

March 14, 1933.

J. J. McCABE

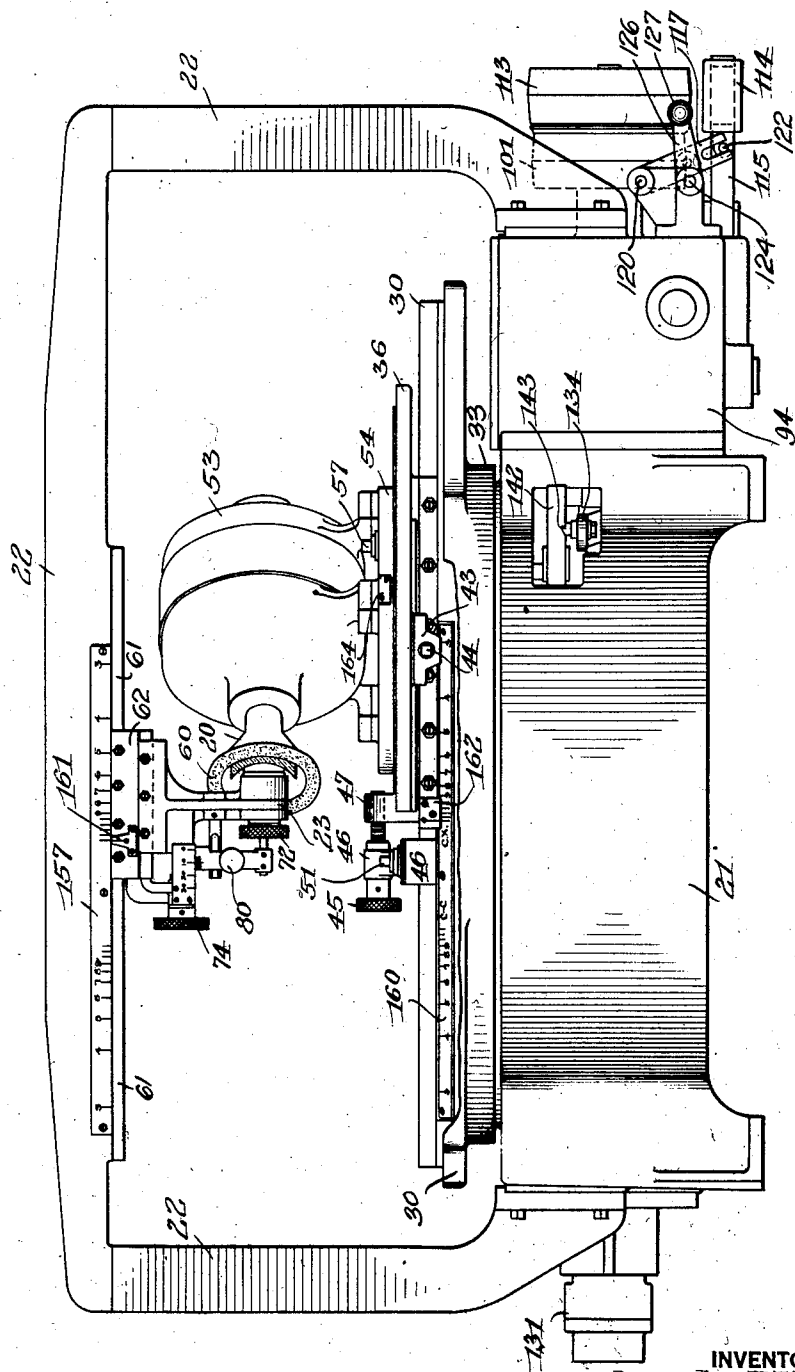
1,901,181

TORIC LENS GENERATING MACHINE

Filed April 5, 1927

11 Sheets-Sheet 1

Fig. 1



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March 14, 1933.

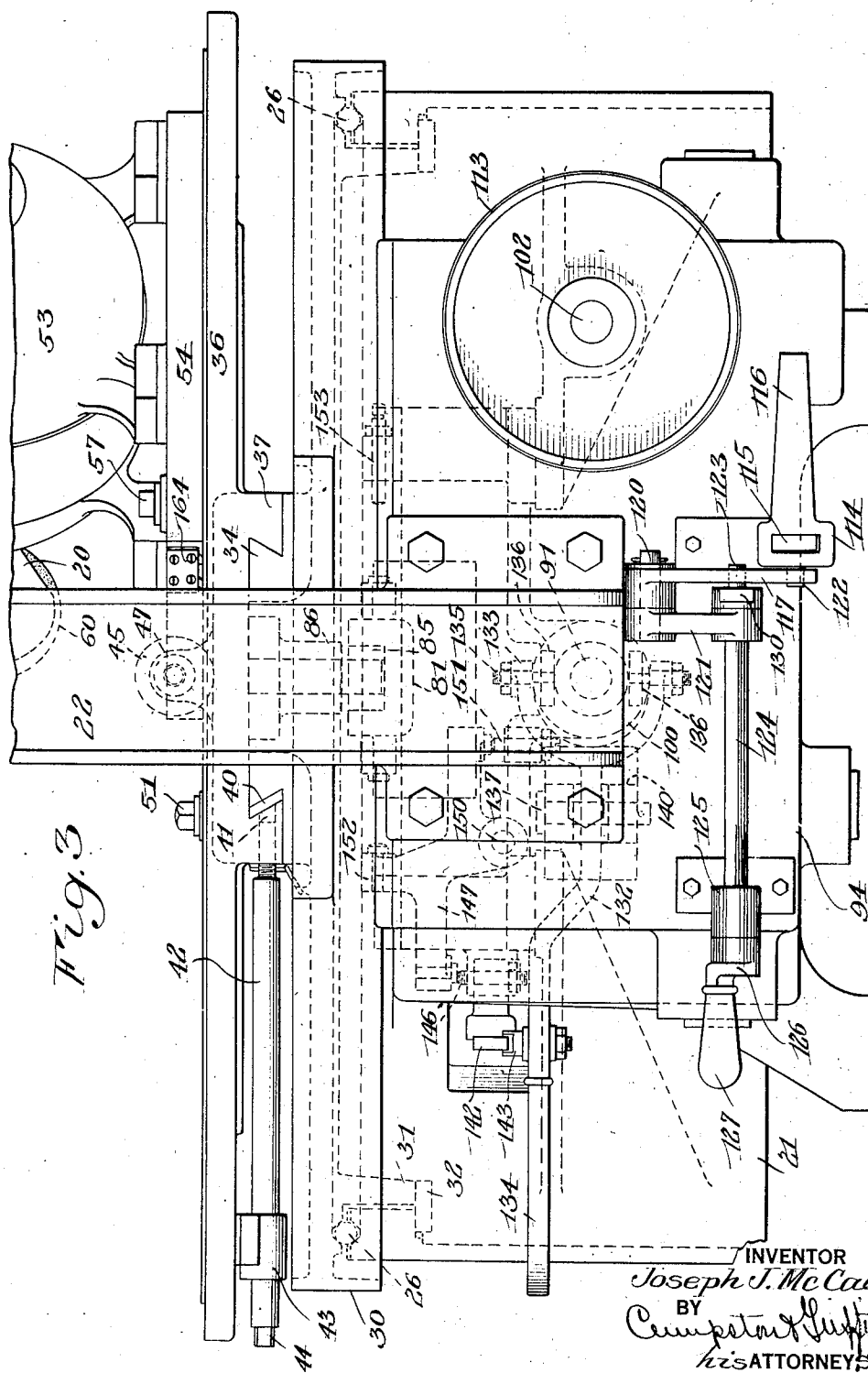
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TORIC LENS GENERATING MACHINE

Filed April 5, 1927

11 Sheets-Sheet 3



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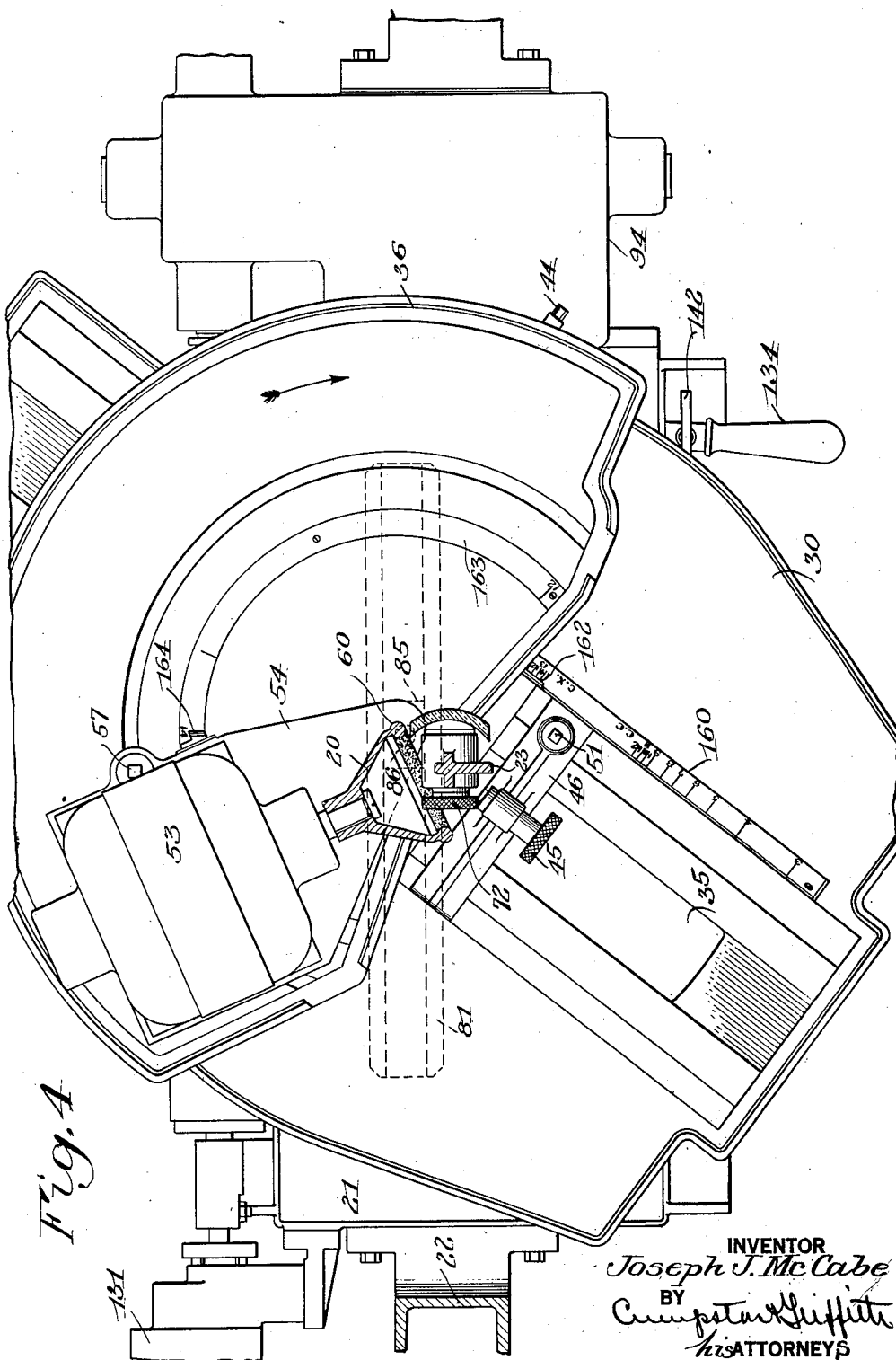
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TORIC LENS GENERATING MACHINE

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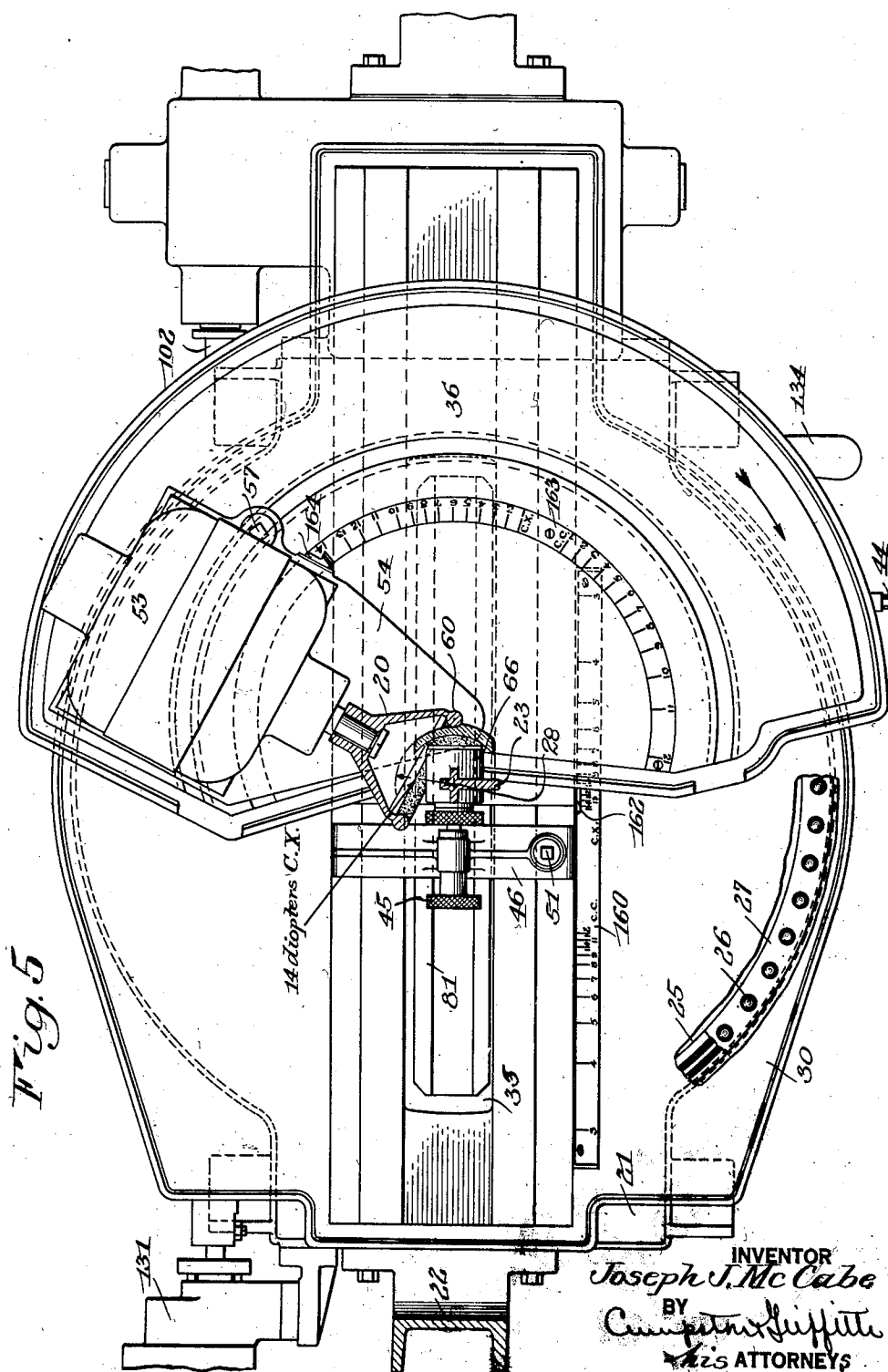
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**1,901,181**

# TORIC LENS GENERATING MACHINE

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11 Sheets-Sheet 5



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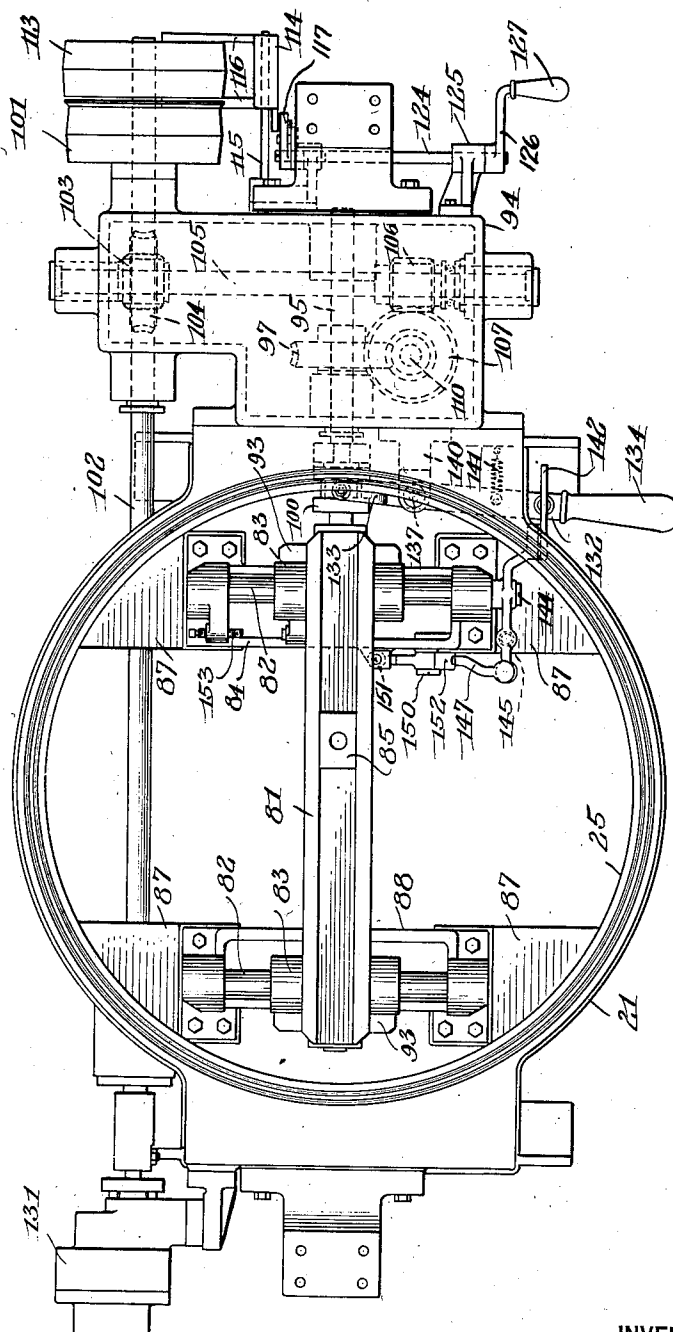
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TORIC LENS GENERATING MACHINE

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11 Sheets-Sheet 7

Fig. 7



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TORIC LENS GENERATING MACHINE

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Fig. 9

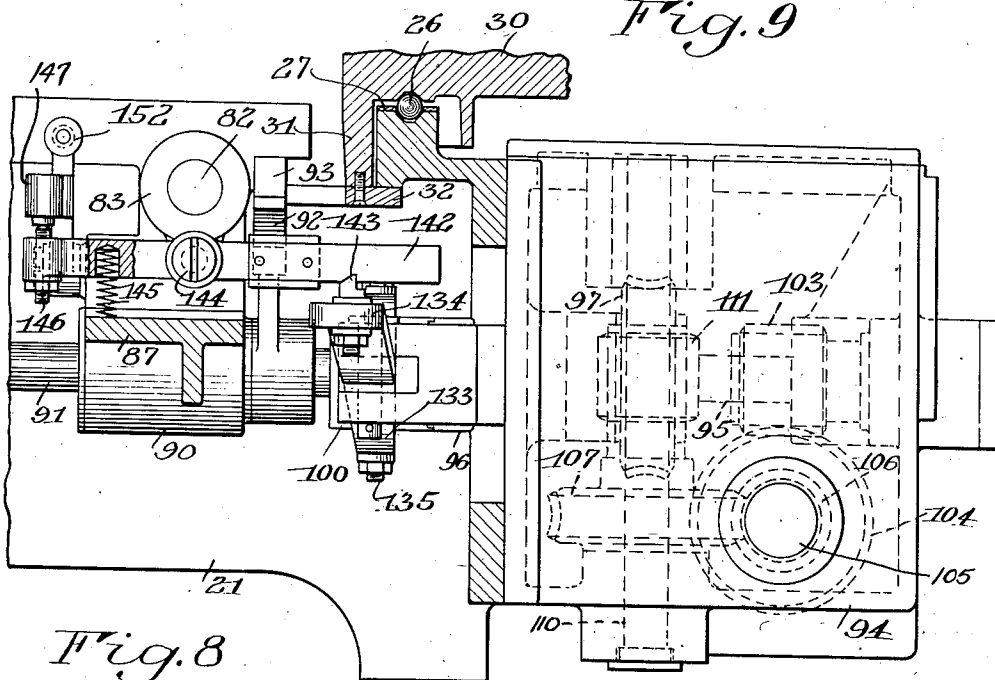
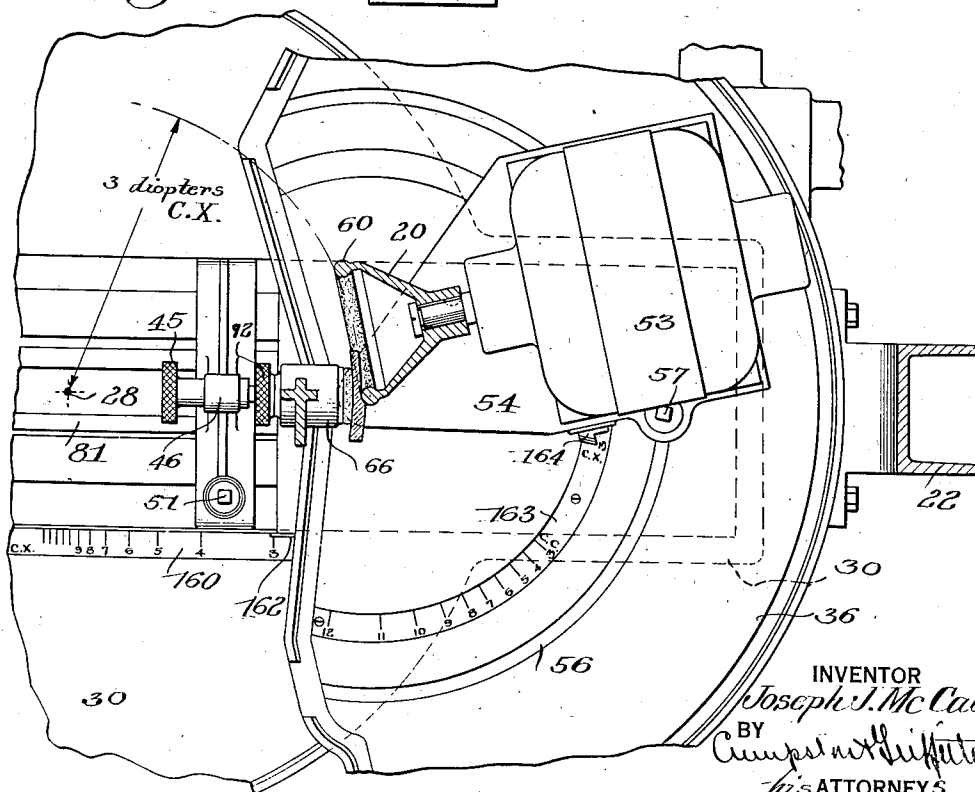


Fig. 8



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TORIC LENS GENERATING MACHINE

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Fig. 16.

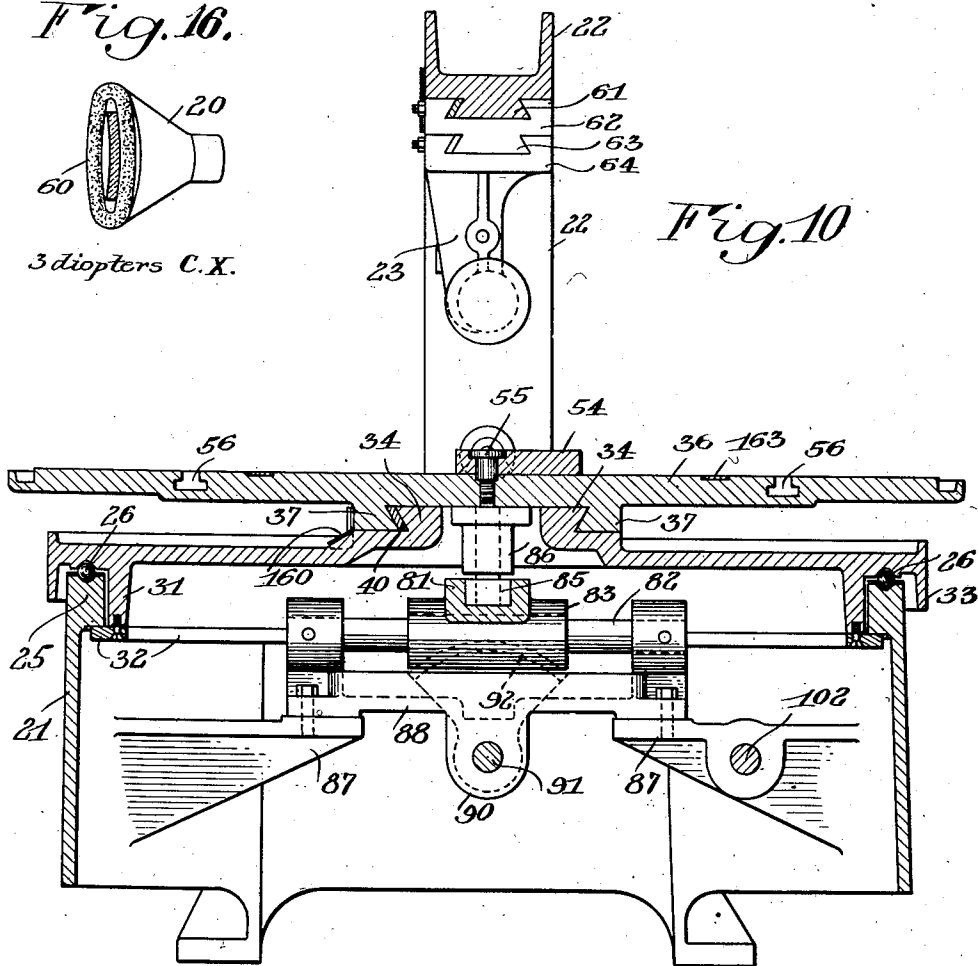
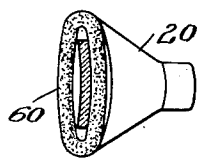


Fig. 10

Fig. 11

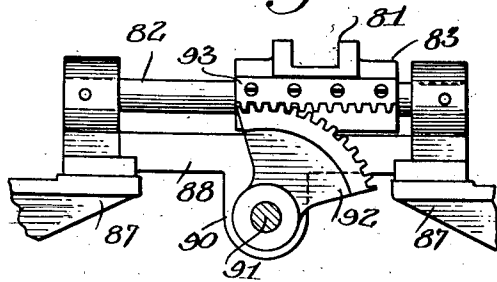
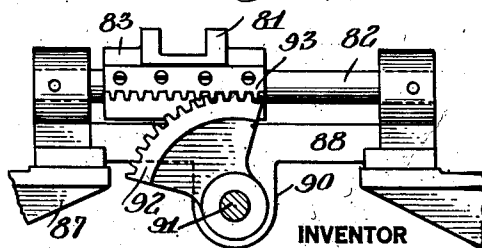


Fig. 12



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TORIC LENS GENERATING MACHINE

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Fig. 14

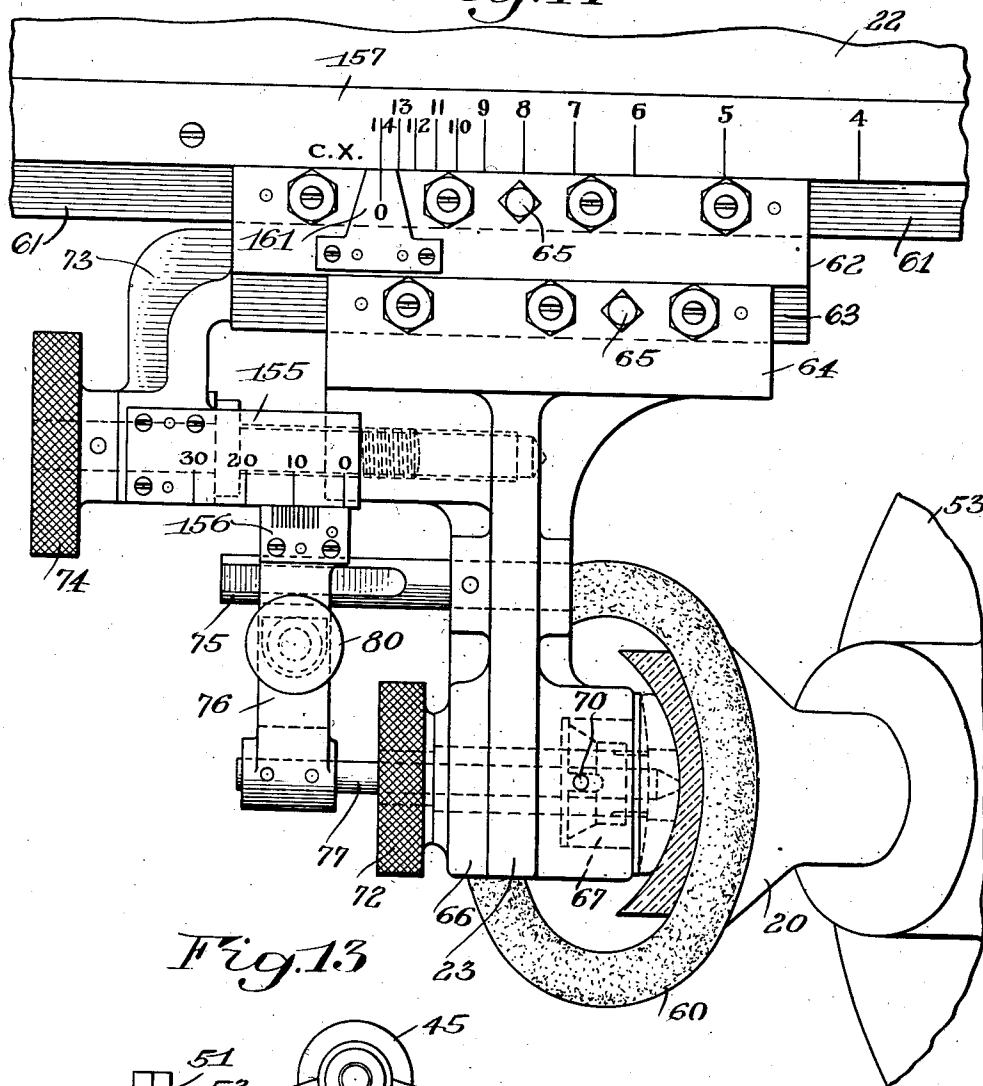
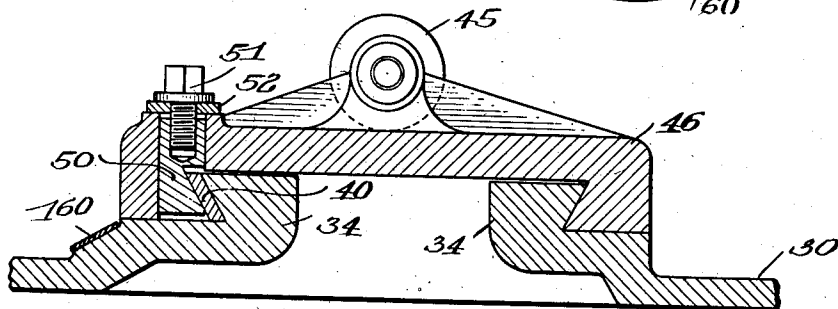


Fig. 13



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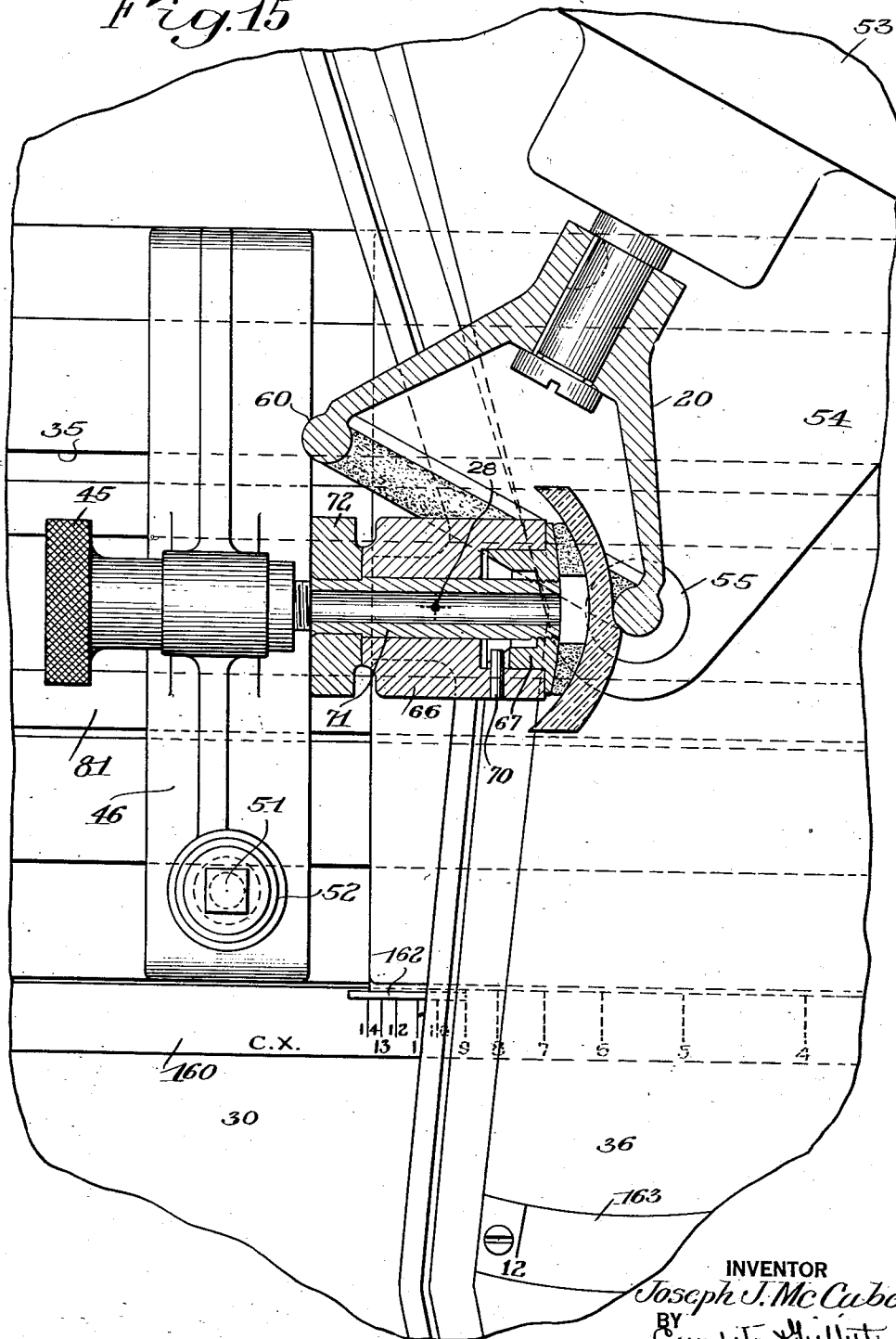
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TORIC LENS GENERATING MACHINE

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Fig. 15



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## UNITED STATES PATENT OFFICE

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## TORIC LENS GENERATING MACHINE

Application filed April 5, 1927. Serial No. 181,202.

This invention relates to lens grinding machines and particularly to machines for generating toric lenses.

An object of this invention is to provide a machine of the above nature which is capable of thoroughly efficient and dependable operation. Another object is to provide a machine of the above nature by means of which toric lenses may be quickly and efficiently produced. Another object is to provide improved means for accomplishing the above objects. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is shown one of the various possible embodiments of this invention,

Figure 1 is a side elevation of the assembled machine;

Figure 2 is a sectional side elevation taken substantially through the center of the machine;

Figure 3 is a fragmentary end elevation of the machine;

Figure 4 is a fragmentary plan view with the lens block supporting means removed, and showing the tool or cutter in position for the commencement of a cutting operation;

Figure 5 is a plan view of the machine with the lens block supporting means removed, and showing the tool in its middle position while developing a convex surface;

Figure 6 is a view similar to Figure 5, but showing the tool in its middle position while developing a concave surface;

Figure 7 is a plan view of the base, showing the driving mechanism;

Figure 8 is a fragmentary plan view similar to Figures 5 and 6;

Figure 9 is a fragmentary elevation of the base, partly in section showing the driving means and the means for rendering the driving means inoperative;

Figure 10 is a sectional end elevation taken

substantially through the center of the machine;

Figures 11 and 12 are views of the slidable drive member and the gear means for moving the same;

Figure 13 is a sectional view of the means for adjusting the tool carriage on its support;

Figure 14 is a view of the lens supporting and positioning means;

Figure 15 is a sectional plan view of the lens block and rotary annular cutter; or abrasive cup wheel; and

Figure 16 is an elevation of the cutter in contact with the convex surface of a lens.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to Figure 1 of the drawings, there is shown a rotary tool or cutter 20 having a convex annular cutting surface adjustably mounted on a base 21. A supporting frame 22 is mounted on the ends of the base 21 and extends above and substantially centrally of the base. Lens supporting means indicated generally by the numeral 23 are adjustably mounted on the upper horizontal portion of the frame 22 and are adapted to support a lens adjacent the periphery of the cutter 20. The lens supporting means and cutter are independently movable longitudinally of the frame. The cutter is also angularly adjustable relatively to the lens block, and movable through an arcuate path about the lens block.

The base 21 may be described as a shell having vertically extending side walls provided with an integral inwardly extending flange 24 at the top. An upwardly projecting annular shoulder or bearing member 25 may be formed integrally with or rigidly attached to the flange 24 at its inner edge and is provided with an annular groove forming a seat for the bearing balls 26. For spacing and retaining the balls 26 in their proper relative positions a plate 27 provided with spaced circular apertures is mounted on the upper surface of the member 25. A tool supporting member 30 is mounted for rotation about a fixed axis, indicated by the

numeral 28 (Figs. 8 and 15), on the base 21 and has an annular groove formed in its lower surface for the reception of the upper portions of the balls 26. The support 30 has an integral depending annular flange 31 which supports an annular retaining ring 32 in contact with the lower face of the member 25. A depending flange 33 is formed integrally with the support 30 and forms an outer protecting cover for the ball bearing. Parallel guide rails 34 having inwardly beveled outer side surfaces are formed integrally with the support 30 on opposite sides of a central longitudinal slot 35, and extend substantially the entire length of the support. A carriage 36 having depending parallel guide rails 37 formed integrally therewith and having beveled faces adapted to engage the beveled faces of the guide rails 34, is slidably mounted on the support 30. As shown in Figs. 3, 10 and 13, a thin protecting strip of metal 40 may be positioned between a beveled face of a guide member 34 and the adjacent face of a guide member 37 to form, with the movable pin 41 and rod 42, means for locking the tool carriage 36 in position on the support 30. The rod or shaft 42 is rotatably mounted in a boss or lug 43 mounted on the under surface of the tool carriage adjacent an edge thereof, and has an outer head portion 44 and an inner threaded end portion which extends through a threaded opening in a guide member 37 and is adapted for contact with the outer end of the movable pin 41.

The tool carriage may be adjusted on the support through a thumb screw 45, shown especially in Figs. 12 and 13, a reduced portion of which is rotatably mounted in a yoke 46, and which has a threaded end portion entering a threaded opening in a lug or projection 47 on the tool carriage. The yoke 46 has leg portions provided with beveled faces for engaging a beveled face of a guide rail 34 and a face of the protecting strip 40. One of the legs of the yoke 46, as shown in Fig. 13, has an opening therethrough in which a pin 50 is slidably mounted. The lower portion of the pin 50 has a portion cut away to provide a beveled face for engaging a beveled face of a guide rail 34 on the outer face of the strip 40, and the upper portion of the pin 50 has a threaded recess therein for the reception of the threaded end portion of a bolt or set screw 51. The head of the member 51 bears upon the upper surface of a washer 52, the lower surface of which is in contact with the upper surface of a portion of the yoke.

In setting the tool carriage 36 to the desired position, the locking screws 42 and 51 are first loosened and the tool carriage 36 is moved along the guideway 34 to approximately the desired point. Then the yoke 46 is clamped to the guideway by tightening the

screw 51, and the screw head 45 is rotated to shift the tool carriage 36 accurately to the desired position, after which the tool carriage may be locked in said position by rotating the squared head 44 of the locking rod 42.

The tool 20 is rigidly mounted on the shaft of a motor 53 which is in turn rigidly mounted on a base 54. The motor base 54 is swiveled on the head end portion of a bolt 55, the threaded end portion of which is mounted in a threaded opening in the upper surface of the blocking member 36. An arcuate groove 56 formed in the upper surface of the tool carriage and having its center of curvature lying in the vertical axis of the bolt 55 has a widened bottom portion which is adapted to receive a threaded nut which is slidable in the widened portion of the groove. A bolt 57 has its threaded end portion extending through an opening in the motor base and into the threaded opening in a nut positioned in the groove 56. The bolt 57 may be manipulated to lock the motor base in position on the tool carriage or to release the motor base to permit angular adjustment of the tool.

The tool 20, as shown especially in Figs. 15 and 16, is substantially in the form of a funnel, the spout of which has a uniform bore of circular cross-section for the reception of an end portion of the motor shaft. The cutter is rigidly attached to the motor shaft for rotation therewith. The body portion of the cutter while shown to be of substantially truncated cone shape, may have a tubular form or any other desirable form which will provide for the proper functioning of the cutting portion. The annular bead 60, which is arcuate or substantially circular in cross-section, forms the cutting portion of the tool, and substantially the entire convex surface is adapted to be used for cutting or grinding. The cutting portion may be formed of any suitable material but it is preferably of diamond-charged copper construction. The motor is so positioned on its base and the tool is so positioned on the motor shaft that a center point of the annular cutting portion at an extreme outer edge thereof does not move relatively to the tool carriage during the pivotal movement of the motor base thereon. For instance, in Figure 15 there is shown a sectional plan view through the center of the tool, and it will be noted that the center of curvature of the annular bead or cutting portion at one side lies in the vertical axis of the pivot or bolt 55.

Referring now especially to Fig. 14, the horizontal portion of the frame 22 is provided with a longitudinally extending central guide member 61 on which a lens block supporting member 62 having a similar depending guide member 63 is slidably mounted. A bracket 64 is slidably mounted on the guide

member 63. Set screws 65 extend through openings in side portions of the members 62 and 64 and are adapted to be manipulated to bear upon beveled faces of the guide members 5 61 and 63 to lock the members 62 and 64 in position on the members 61 and 63. The bracket 64 is provided with a substantially tubular head portion 66 the longitudinal axis of which lies substantially in a vertical plane 10 through the longitudinal center of the machine. As shown in Figures 14 and 15, the opening through the head portion is enlarged at one end for the reception of a lens block 67, and a locking member extends through 15 the opening in the head member and holds the block in position on the bracket.

The block comprises a substantially tubular internally threaded member of circular cross-section and having an annular shoulder 20 projecting from the sides thereof adjacent one end. The opposite end portion of the block wall is provided with a longitudinal open end slot which is adapted to receive an inwardly projecting pin 70 which is rigidly 25 mounted on the head portion. A face of the shoulder portion of the block is adapted to bear upon an end face of the head portion. The locking means comprises a tubular member 71 having a threaded end portion 30 which fits within the threaded portion of the block, and an operating member or thumb nut 72 which is rigidly mounted on the opposite end portion of the member 71 and has a face portion which is adapted for contact with an end face of the tubular head 35 portion 66.

A depending supporting arm 73 is mounted on or formed integrally with the supporting member 62 and has a horizontally 40 extending thumb screw 74 journaled in its lower end portion. The threaded end portion of the thumb screw 74 fits within a threaded opening or recess in the bracket 64, and the thumb screw may be manipulated to 45 move the bracket relatively to the lens block supporting member 62. A supporting arm 75 is rigidly mounted on the bracket 64 and has a clamp member 76 adjustably mounted thereon. This clamping member 76 may 50 comprise a split yoke having a portion extending on each side of the arm 75. The thumb screw 80, when tightened, is adapted to draw the two portions of the yoke together so that they bear against the arm 75 and 55 are thus clamped rigidly to the arm. The clamp 76 supports a pointer 77 which is adapted to extend centrally through the tubular member 71 and the block 67, and which serves as a finder for positioning the lens 60 blank relatively to the cutter. A thumb screw 80 is provided for locking the clamp in position on the arm 75.

During the cutting or grinding operation the cutter is moved bodily relatively to the 65 lens block through a drive member which is

mounted for reversible rectilinear sliding movement within the base. The drive member comprises a body portion 81 having a uniform rectangular groove in its upper surface extending from end to end thereof. 70 Guide members 82 extend through openings in the lugs or bosses 83 attached to the under side of the body portion 81 at the opposite ends thereof, and have their end portions 75 mounted in openings formed in bosses or lugs on the brackets 84 and 88 which are rigidly mounted on supporting arms 87 within the base. An apertured block 85 is mounted for sliding movement longitudinally of the base 80 within the groove formed in the body portion 81, and a vertically extending pin 86 which is rigidly mounted on the under surface of the blocking member 36 has an end portion which extends into and may rotate within the aperture in the said block member. The pin 85 86 is preferably mounted immediately below the pin 55 and the outer cutting edge of the cutter so that there is no likelihood of the axis of the pin coinciding with the axis of rotation of the support 30 and preventing 90 rotation of the support for any normal operative position of the cutter.

The brackets 84 and 88 have central depending portions 90 in which a shaft 91 95 having gear segments 92 rigidly mounted thereon is journaled for rotation. The teeth of the gear segments 92 are adapted to mesh with the teeth of the horizontal racks 93 which are fixed on the slidable drive member adjacent the opposite ends of the body portion 100 81.

A gear housing 94 is mounted on and forms part of the base 21, as shown in Figs. 2, 7 and 9. A shaft 95 having a clutch member 96 and a worm wheel 97 rigidly mounted 105 thereon is journaled in bearings on the front and rear walls of the housing 94 with its axis coinciding with the axis of the shaft 91. The end portion of the shaft 95 on which the clutch member 96 is mounted is positioned 110 adjacent an end of the shaft 91 on which a clutch member 100 is keyed for longitudinal sliding movement. The jaws of the clutch members 96 and 100 are adapted to engage 115 or mesh, and means to be later described are provided for moving the clutch member 100 into and out of engagement with the clutch member 96.

A drive pulley 101 is rigidly mounted on a main shaft 102 (see Fig. 7) and operates 120 through a suitable train of gears to rotate the shaft 95. The shaft 102 is rotatably mounted in suitable bearings and extends substantially the entire length of the machine. A worm 103 is rigidly mounted on 125 the shaft 102 within the housing 94 and meshes with a worm wheel 104 which is rigidly mounted on the horizontal shaft 105. The shaft 105 is mounted for rotation in suitable bearings on the side walls of the machine. A 130

worm 106 which is also rigidly mounted on the shaft 105 adjacent an end thereof is adapted to engage a worm wheel 107 which is rigidly mounted on a vertical shaft 110. The shaft 110 is suitably mounted for rotation in bearings formed on the top and bottom walls of the housing 94 and has a worm 111 rigidly mounted thereon for engaging the worm wheel 97 mounted on the shaft 95. Thus, rotation of the shaft 102 is transmitted through worm 103, worm wheel 104, worm 106, worm wheel 107, worm 111, and worm wheel 97 to the shaft 95, and the movement of shaft 95 when the clutch members 96 and 100 are in engagement, is transmitted to the gear segments 92 for moving the slidable drive member and thus rotating the support 30. The worms and worm wheels described above may be of any suitable relative sizes to obtain the desired reduction.

The drive pulley 101 may be operated by a belt connected with any suitable source of power. A loose pulley 113 is mounted adjacent the pulley 101 on an end portion of the shaft 102 and means are provided for shifting the drive belt from one pulley to the other. The belt shifting means comprise a member 114 mounted for sliding movement on a rigid horizontal arm 115, and having spaced arms 116 projecting forwardly therefrom, as best shown in Figs. 1, 3 and 7. A lever 117 is pivotally mounted adjacent an end thereof on a pin 120 carried by a bracket 121, and has an open end slot formed therein adjacent its other end, and an elongated slot formed therein intermediate its ends. A pin 122 which is rigidly mounted on and projects rearwardly of the member 114 is adapted to enter the open end slot and a pin 123 which is rigidly mounted on a rigid arm 130 carried by the shaft 124 is adapted to enter the intermediate slot. The shaft 124 is mounted for rotation in the bracket 121 and a bracket 125 and has a lever arm 126 and an operating handle 127 rigidly attached thereto. When the shaft 124 is rotated, the pin 123 operates to move the lever 117 which causes a movement of the member 114 and projecting arm members 116 through the pin 122.

A pump 131 is mounted on the base 21 adjacent an end thereof and operated by the main shaft 102. Suitable conduits (not shown) may be provided for conducting a cooling fluid from the pump to the cutter during a cutting or grinding operation.

For manipulating the clutch member 100 and causing its jaws to engage the jaws of the clutch member 96, there is provided an operating lever 132, shown in Figs. 2, 3 and 7, having a bifurcated end portion forming arms 133, and an operating handle 134 projecting beyond an outer wall of the base 21. The arms 133 have screw members 135 provided with reduced end portions extending therethrough. The reduced end portions of

the members 135 are positioned in apertures formed in slide members 136 which are mounted within a rectangular annular groove formed in the clutch member 100. Accordingly, the lever 132 may remain in a fixed position while the clutch member 100 rotates with the shaft 91.

The clutch lever 132 is pivoted intermediate its ends on a vertical pin 137 carried by a stationary bracket 140. A helical spring 141 (Fig. 7) has an end anchored to the base 21 and its opposite end attached to the lever 132 intermediate the handle 134 and the pivot, and tends to hold the clutch member 100 out of engagement with the clutch member 96. A latch member 142, a portion of which is adapted to engage a projection 143 on the lever 132 adjacent the handle 134, is provided for locking the clutch member 100 in engagement with the clutch member 96.

The latch member 142 is best shown in Figs. 3, 7 and 9, and is pivotally mounted intermediate its ends on the bracket 84 as at 144, and a helical spring 145 having an end resting upon the upper surface of a supporting arm 87 and its opposite end portion extending into a recess in the latch member exerts an upward pressure on one end portion of the latch member and tends to hold the opposite end portion in engagement with the projection 143. The end portion of the member 142 adjacent the spring 145 has an upwardly projecting adjustable set screw 146 threaded therethrough. The upper end of the screw member 146 is adapted to yieldingly engage a free end of an arm of a bell crank lever 147 which is pivotally mounted on the bracket 84 as at 150. The free end of the other arm of the bell crank lever is adapted to normally engage the upper end of an adjustable set screw 151 mounted in a projection on a side of the bracket 84. The bell crank lever has an upwardly extending projection 152 which lies in the path of travel of the body portion 81 of the slidable drive member. When the drive member strikes the projection 152 during its movement it rocks the bell crank lever 147 which rocks the latch member 142 releasing the clutch lever 142 and permitting the helical spring 141 to operate to move the clutch members 100 and 96 out of engagement and render the driving means inoperative. An adjustable screw member 153 is positioned in the path of travel of the slidable drive member and limits its movement in one direction.

Calibrated scales 155, 156, 157, 160 and indexes 161 and 162 may be provided for aiding in positioning the lens and tool relatively to the axis of rotation of the support 30. Scale 155 is mounted on the arm 73 of the lens block supporting member for cooperation with the scale 156 carried by the pointer clamp 76. The position of the free end of the pointer 77 relatively to any fixed

point on the lens block supporting member 62 may be determined by the relative positions of any two lines on the scales 155 and 156, and the scale 157 is so arranged on the horizontal portion of the frame 22 that the position of any fixed point on the member 62, relatively to the axis of rotation of the support 30, may be determined. Thus, through the medium of the scales 155, 156, 157 and the zero line on the index 161 which is fixed on member 62, the position of the free end of the pointer relatively to the axis of rotation of the support 30 may be determined. For instance, when a certain line on the scale 156 coincide with the zero line on the scale 155 and the zero line on the index 161 coincides with a line on the scale 157 indicating a certain curvature, the extreme end point on the free end portion of the pointer 77 may be spaced from the axis of rotation of the support 30 a distance corresponding to the radius of curvature indicated by the index 161 on the scale 157. Likewise, the scale 160 which is fixed on the support 30 and the index 162 which is fixed on the tool carriage 36 are so arranged that the position of the center point of the cutting side of the cutting member relatively to the axis of rotation of the support 30 may be determined.

A calibrated arcuate scale 163 fixed on the upper surface of the tool carriage and an index 164 carried by the motor base are provided for aiding in making the angular adjustment of the tool for the purpose of determining the curvature in the vertical meridian.

A lens blank to be ground is first attached to the block 67 by means of pitch or other suitable adhesive means with its axes at the proper angles relatively to the open end slot in the block wall, and its center lying in the longitudinal axis of the block. The block is then inserted in the large end of the tubular head portion 66 of the bracket and locked in position as described above. The clamp 76 carrying the pointer 77 is then locked in position by means of the set screw 80 on the supporting arm 75, with the pointer extending through the tubular locking member, and the end of the pointer engaging the center point on the rear face of the lens blank. The lens block supporting member 62 carrying the bracket 64 is moved on the frame 22 until the zero line of the index 161 coincides with a line on the scale 157 indicating the desired curvature. Next, the rear face of the lens blank is placed in its proper position relatively to the axis of rotation of the support 30 by manipulating the thumb screw 74 and moving the bracket 64 relatively to the lens block supporting member 62. The distance of the rear face of the lens from the axis of rotation of the support should be less than the desired radius of curvature in the horizontal meridian by an amount equal to the center thickness of finished lens. The thickness of the

lens may be determined by the relative positions of the graduations on the scales 155 and 156.

After the lens block has been properly positioned on the lens block supporting member, and the lens block supporting member has been properly positioned on the horizontal portion of the frame 22, they are locked in position by means of the set screws 65.

The support 30 may then be rotated to position the tool at one side of the lens block and the tool carriage moved by hand on the support 30 to an approximate proper position in which the index 162 indicates a curvature on the scale 160 corresponding to the curvature indicated by the index 161 on the scale 157. The yoke 46 may be then locked in position by means of the bolt or set screw 51 and pin 50, and the final adjustment of the tool carriage is made through the thumb screw 45. The rod or shaft 42 is then manipulated to lock the tool carriage in position.

The tool may then be angularly adjusted to provide the desired curvature in the vertical meridian by shifting the motor base until the index 164 indicates the proper curvature on the scale 163, after which the member 57 is manipulated to lock the tool in its proper position.

The apparatus may be adjusted to generate either convex or concave surfaces and suitable graduations have been provided on the scales described above. The type of surface produced is determined by the position of the pin 86 relatively to the axis of rotation of the support 30, and the angular position of the tool. Figures 1, 2, 4, 5 and 8 show the apparatus adjusted to develop convex surfaces. It will be noted that in Figure 2 the pin 86 is positioned on the right of the axis of rotation of the support 30 which is midway between opposite similar points on the annular bearing member 25. It will also be noted that the member 81 is positioned at one side of the longitudinal center of the machine. Figure 6 shows the apparatus adjusted to develop a concave surface. When the apparatus is adjusted to start the development of a concave surface, the slide member 81 is positioned on the same side of the longitudinal center of the machine as for the development of a convex surface, but the pin 86 is positioned on the opposite side of the axis of rotation of the support.

Figure 4 shows a plan view of the apparatus adjusted to develop a convex spherical surface having a curvature of 14 diopters with the tool in position to start cutting. When the apparatus is set as shown in Figure 4, the handle 127 may be moved to shift the belt to the drive pulley 101, then the motor 53 may be started for the purpose of rotating the tool, after which the clutch lever 132 may be manipulated to move the clutch member 100 into engagement with the clutch member 96. The

shaft 91 and gear segments 92 are thus caused to rotate, moving the member 81 in a straight path from one side of the longitudinal center of the machine to the other side.

5 The pin 86 transmits the movement of the member 81 to the tool carriage 36 and thus to the support 30 since the tool carriage is locked in position on the support. Since the support 30 is mounted on an annular bearing its movement is necessarily rotational. Thus, 10 since the lens block is locked against movement and the cutter is mounted for movement with the support 30, the cutter is caused to travel through an arcuate path about the lens block. Figures 2 and 5 show the relative 15 positions of the various parts when the cutter has completed approximately one-half of its travel. The apparatus may be so adjusted that immediately after the tool has finished 20 cutting, the member 81 strikes the projection 152 rocking the bell crank lever 147 and rendering the driving mechanism inoperative as described above. The cutter and its associated parts are returned by hand to the starting position. 25

The direction of rotation of the cutter and support 30 during the development of a convex surface is indicated by the arrows in Figures 4 and 5, and the direction of rotation 30 during the development of a concave surface is indicated by the arrow in Figure 6. It will be noted that the direction of rotation of the support 30 during the development of a concave surface is the reverse of the direction of rotation for the development of a convex surface. Also, that for the development of the 35 two types of surfaces the major portion of the motor base is positioned on opposite sides of the longitudinal center line of the tool carriage. The change in the direction of rotation of the support is due to the fact that while the pin 86, is positioned on opposite sides of the axis of rotation of the support for the two operations, the direction in which the 40 slide 81 is driven is constant.

Figure 8 shows the apparatus adjusted to develop a spherical convex surface having a curvature of three diopters. At this point, it may be noted that the angular adjustment 50 of the tool is not determined by the positions of the tool carriage and the lens block. The setting of the lens block must correspond to the setting of the tool carriage on the support in order to obtain the desired thickness of lens and the proper curvature in the horizontal meridian, but the curvature in the vertical meridian is determined entirely by the angular position of the cutter, and the cutter may be adjusted to provide any desired curvature 55 in the vertical meridian regardless of the curvature in the horizontal meridian which may be provided by any particular setting of the lens block and tool carriage. 60

From the foregoing it will be seen that there 65 is herein provided an apparatus which em-

bodies the features of this invention and achieves the objects thereof, including many practical advantages. A toric generator is provided which is dependable in operation and by means of which toric lenses may be 70 quickly and efficiently produced.

Although the machine disclosed herein is provided with lens supporting means which are adapted to remain stationary during the cutting operations, and a tool or abrasive cup 75 wheel which is mounted to travel through an arcuate path about the lens supporting means, it is to be understood that the invention is adaptable to provide machines in which the lens supporting means are mounted to travel 80 through arcuate paths about tools which may be mounted to rotate in fixed positions.

As many embodiments may be made of the above invention, and as many changes might be made in the embodiment above set forth, 85 it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In a machine of the class described, a 90 rotatable support, a tool carriage adjustably mounted on said support, an annular cutter adjustably mounted on said tool carriage, a transversely moving guideway, and means 95 including a member operatively connected with said tool carriage and movable along said guideway when said tool carriage is adjusted relative to said support, for rotating said support. 100
2. In a machine of the class described, a rotatable support, a cutter mounted on said support for movement therewith, a drive member mounted for rectilinear movement, means connecting said drive member and said 105 support to rotate said support when said drive member moves, means for moving said drive member, and means for rendering said moving means inoperative when said drive member reaches a predetermined point in its 110 travel in one direction.
3. In a machine of the class described, a rotatable support, a tool carriage adjustably mounted on said support, a rotary annular cutter adjustably mounted on said tool carriage, a drive member mounted for rectilinear 115 movement, means connecting said drive member and said support to rotate said support when said drive member moves, means for moving said drive member, and means for 120 rendering said moving means inoperative when said drive member reaches a predetermined point in its travel in one direction.
4. In a machine of the class described, a support mounted for rotation about a fixed 125 axis, a tool carriage mounted on said support and movable substantially radially from a position on one side to a position on the opposite side of the axis of said support, and a rotary annular cutting member mounted 130

on said tool carriage for bodily movement therewith, said cutting member being adjustable on said tool carriage by oscillation thereon about an axis substantially parallel to said fixed axis of said support.

5 5. In a machine of the class described, a support mounted for rotation about a fixed axis, a tool carriage mounted on said support and movable thereon along a line passing through the axis of said support, an angularly adjustable annular cutting member mounted on said tool carriage and a movable lens supporting member for supporting a lens adjacent the periphery of said cutting member.

15 6. In a machine of the class described, a rotatable support, a tool carriage adjustably mounted on said support, an annular cutting member adjustably mounted on said support, a drive member mounted for rectilinear movement, and having a guideway, means including a member adjustable to various position along said guideway for connecting said drive member and said tool carriage for rotating said support through motion imparted to said tool carriage, and movable means for supporting a lens adjacent the periphery of said cutting member.

30 7. In a machine of the class described, an adjustably mounted lens supporting member, a rotatable support, a tool carriage adjustably mounted on said support, an angularly adjustable annular cutting member mounted on said tool carriage. A drive member mounted for rectilinear movement, means connecting said drive member and said tool carriage for rotating said support, means for moving said drive member, and means for rendering said moving means inoperative when said drive member reaches a predetermined point in its path of travel.

45 8. In a machine of the class described, a base, a rotatable support mounted on said base, a tool carriage adjustably mounted on said support, a rotary cutter adjustably mounted on said tool carriage, a drive member mounted for rectilinear movement on said base and having a guideway, means including a member movable along said guideway connecting said drive member and said tool carriage for rotating said support through motion imparted to said tool carriage, and a lens supporting member adjustably mounted adjacent said cutting member.

55 9. In a machine of the class described, a base, a rotatable support mounted on said base, a tool carriage adjustably mounted on said support, an annular cutter adjustably mounted on said tool carriage, a lens supporting member adjustably mounted on said base, a drive member mounted for rectilinear movement, means connecting said drive member and said tool carriage for rotating said support, means for moving said drive member, and means for rendering said moving

means inoperative when said drive member reaches a predetermined point in its travel.

10. A machine for generating toric surfaces comprising a driven shaft, a generating element mounted on said shaft to rotate therewith, said element comprising a substantially conical body secured to said shaft at its smaller end and having an annular work-engaging bead at its larger end, mechanism for holding work in position to be acted upon by said annular bead, means for adjusting the angular relation between the work and the annular bead to determine the curvature of the generated surface in one meridian, said work contacting with different portions of the same annular bead for production of different curvatures whether concave or convex, mechanism for producing a relative arcuate swinging movement between the work and the generating element to traverse the one across the other, and means for adjusting the radius of said arcuate swinging movement to determine the curvature of the generated surface in another meridian.

11. A machine for generating toric surfaces comprising a frame, an annular generating element, a work holding element, a member oscillatable about an axis, a slide mounted on said member for substantially radial movement with respect to said axis, means for mounting one of said elements on said slide so that by radial adjustment of said slide the distance of said element from said axis may be varied to vary the curvature of the path through which said element will sweep when said member is oscillated about its axis and to vary the curvature of the generated surface in one meridian, means for mounting the other of said elements on said frame in cooperative relation to the element mounted on the slide, means for adjusting the angular relation of said generating element to work held by said work holding element, to vary the curvature of the generated surface in another meridian, power mechanism for oscillating said member about said axis to move said work holding element and said generating element relative to each other to generate a surface on work held by said holding element, and stop means for automatically stopping such oscillation after the generation of said surface has been completed.

12. A machine for generating toric surfaces comprising a frame, a generating element having an annular generating edge which is arcuate in radial cross section and of substantial radius, a work holding element, a member oscillatable about an axis, a slide mounted on said member for substantially radial movement with respect to said axis, means for mounting one of said elements on said slide so that by radial adjustment of said slide the distance of said element from said axis may be varied to vary the curvature

of the path through which said element will sweep when said member is oscillated about its axis and to vary the curvature of the generated surface in one meridian, means for mounting the other of said elements on said frame in cooperative relation to the element mounted on the slide, means for adjusting the angular relation of said generating element to work held by said work holding element, by turning said generating element about an axis concentric with said arcuate generating edge, to vary the curvature of the generated surface in another meridian, power mechanism for oscillating said member about said axis to move said work holding element and said generating element relative to each other to generate a surface on work held by said holding element, and stop means for automatically stopping such oscillation after the generation of said surface has been completed.

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