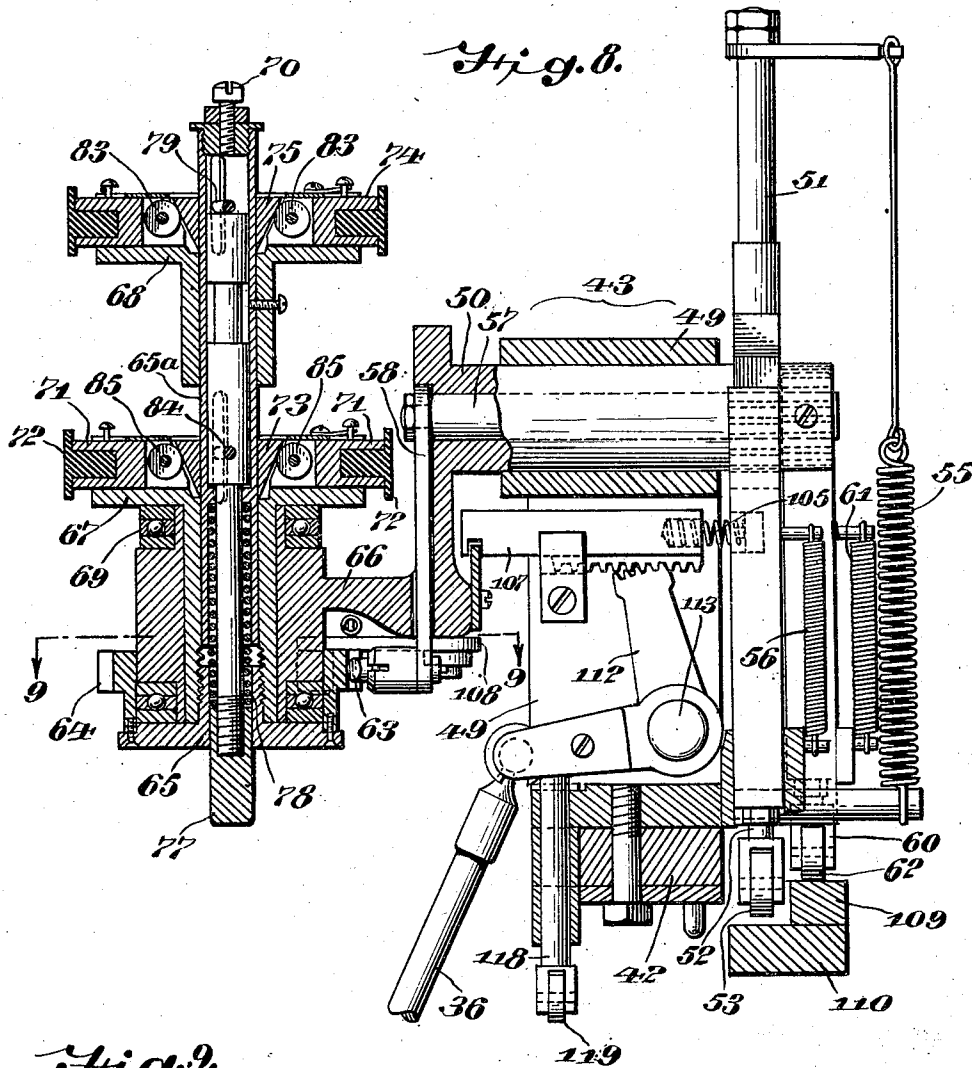
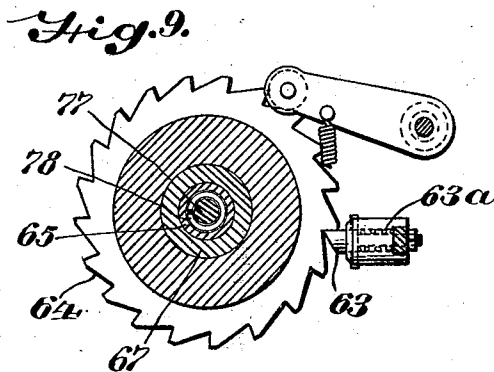
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GLASS GRINDING MACHINE

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7 Sheets-Sheet 6



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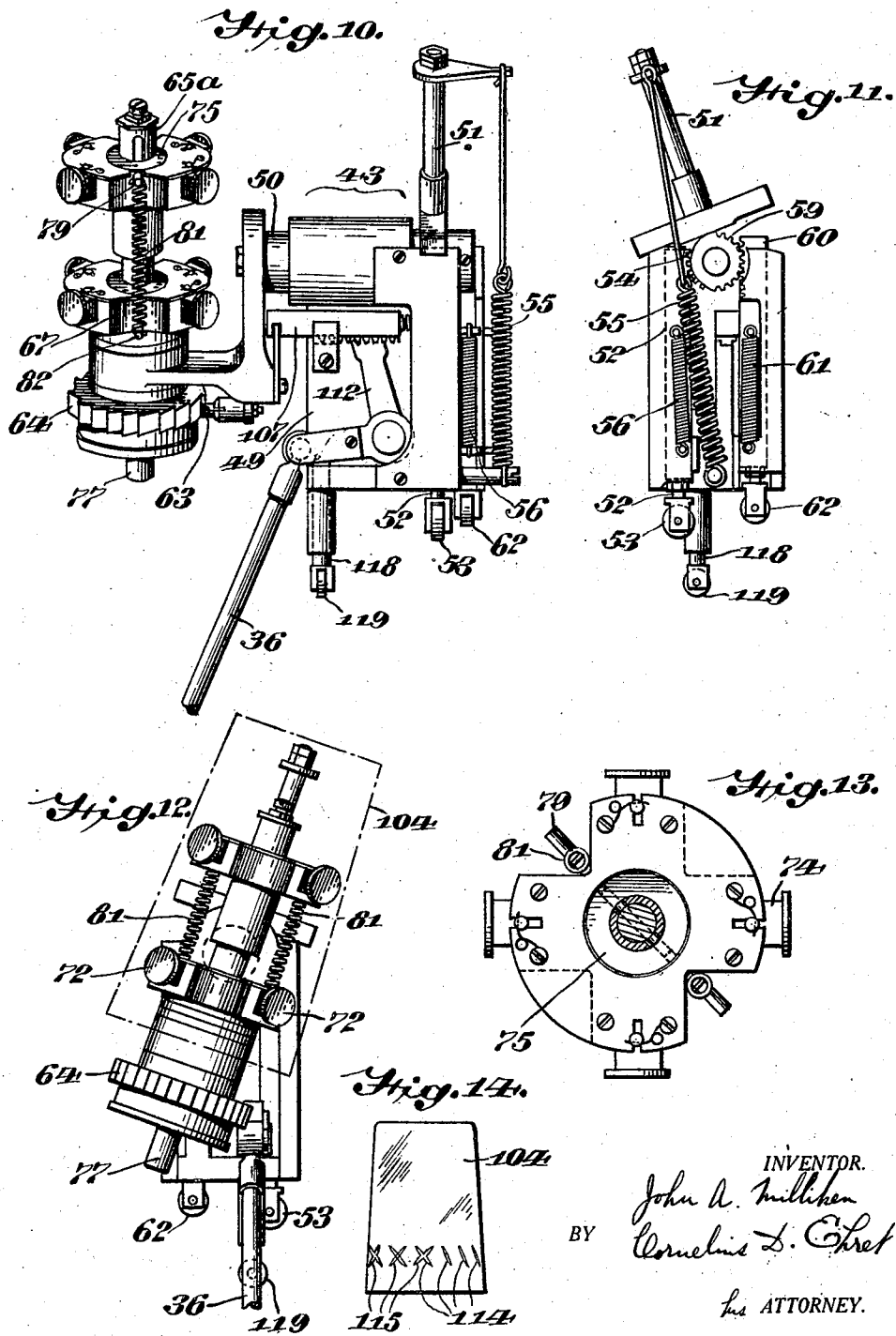
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GLASS GRINDING MACHINE

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE.

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GLASS-GRINDING MACHINE.

Application filed November 1, 1922. Serial No. 593,315.

My invention relates to glass-grinding machines and particularly to machines employed in cutting or grinding glassware.

One of the objects of my invention is the provision, in a machine of the class referred to, of an improved arrangement of mechanism for automatically effecting changes in the relative positions of the glass article being ground and the cutting tool, so that various portions of the glass article may be automatically presented to the grinding wheel in a predetermined sequence.

Another object of my invention is to provide an improved and simplified form of mechanism for treating glass articles, such mechanism being largely automatic in its operation.

My apparatus includes a rotatable carrier that has glassware holders disposed about its periphery and circumferentially of a grinding disc that is rotatably independent of the carrier. Means are provided for intermittently imparting rotative movement of the holders about their individual axes as the carrier rotates, in order to present spaced points of an article being ground to the grinding disc. In order that the surfaces between the said spaced points may not be marred, means are provided for moving the holder and the article carried thereby radially out of engagement with the grinding disc, while the said individual rotative movement is being imparted thereto.

Other means are provided for automatically changing the angularity of the holders during their movement about the axis of the grinding disc, so that cuts of different angularity may be made in the glass article to enhance the decorative effect. The holder makes two complete revolutions about its axis during one revolution of the carrier, and the change in the angular position of the holder is effected after the holder has made one revolution about its individual axis.

I do not limit my invention to the foregoing features, but recite such features in order that the operation of the mechanism may be more readily understood during a reading of the specification.

One form in which my invention may be employed is shown in the accompanying drawing wherein

Fig. 1 is a view, partially in elevation

and partially in section, of an apparatus embodying my invention.

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a plan view of the apparatus.

Fig. 4 is a view taken on the line 4—4 of Fig. 1.

Fig. 5 is a detail view taken on the line 5—5 of Fig. 1.

Figs. 6 and 7 are enlarged detail views of a locking lever and an actuating lever, respectively, taken on the lines 6—6 and 7—7 of Fig. 1.

Fig. 8 is a view, partially in side elevation and partially in section, of the apparatus of Fig. 10.

Fig. 9 is a view taken on the line 9—9 of Fig. 8.

Fig. 10 is a view of one of the tumbler holders and the actuating mechanism therefor, shown in Fig. 1, with the tumbler removed.

Fig. 11 is a view, in end elevation, of the apparatus of Fig. 10.

Fig. 12 is a view of the apparatus of Fig. 10, looking from the left.

Fig. 13 is a plan view of a portion of the apparatus of Fig. 10.

Fig. 14 is a view, in perspective, showing a glass tumbler after the cutting thereof has been completed.

The apparatus comprises a frame work provided with bracing members 16 and 17 that support a bearing 18, (Fig. 2). A rod 20 is disposed within the bearing 18 and is provided with a shoulder portion that rests upon a block 21 that is secured to the members 17. A hollow shaft 22 surrounds the rod 20 and is provided with a beveled gear 23 by means of which it is rotated. A collar 22^a is secured to the shaft 22 and engages thrust bearing 22^b that is supported by a sleeve 19.

A second hollow shaft 24 surrounds the sleeve 19 and is directly supported by the bearing 18. The shaft 24 is provided with a worm gear 25 that is driven by a worm 26 and is rotatable independently of the shaft 22.

The gear 23 is driven by a pulley 27, through a pinion 28. Upon rotation of the pulley 27 the shaft 22 revolves and carries with it a grinding disc 29 that is supported upon the upper end thereof. The member

29 may be of carborundum or other suitable glass-grinding material. As the disc 29 rotates it will grind the surfaces of articles that may be brought into engagement therewith.

I will now describe the manner in which articles to be ground by the disc 29 are manipulated so that certain cycles of movement may be automatically effected.

The sleeve shaft 24 is driven, through the worm 26 and worm gear 25, by a pulley 30. The pulley 27 that drives the grinding tool and the pulley 30 may be driven from a common source of power. The sleeve 24 is provided with a plurality of arms 32 that have anti-friction rollers 33 secured thereto. The rollers 33 cooperate with a sleeve member 34, that is provided on its under side with a series of cam lugs 36, as shown more clearly in Fig. 1.

When the hollow shaft 24 is rotated the sleeve member 34 will move upwardly as the rollers 33 are carried under the cam surfaces, the sleeve 34 and the parts carried thereby being returned to their lower positions after each upward movement, by the action of gravity.

The sleeve 34 carries a spider 35 that supports a series of circumferentially disposed rods 36 which are normally biased to their lower positions by springs 37 that are interposed between nuts 38 carried by the rods 36 and plates 39 that are secured to the spider 35.

A carrier 41 rests upon a bearing 31 and a sleeve 31^a that is secured to the sleeve 19, and is provided with an annular ring 42 which supports holders 43 upon which articles to be ground are carried. An annular member 44 is secured to the carrier 41 to limit upward movement of buffer members 45 which are supported by pins 46 that are secured to the spider 35, springs 47 being provided in order to cushion the blows when vertical movement occurs between the spider 35 and the carrier 41 and to return the spider to its lowermost position.

Referring now more particularly to Fig. 8, each holder comprises a frame 49 that supports a sleeve member 50 which operates as a rock shaft and is provided with an upstanding portion 51. A rack 52 is slidably supported in the frame 49 and carries a roller 53 at its lower end. At its upper end the rack 52 has teeth that engage teeth 54 (Fig. 11) that are formed upon the outer end of the sleeve or rock shaft 50. A spring 55 normally biases the rock shaft to the position shown in Figs. 10 and 11, while a spring 56 biases the rack 52 downwardly, the spring 56 being connected to pins that are secured to the rack and the frame 49. If the plunger 52 be moved up and down as hereinafter explained, the angular position of the arm 51 will be reversed, by reason of

the intermeshing of the teeth 54 with the rack teeth.

A shaft 57 is mounted within the shaft 50 and is provided with an arm 58 at one end, and upon its other end is provided with a toothed collar 59 (Fig. 11). A rack 60 is slidably supported by the frame 49 and is normally biased downwardly by a tension spring 61 that is secured to pins that are carried by the rack and the frame 49. A roller 62 is mounted upon the lower ends of the rack 60. As the rack 60 rises and falls it will oscillate the shaft 57 and the arm 58, carried thereby. The arm 58 carries a pawl 63 that is biased by a spring 63^a (Fig. 9) into engagement with a ratchet wheel 64. As the arm 58 moves through an arc it is apparent that the pawl 63 imparts intermittent motion to the ratchet wheel 64. The ratchet wheel 64 is secured to a shaft comprising sleeve members 65 and 65^a that are rotatably supported in an extended portion 66 of the rock shaft 50. The shaft members 65—65^a are rigidly joined by a sleeve member 67 and support a sleeve 68. The sleeve member 67 is supported upon extended portion 66 by an antifriction-bearing 69. A screw 70 serves as a stop member to limit the downward movement of a tumbler.

A lever 64^a that is provided with a roller is held in yielding engagement with the wheel 64 to prevent movement thereof backwardly (see Fig. 9).

The sleeve member 67 is provided with radially extended portions in which gripping members 71 are slidably supported, the gripping members 71 being provided with blocks 72 of rubber. The gripping members 71 are normally biased outwardly by means of a cone block 73 as will be hereinafter described. The sleeve member 68 is provided with gripping members 74 which are biased outwardly by a cone block 75.

The shaft 65—65^a and the parts supported thereby are all rotatable within bearing block 66. A plunger 77 extends through the shaft 65—65^a and is normally biased downwardly by a spring 78. A pin 79 extends across the upper end of the plunger 77, through slots in the sleeve member 65^a of the shaft and through the cone block 75 (Figs. 8 and 10). A pair of springs 81 that have their upper and lower ends secured respectively to the pin 79 and to the ends of a pin 82 that is secured to the sleeve 67 serve to bias the cone block 75 downwardly into engagement with rollers 83 that are carried by the gripping members 74, thus forcing such gripping members outwardly into engagement with the interior wall of a glass article, to grip the same.

A pin 84 extends through the cone block 73 and the plunger 77, so that such cone block 73 moves with the plunger 77 and normally forces the gripping member 71 out-

wardly, through engagement with rollers 85 that are carried by the gripping members 71, by reason of the compression of the spring 78 that biases the plunger 77 downwardly. It will thus be seen that the gripping members 71 and 74 are held in advanced positions until the plunger 77 is moved upwardly to permit the gripping members to be retracted.

The carrier 41 is of sufficient size to support 11 holders for tumblers (see Fig. 3), and is rotated, to move the group of tumblers circumferentially of the grinding wheel, by a mechanism which will now be described.

The shaft 24 carries a collar 87 (Figs. 1 and 2) that is provided on its upper side with cam lugs 88 and on its periphery with cam lugs 89 (Fig. 4). As the pulley wheel 30 is driven and the shaft 24 rotates, the cam portions 89 will be moved into engagement with a roller 90 that is supported intermediate the ends of an arm 91, the arm 91 being pivoted at one end to a cross-bar 92 of the frame-work and at its other end supporting a link 93. The roller 90 is biased into engagement with the lugs 89 by a spring 94. Upon rotative movement of the collar 87 the lever 93 and the bell crank lever 95 to which it is connected, will oscillate.

The bell crank lever 95 is connected, through a link 96, with a lever 97 (Fig. 7) which carries, at its upper end, a pawl 98 that is normally biased into engagement with teeth 99 that are formed upon the under side of the ring 42 of the carrier 41. Each time a cam lug 89 passes the roller 90 one step of rotative movement will be imparted to the carrier 41.

The cam lugs 88 that are formed upon the upper side of the collar 87 engage the inner end of a lever 100 (Fig. 1) that is pivoted at 101 to the frame work. The outer end of the lever 100 engages a lug on the link 102 (Figs. 1 and 6) that is normally biased upwardly by a tension spring 103 into locking engagement with the teeth 99 on the underside of the ring 42. The cam lugs 88 are so positioned that they will engage the inner end of the lever 100 to move it upwardly and withdraw the link 102 from engagement with the lugs 99 only when the cam lugs 89 are operating the lever 97 to move the carrier another step, thus holding the carrier against accidental movement.

The tumblers 104 that are shown in position upon the holders 43 (Figs. 1, 2, 3, and 4), are given a slight rotative movement about their respective axes 77, at each actuation of the lever 97 by the cam lugs 89, thus presenting successive portions of the surface of the glass article to the grinding wheel 29. The tumblers 104 and their supporting members are biased into engagement with the

grinding wheel by a spring 105 that is interposed between a portion of the frame work 49 and a rack bar 107. The bar 107 engages a bar 108 that is secured to the rock shaft 50 and controls the longitudinal position of the shaft 50 in the frame 49.

The rotative movement of each tumbler about its individual axis is effected by the rise and fall of the rack bar 60 that oscillates the shaft 57 and imparts a step-by-step movement to the ratchet wheel 64, as above explained. The rack bar 60 is moved upwardly against the tension of the spring 61 by reason of the upwardly extending lugs 109 that are formed on a circumferential shoulder 110 that is supported upon the top of the frame work 15. During each cycle of movement of the rack bar 60 one step of rotative movement is imparted to the tumbler so that another portion of its surface may be presented to the grinding wheel 19.

It is desirable to withdraw the tumbler from engagement with the grinding wheel 29 while the tumbler is being rotated about its axis, and this withdrawal is effected by means of the spider 35 and the rods 36, one rod 36 being provided for each of the tumbler holders 43.

As above explained, the rotative movement of the sleeve shaft 24 causes the spider 35 to rise and fall. As such spider rises the rods 36 are pushed upwardly, thus causing bell crank levers 112 (Fig. 8) to rotate in a clock-wise direction about their pivots 113, and retracting rack bars 107 against the tension of the springs 105, thereby withdrawing the tumblers 104 from engagement with the grinding wheel 19.

By reason of the step-by-step movement of each tumbler about its axis, during a portion of one revolution of the carrier 41, a series of cuts 114 (Fig. 14) will be made in the tumblers, and the surface between each cut will not be marred, owing to the withdrawal of the tumbler from the wheel at each rotative step.

In order to present the tumbler to the cutter at a different angle and have cuts 115 (Fig. 14) made therein, a ledge 116 is provided upon the circumferential member 110 of the frame work 15, for substantially one-half of its circumference. The ledge 116 has inclined surfaces 117 at its ends. As the roller 53 of a plunger 52 passes up one inclined surface 117 the arm 51 is thrown over against the tension of the spring 55, thus rocking the sleeve shaft 50 that carries the tumbler holders, and reversing the angular position of that tumbler with respect to the wheel, as shown in Fig. 3. When the roller 53 passes off the other end of the ledge 116 the spring 55 will return the tumbler holder to its former position.

The cam lugs 109 are provided in sufficient number that a complete rotation of the

tumbler about its axis 77 takes place during the movement of the carrier through nearly 180 degrees, so that the tumbler during one-half of a complete revolution of the carrier will be presented throughout its circumference, at one angle, to the cutting disc 19, and during the other half of such revolution by the carrier 41 will be presented, throughout its circumference, at another angle.

Each tumbler as it is brought by the carrier to its starting point is released from its holder by means of a cam member 120 (Figs. 2 and 3), which is formed upon the outer end of an arm 122, and which is positioned to be engaged by the plunger 77, moving such plunger upward and releasing the gripping members 74 and 71.

In order to withdraw each tumbler from the engagement with the grinding wheel at the completion of the grinding operation I provide a plunger 118, that carries a roller 119 at its lower end and at its upper end abuts against the bell crank lever 112 (Figs. 8 and 10). The roller 119 is engaged by a cam lug 121 (Fig. 2) just previous to the engagement of the plunger 77 and the cam member 120 above referred to. The upward movement of the plunger 118 (Fig. 8) rocks the bell crank lever 112 against the tension of the spring 105 and withdraws the tumbler holder 43, thus holding the tumbler away from the grinding wheel 19 and permitting its withdrawal from the holder.

The annular member 110 has the cam lugs 109 omitted therefrom for a sort distance, as shown at 123 (Fig. 3) which represents an idling surface that the holders pass over while the tumblers are being placed and removed, at the beginning and the end, respectively, of the cycle of operation.

It will be understood that the operation of the various parts of the mechanism above described automatically takes place in a predetermined sequence, owing to the relative positions of the cam surfaces carried upon the annular member 110 at the top of the frame work 15 and of the cam lugs located on the collars 34 and 87.

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.

I claim:

1. A glass grinding machine comprising a grinder, a plurality of holders for supporting the articles to be ground, a carrier for supporting the holders and for moving them with respect to the grinder, and means for varying the angular position of the holders with respect to the grinder as the carrier is moved, preliminary to another operation by said grinder.

2. A glass grinding machine comprising a grinder, a plurality of holders for sup-

porting the articles to be ground, a carrier for supporting the holders and for moving them with respect to the grinder, means for rotating the said articles with respect to the carrier, and means for varying the angular position of the holders with respect to the grinder as the carrier is moved.

3. A glass grinding machine comprising a rotatably supported grinder the axis of which is normally maintained in a non-shiftable position, means for supporting the article to be ground, and means automatically operated in predetermined sequence for intermittently moving the article into and out of engagement with the grinder, means for rotatably adjusting the article at the conclusion of each grinding operation, and means for varying the angular position of the article with respect to the grinder at the conclusion of a plurality of grinding operations.

4. A glass grinding machine comprising a rotatably supported grinder the axis of which is normally maintained in a non-shiftable position, means for supporting the article to be ground, driving mechanism for the supporting means, and means controlled by said driving mechanism for intermittently moving the article into and out of engagement with the grinder, means for rotatably adjusting the article at the conclusion of each grinding operation, and means for varying the angular position of the article with respect to the grinder at the conclusion of a plurality of grinding operations.

5. A glass grinding machine comprising a rotatably mounted holder for an article to be ground, means normally maintained in a non-shiftable position for grinding said article, means for moving the holder and the article carried thereby away from the grinder at the conclusion of a single grinding operation, and means for imparting rotative movement to the holder subsequent to the movement thereof away from the grinding means.

6. A glass grinding machine comprising a grinder, a carrier, a plurality of holders for articles to be ground disposed circumferentially of the carrier and of the grinder, mechanism for rotating the carrier and means controlled by the said mechanism for reciprocating the holders and the articles carried thereby radially of the carrier and for intermittently rotating each holder about its longitudinal axis.

7. A glass grinding machine comprising a grinder, a carrier, a plurality of holders for articles to be ground disposed circumferentially of the carrier and of the grinder, mechanism for rotating the carrier and means controlled by the said mechanism for moving the holders radially of the carrier and for intermittently rotating each holder

about its longitudinal axis upon outward movement of such holder.

8. A glass grinding machine comprising a grinder, a carrier, a plurality of holders for articles to be ground disposed circumferentially of the carrier and of the grinder, mechanism for rotating the carrier and means controlled by the said mechanism for moving the holders to inoperative position with respect to the grinder, for intermittently rotating each holder about its longitudinal axis, and for varying the angular position of the holder.

9. A glass grinding machine comprising a grinder, a carrier, a plurality of holders for articles to be ground disposed circumferentially of the carrier and of the grinder, mechanism for rotating the carrier and means controlled by the said mechanism for moving the holders radially of the carrier, for intermittently rotating each holder about its longitudinal axis, and for varying the angular position of the holder, the said movements of the holder all occurring in a predetermined sequence.

10. A glass grinding machine comprising a rotatable grinding wheel, a plurality of holders for articles to be ground, disposed circumferentially of the wheel, means for rotating the holders as a unit, and means for holding the said articles against the said wheel in one angular position during a portion of their circumferential movement and for changing such angular position during another portion of such movement.

11. A glass grinding machine comprising a rotatable grinding wheel, a plurality of holders for articles to be ground, disposed circumferentially of the wheel, means for rotating the holders as a unit, means for holding the said articles against the said wheel in one angular position during a portion of their circumferential movement and for changing such angular position during another portion of such movement, and means for rotating each holder about an individual axis thereof.

12. A glass grinding machine comprising a rotatable grinding wheel, a plurality of holders for articles to be ground, disposed circumferentially of the wheel, means for rotating the holders as a unit, means for holding the said articles against the said wheel in one angular position during a portion of their circumferential movement and for changing such angular position during another portion of such movement, means for rotating each holder about an individual axis thereof, and means for retracting the holders while the said rotative movement is being imparted thereto.

13. A glass grinding machine comprising a rotatable grinding wheel, a plurality of holders disposed circumferentially of the wheel for engaging articles to be ground,

means for rotating the holders about the axis of the wheel, means for rotating said holders a plurality of times about their individual axes, means for bodily shifting said holders between said last named cycles of rotary movement, and means for automatically releasing said articles as the holder by which each is carried completes its cycle of movement.

14. A glass grinding machine comprising a rotatable grinding wheel, a plurality of holders for articles to be ground, disposed circumferentially of the wheel, means for rotating the holders as a unit, means for imparting intermittent rotative movement to each holder about an individual axis thereof, and means for retracting each holder during its individual rotative movement.

15. A glass grinding machine comprising a rotatable grinding wheel, a plurality of holders for articles to be ground disposed circumferentially of the wheel, means for rotating the holders as a unit, means for simultaneously rotating the respective holders about individual axes, and means for simultaneously retracting the holders during the said individual rotative movements.

16. A glass grinding machine comprising a rotatable grinding wheel, a plurality of holders for articles to be ground disposed circumferentially of the wheel, means for rotating the holders as a unit, means for simultaneously rotating the respective holders about individual axes, means for intermittently varying the angular positions of the holders during their unitary rotative movement, and means for retracting the holders during the said intermittent changes in positions.

17. A glass grinding machine comprising a grinder, a plurality of holders for supporting articles to be ground, a carrier for supporting the holders and for moving them with respect to the grinder, and means effective upon movement of said carrier for varying the relative angular cutting positions of the grinder and said holders.

18. A glass grinding machine comprising a grinder, a rotatable carrier, a plurality of work holders carried by said carrier and disposed circumferentially of the grinder, and means for rotating said work-holders about their respective axes and for simultaneously imparting relative movement to said work holders and grinder in a direction radial of the plane in which the said carrier moves.

19. A glass grinding machine comprising a rotatable grinder, a plurality of work holders disposed circumferentially of the grinder, a carrier for supporting said work holders and moving them around the grinder, means for varying the relative angular cutting positions of the grinder and work holders, and means for imparting relative

movement to said grinder and work holders.

20. Glass working apparatus comprising a carrier, a plurality of work holders supported thereby, a grinder past which the carrier moves said work holders, and means for changing the positions of said work holders on the carrier, in predetermined relation to the movement of said carrier.

21. Glass working apparatus comprising a carrier, a rotatable work holder thereon, a cutter for operating on an article to be supported by said holder, and means operated by movement of said carrier after each revolution of said work holder for changing the relative angularity of the axes of said work holder and cutter to present different areas of the article to said cutter.

22. A glass grinding machine comprising a carrier, a work holder mounted upon said carrier, a grinder for operating on work carried by said holder, means for bringing said holder and grinder into operative relation to cut a design circumferentially of the work, and means controlled by the movement of said carrier for changing said operative relation to effect the cutting of another design circumferentially of said work.

23. A glass grinding machine comprising a carrier, a work holder mounted upon said carrier, means for rotating said work holder about its own axis, a grinder for operating on work carried by said holder, means for bringing said holder and grinder into operative relation to cut a design circumferentially of the work, and means controlled by the movement of said carrier for changing said operative relation to effect the cutting of another design on said work.

24. A glass grinding machine comprising a carrier, a work holder mounted upon said carrier, a grinder for operating on work carried by said holder, means for bringing said holder and grinder into operative relation to cut a design circumferentially of the work, means controlled by the movement of said carrier for changing said operative relation to effect the cutting of another design circumferentially of said work, and means for moving said grinder and holder out of operative relation while said change is taking place.

25. A glass grinding machine comprising a rotatable carrier, a work holder mounted upon said carrier, a grinder for operating on work carried by said holder, means operative during a portion of the rotative movement by the carrier to bring said holder and grinder into operative relation to cut one design circumferentially of the work, and means operative during another portion of the rotative movement by said carrier to move said holder and grinder to another operative relation to cut another design circumferentially of the work.

26. A glass grinding machine comprising

a rotatable carrier, a work holder mounted upon said carrier, a grinder for operating on work carried by said holder, means controlled by movement of the said carrier during a portion of the rotative movement by the carrier to bring said holder and grinder into operative relation to cut one design circumferentially of the work, and means controlled by movement of the carrier during another portion of the rotative movement by said carrier to move said holder and grinder to another operative relation to cut another design circumferentially of the work.

27. A glass grinding machine comprising a carrier movable through recurring cycles, a work holder mounted upon the carrier, a grinder for operating on work carried by said holder, mechanism for rotating said carrier, means controlled by said mechanism for changing the relative operative positions of the said grinder and holder and for rotating said holder twice during one cycle of movement of said carrier, in order to grind a plurality of circumferentially disposed configurations on the work.

28. Glass grinding apparatus comprising a carrier, a work holder mounted for movement with the carrier and for rotative movement about its individual axis, a grinder for operating on work carried by said holder, and means operative in predetermined relation to the movement of said carrier to change the operative positions of said grinder and work holder after each revolution of said holder, to effect the cutting of a plurality of designs circumferentially of the work.

29. Glass grinding apparatus comprising a carrier, a work holder mounted for movement with the carrier and for rotative movement about its individual axis, a grinder for operating on work carried by said holder, and means operative after each revolution of the work holder to change the operative positions of said grinder and work holder, to effect the cutting of a plurality of designs circumferentially of the work.

30. Glass grinding apparatus comprising a carrier, a work holder mounted for movement with the carrier and for rotative movement about its individual axis, a grinder for operating on work carried by said holder, and means automatically operative upon the completion of each rotation of said work holder to change the relative angular positions of said grinder and work holder,

31. Glass grinding apparatus comprising a carrier, means for imparting step-by-step rotative movement to said carrier, a work holder mounted upon said carrier, a grinder for operating upon an article to be carried by said work holder, means operative during each step of said rotative movement by the carrier to withdraw the work holder from

operative relation with respect to said grinder, and means for imparting rotative movement to said work holder about its individual axis upon withdrawal of said work holder.

32. Glass grinding apparatus comprising a carrier, means for imparting step-by-step rotative movement to said carrier, a work holder mounted upon said carrier, a grinder for operating upon an article to be carried by said work holder, means operative during each step of said rotative movement by the carrier to withdraw the work holder from operative relation with respect to said grinder, means for imparting rotative movement to said work holder about its individual axis upon withdrawal of said work holder, and means operative at a predetermined point during rotative movement of said carrier to change the relative angular positions of said grinder and work holder.

33. Glass grinding apparatus comprising a rotatable carrier, means for imparting intermittent movement to said carrier, a work holder mounted upon said carrier, a grinder for operating on work to be carried by said holder, means operative in predetermined relation to said intermittent movement for imparting rotative movement to said holder, and means operating in predetermined relation to said intermittent movement for bodily shifting said work holder to present a plurality of circumferentially disposed areas of the work to said grinder.

34. Glass grinding apparatus comprising a grinding tool, a rotatable work holder, means for moving said tool and rotatable work holder into operative relation to effect the grinding of a design circumferentially of an article carried by said work holder, and means operative in predetermined relation to the rotative movements of said work holder to shift the relative positions of said work holder and said grinder and thereby effect the grinding of another design circumferentially of said article.

35. Glass grinding apparatus comprising a rotatable carrier, means for imparting a step-by-step movement to said carrier, means controlled by movement of said carrier for locking the same between the periods of said step-by-step movement, a work holder mounted upon said carrier, a grinder for operating on an article carried by said work holder, and means operable in predetermined relation to the movement of said carrier for effecting movement of said work holder into and out of operative relation to said grinder.

36. Glass grinding apparatus comprising a rotatable carrier, means for imparting a step-by-step movement to said carrier, means controlled by movement of said carrier for locking the same between the periods of said step-by-step movement, a work holder

mounted upon said carrier, a grinder for operating on an article carried by said work holder and means operable in predetermined relation to the movement of said carrier for effecting movement of said work holder into and out of operative relation to said grinder and for imparting rotative movement to said work holder.

37. Grinding apparatus comprising a grinder, a traveling carrier, a work holder mounted on said carrier means for moving said carrier step-by-step, in position to cooperate with said grinder, and means effective upon movement of said said carrier through a plurality of steps for varying the relative angular cutting positions of said grinder and work holder.

38. Grinding apparatus comprising a grinding tool, a carrier movable step-by-step, a work holder mounted upon said carrier in position to cooperate with said tool and rotatable about its own axis a plurality of times during one cutting operation, and means effective upon movement of said carrier through a plurality of steps to change the angular position of said holder with respect to said carrier before the completion of a cutting operation.

39. Grinding apparatus comprising a grinder, a plurality of work holders rotatable about their individual axes, a carrier for moving said holders with respect to said grinder, and means effective upon movement of said carrier for indexing said holders about their respective axes and relative to said grinder.

40. Grinding apparatus comprising a carrier, means for intermittently rotating said carrier, a work holder mounted upon said carrier, a grinding tool, and means for effecting movement of said holder with respect to said tool, for each intermittent movement of said carrier.

41. Grinding apparatus comprising a carrier, means for intermittently rotating said carrier, a work holder mounted upon said carrier, a grinding tool, and means operative in predetermined relation to the intermittent movements of said carrier for completing a series of cutting operations on an article supported by said holder.

42. Grinding apparatus comprising a movable carrier, a work holder mounted upon said carrier and rotatable about its own axis, a grinding tool adapted to cooperate with said work holder, and means operative after predetermined movement of said carrier to change the angle of said axis with respect to the axis of said grinding tool and to effect further grinding of an article carried by said holder.

In testimony whereof I have hereunto affixed my signature this 30th day of October, 1922.

JOHN A. MILLIKEN.