Feb. 25, 1964 D. GRAY ETAL 3,121,979

BEVEL EDGE GRINDER

Filed May 24, 1961 4 Sheets-Sheet 1

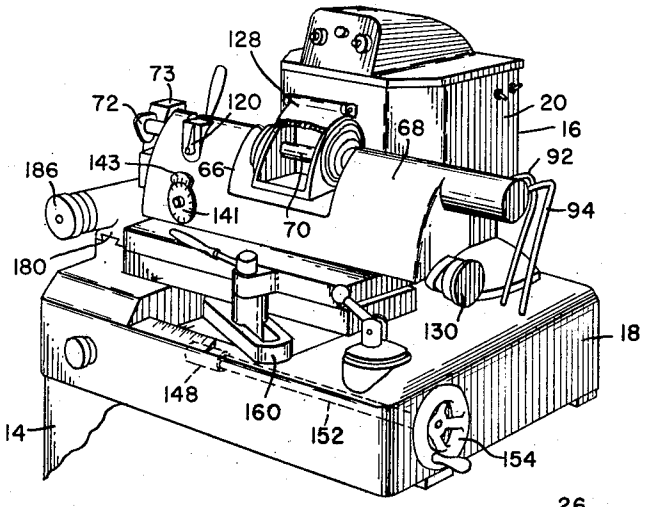



FIG. 1

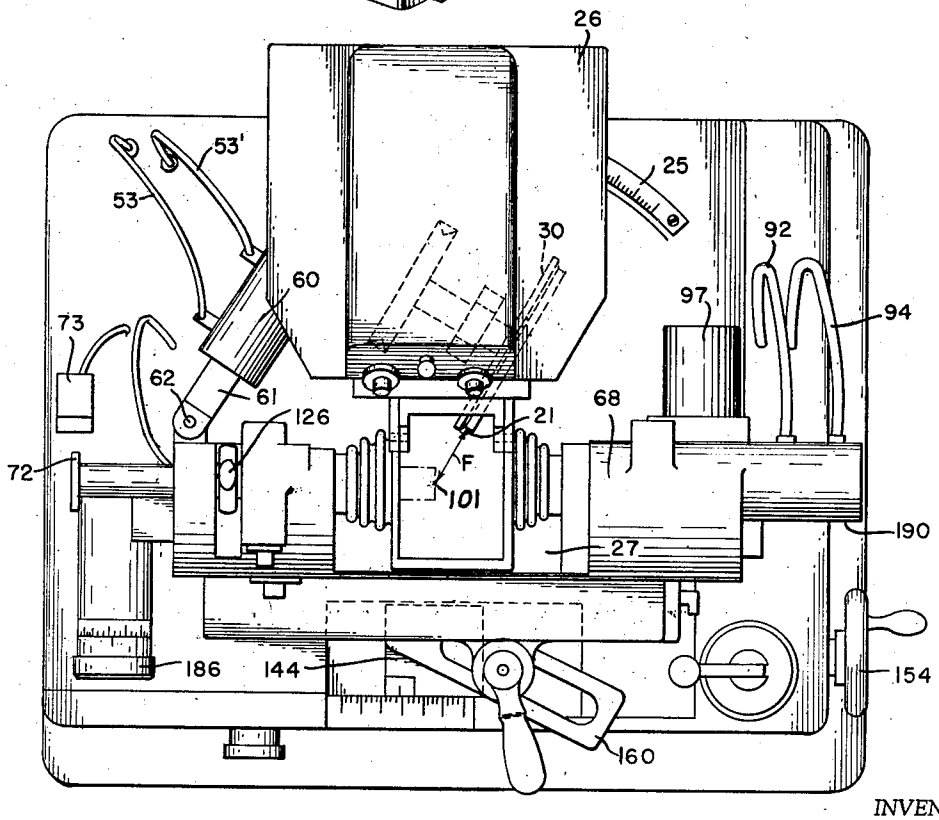



FIG. 2

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FIG. 3

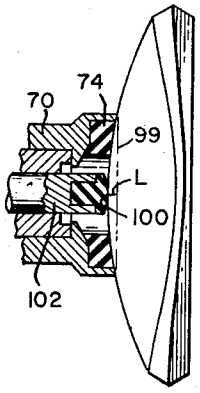



FIG. 3A

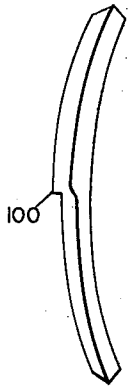



FIG. 4

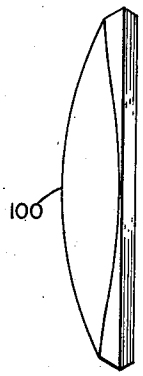



FIG. 4A

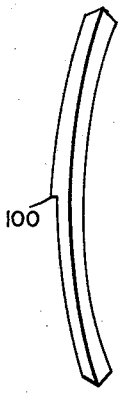



FIG. 6

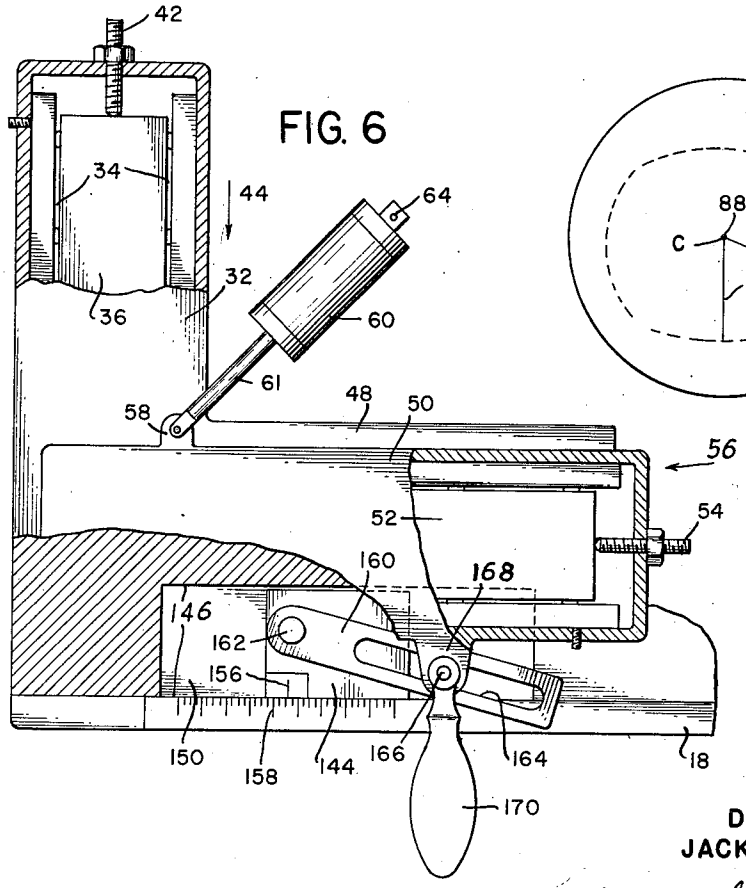






FIG. 5

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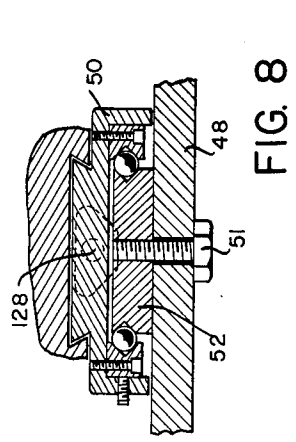
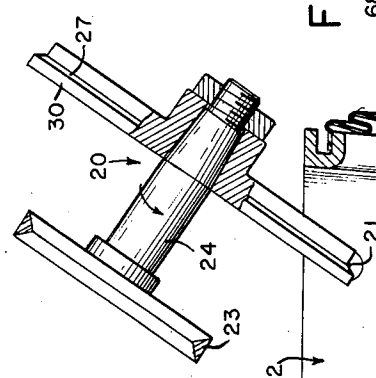



FIG. 8



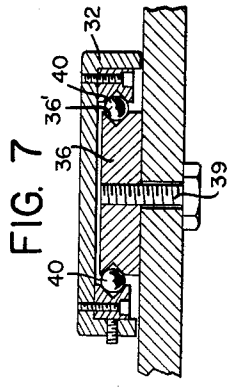




FIG. 7

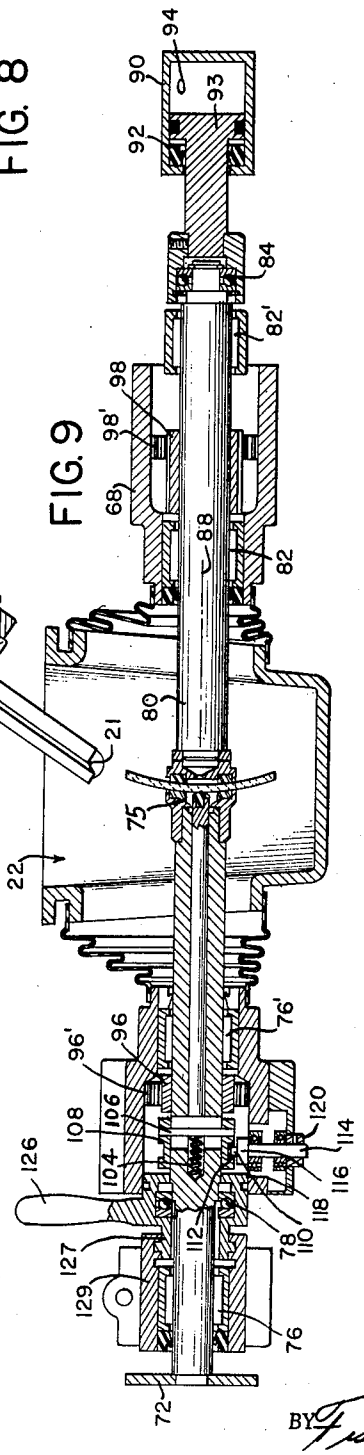



FIG. 9

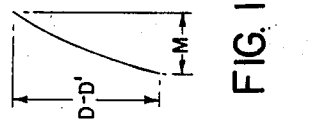



FIG. 11

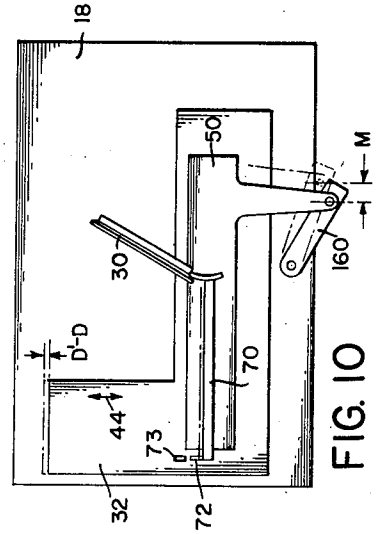



FIG. 10

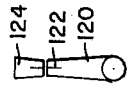



FIG. 9b

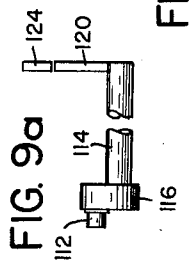



FIG. 9a

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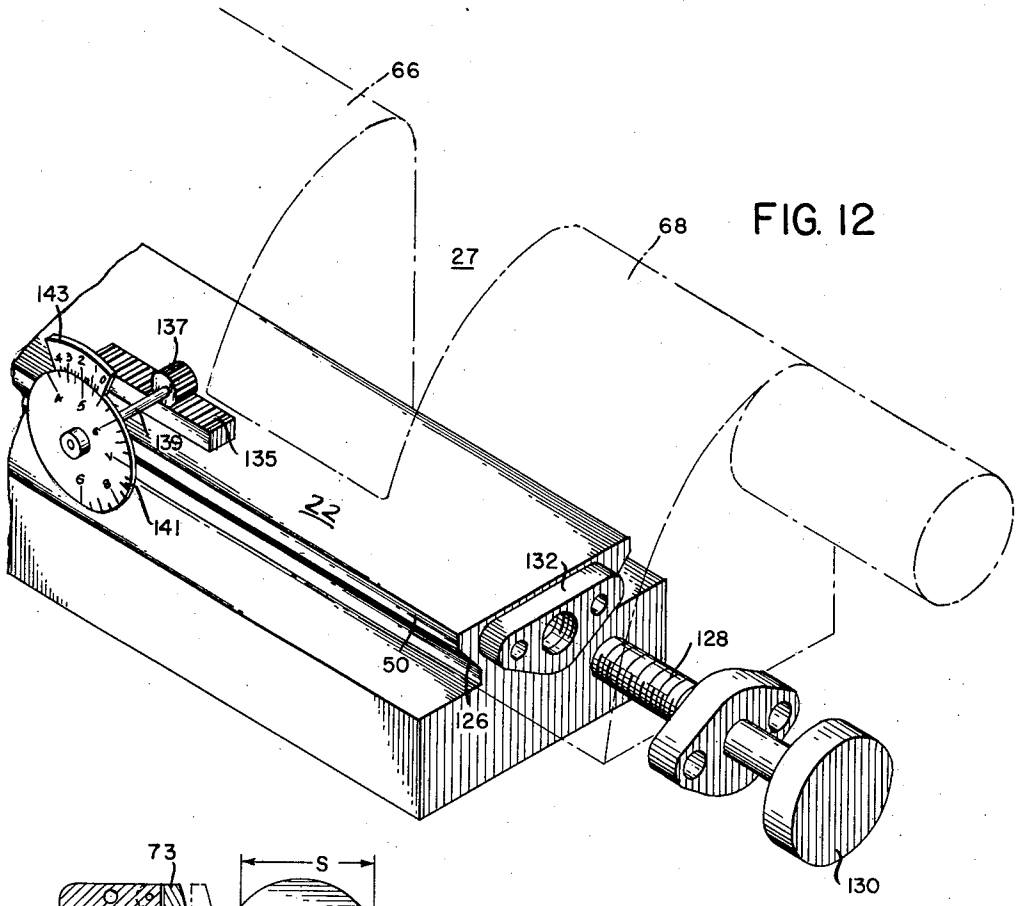



FIG. 12

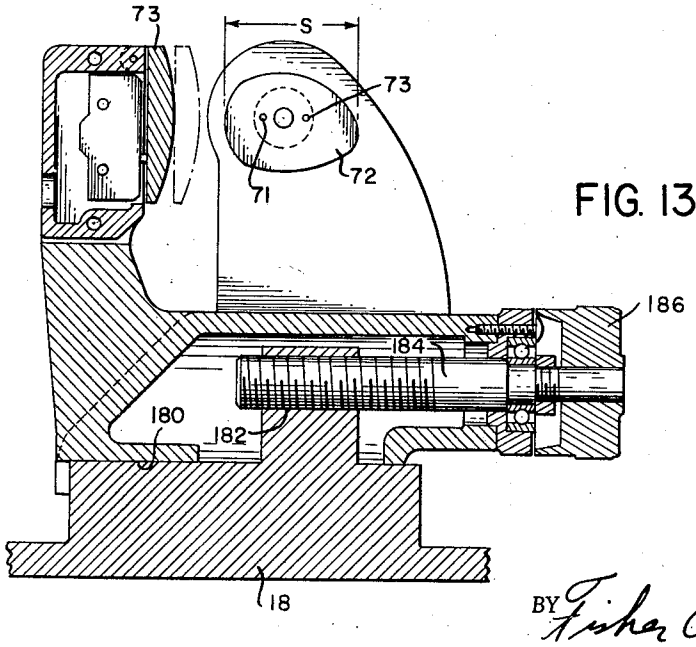



FIG. 13

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United States Patent Office 3,121,979 Patented Feb. 25, 1964



3,121,979

# BEVEL EDGE GRINDER

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17 Claims. (Cl. 51—101)

This invention relates to an improvement in bevel edge grinding machines and specifically relates to an edge grinding machine for forming geometrical regular or irregular peripheral beveled edges on meniscus and toroidal shaped articles such as ophthalmic lens.

An instrument according to this invention comprises in combination a rotating grinding wheel having a V-groove abrading edge for forming the bevel on the peripheral edge of the lens, a lens supporting means for placing the peripheral edge of the lens in contact with the grinding surface of the grinding means, said supporting means imparting rotary movement to the lens, means for imparting a desired movement in the lens supporting means for maintaining the peripheral edge of the lens in correct alignment with the bevel grinding surface, and means displacing the lens supporting means causing the lens to advance towards, and recede from, the V-groove in accordance with the peripheral contour of the lens, whereby said grinding wheel forms the desired bevel on the edge of said lens.

The movement of the lens supporting means and its displacement towards and away from the grinding means is effected by a cam, the profile of which corresponds to the finished peripheral shape of the lens. This cam is mounted on a rotating chuck and, during the chuck rotation, effects the desired displacement of the lens supporting means.

One of the major objectives of this invention is to provide improved structure for guiding the peripheral edge of an ophthalmic lens into the rotatable abrading element. This objective is accomplished through structure which positively controls the movement of the edge portion of the lens into engagement with the abrading element on a line constantly tangential to the radius of a selected curve for the particular lens being ground.

Another objective of this invention is to provide an ophthalmic lens edge-grinding instrument of rigid construction comprised of a series of sub-carriages respectively limited to rectilinear movement but whose combined movements causes the lens to follow a predetermined curvilinear path into the abrading tool.

A still further objective of this invention is to provide a bevel edge grinding machine which eliminates the need for "floating head" type equipment now prevalent in the art. Such prior art equipment produces a curved beveled edge because of its sole dependence on the peripheral contour of the pattern cam for its engagement with the grinding wheel. This causes S-curves in the beveled edge of the lens when the abrading wheel is confronted with a lens having varying thicknesses or contours. In contrast, this invention provides a tangential bevel edge which is much more desirable from a cosmetic point of view in glasses. The tangential bevel is also much more desirable for mounting the lens in a frame.

A further objective of the invention is to provide a bevel edge-grinder which is adjustable to a selected curve of the lens, so that the lens as it rotatably engages the apex of the V-groove of the abrading apparatus will be constantly aligned with respect thereto regardless of a condition change during grinding.

Another objective of the invention is to provide a machine of the type described for moving an article toward and away from a grinding instrument along a



tangent to the selected curve as determined from the prescriptive data known to an operator.

A further objective of the invention is to provide a bevel edge-grinding machine which is automatic in operation, rigid in construction, relatively inexpensive and simple in its manufacture, and operable in a manner completely divorced from the weight of the chucking mechanism.

A still further objective of the invention is to provide a novel means by which the center of the convex surface of the lens (apogee) is related to the deepest portion of the V-shaped groove in the abrading wheel. In most existing apparatus, the lens is supported in such a manner that it travels in an arcuate path toward and away from the grinding tool determined solely by the peripheral configuration and the selected radius. According to the present invention, the lens is fed to the grinding tool along a continually changing tangential line which is perpedicular to the radius determined by the base curve of the lens. In this manner the apex of the bevel is consistently, within very close tolerances, an even distance from the convex side throughout the entire periphery of the lens.

Another objective of this invention is to provide means by which the apex can be accurately positioned between the peripheral edges of the concave and convex surface.

With the construction according to the present invention, the arcuate path defined by a radius of the base curve is continually divided into an abscissa and ordinant type components having corresponding movements in supporting rectilinear moving carriages which combine to develop the desired arcuate movement.

This rectilinear feed-in gives positive center line control of lens to the diamond grinding wheel at all points along the perimeter of the lens. As a concurrent objective, this gives the operator full choice in selecting the bevel edge location.

A further objective of this invention is to feed the lens to be ground into the groove of the grinding wheel so that the center line of the lens always remains perpendicular to the center line of the groove, and the selected base curve tangent at the edge of the lens intercepts said center line of said groove.

In order that the invention may be clearly understood and carried into effect, an embodiment of the same will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a front elevation of the apparatus according to the invention;

FIG. 2 is a plan view thereof;

FIGS. 3 and 3*a* are elevational views of a lens beveled with prior art devices;

FIGS. 4 and 4*a* are elevational views of a lens beveled by the structure of this invention;

FIG. 5 is a plan view of a lens blank;

FIG. 6 is a partial plan view of the carriage assembly with portions broken away;

FIG. 7 is a sectional view along the line 7—7 of FIG. 6;

FIG. 8 is a partial sectional view along the line 8—8 of FIG. 2;

FIG. 9 is a diagrammatic plan view of the chuck assembly showing the interior thereof;

FIG. 9*a* is an elevational view of an eccentric cam;

FIG. 9*b* is a partial end view of FIG. 9*a*;

FIG. 10 is a diagrammatic sketch showing the geometric movement of the lens supporting structure during different phases of the grinding operation;

FIG. 11 is an enlarged schematic showing of the movements depicted in FIGS. 9 and 10;

FIG. 12 is a diagrammatic view of the bevel placement mechanism; and

FIG. 13 is a diagrammatic cross-section of the lens-size adjustment assembly.

Referring now more particularly to the drawings and to the side views of a group of lenses, it is apparent that the lenses shown in FIGS. 4 and 4*a* are mounted in a frame much more readily than the ones shown in FIGS. 3 and 3*a*. This is so because frames are normally constructed with an interior peripheral groove to receive the exterior bevel of the lens. For reasons of economy, the frame manufacturer, although producing frames of many different peripheral configurations, cannot feasibly produce frames suitable for all prescriptive curves for each peripheral shape. Therefore, lens frames are provided with a straight fit. The straight bevels of FIGS. 4 and 4*a*, however, will always mate perfectly with a straight groove in the framing members.

In providing beveled edges by prior art methods, the bevels throughout the peripheries of the lenses are not shaped to properly fit the frame grooves; that is, such lenses normally have the apex of their bevels spaced at identical distances from the concave and convex surfaces of the lens at various points along the periphery. In such events the apex of the bevel will be irregular and crooked throughout the periphery of the lens as the major and minor curves change values. This necessitates the frame rim encircling the lens to be bent, twisted, reshaped or otherwise distorted to preperly receive the lens. This is accompanied with the constant danger of imparting a strain on the lens and possible breakage thereof.

The above disadvantages are practically non-existent in the presently described device wherein the irregularly shaped lens or other article is moved arcuately into and out of abrading position along a path related to the radius of a selected curve of the lens. The position of said path, with respect to the abrading wheel, being adjustable in accordance with the characteristics of the lens being ground.

Referring now more particularly to the machinery of the invention and to the drawings, where like characters of reference designate like parts throughout the several views, the present invention is embodied in a machine having a cabinet **14** upon which a grinding apparatus **16** is supported. The cabinet **14** houses a power plant, an air compressor, the oil supply, drainage structure, and so forth, which are necessary to any grinding operation. The grinding apparatus is affixed to the cabinet by a stationary base **18** upon which a grinding wheel assembly **20** and a lens positioning chuck assembly **22** are mounted.

The lens grinding assembly **20** is supported for limiting pivoting movement about a vertical shaft **21** in any convenient fashion. The assembly further includes a grinding chamber **26** having a pivoted door **28** closing the front access opening thereof. A circular V-grooved diamond abrading wheel **30** (FIG. 9) extends to within chamber **26** and is adapted to be rotated by shaft **24**. In the embodiment being described, the abrading wheel is vertically disposed in a plane defined by the apex **27** of the groove and said plane is vertically normal to the horizontal base supporting member **18**. To the rear of assembly **20** is a diamond wheel angle scale **25** by which the angular attitude of the grinding wheel plane may be read as it is adjusted about shaft **21**. The extension of the axis of shaft **21** intersects the apex of the **27** of the abrading wheel. The most often used abrading wheel has a 115° (degree) groove. As can be readily seen, the front slope (toward the convex surface) or the rear slope can be proportionately varied by moving housing **20** (and consequently wheel **30**) about shaft **21**.

The wheel **30** is driven about the shaft **24** by a belt **23** or any conventionual connecting means to a motor within cabinet **14**. During operation, the assembly **20** is locked insofar as movement about shaft **21** is involved and remains stationary except for the rotation of the wheel **30**.

The desired lens movement toward the abrading wheel is accomplished by moving the assembly **22** with respect



to the wheel along a controlled selected path. For these purposes, a lower L-shaped carriage **32** (FIGS. 6 and 7) is mounted on base **18** for a straight line reciprocating motion in ball bearing tracks **34**. The tracks are comprised of a stationary plate **36** having ball grooves **36'** and **36"** along its edges. The plate is secured in to base **18** by bolts **39**. The carriage has a generally inverted U-shaped cross-section having a pair of inner rails **38** and **38'** attached to the legs of **32** and are formed with mating grooves opposing the grooves of plate **36**. Ball bearings **40** are disposed between the grooves for substantially friction-free movement between the base and the carriage.

A set screw **42** is threadedly received by the carriage and abuts the plate **36** and limits the movement of carriage **32** in the direction denoted by arrow **44**.

A perpendicular extension **48** of carriage **32** supports a second upper carriage **50** for longitudinal reciprocating movement normal to the movement of carriage **32**. The ball-bearing support for carriage **50** is comprised of a plate **52** affixed to extension **48** by screws **51**, and a similar ball-bearing arrangement. An adjustable set screw **54** is provided for abutting the plate **52** to limit the upper carriages movement in direction **56**. Along the edge of the upper carriage is an apertured lug **58** receiving the piston rod of an air cylinder **60**.

The piston rod **61** is pivotally connected to lug **58** by pin **62**. The cylinder end thereof is pivotally connected to base **18** via pin **64**. Air cylinder **60** is the power means for moving carriages **32** and **50**, and during adjustment is powered to urge the carriages against set screws **42** and **54**; that is, away from the abrading wheel. Flexible air hoses **53** and **53'** supply air to the cylinder. The set screws are used to accurately position the carriages and thereby provide a fixed point from which to position the lens chuck with respect to the abrading wheel so that further adjustments can be made for the particular lens to be beveled.

During operation, the chuck assembly **22** is secured to upper carriage **50** and moves therewith. The assembly has a generally U-shaped configuration consisting of a pair of upwardly extending sections **66** and **68** defining a saddle **27** therebetween, in which the grinding chamber **26** is received. Rotatably secured within section **66**, is a chuck shaft **70** which supports a pattern cam **72** at one end, and is faced with a resilient lens-engaging material **74** surrounded by bushing **75** at the other end thereof. Shaft **70** is supported by roller bearings **76** and **76'** and thrust bearings **78**.

A second chuck shaft **80**, coaxial with shaft **70**, is rotatably supported in extension **68** by roller bearings **82** and **82'** and thrust bearings **84**. Shaft **80** is also faced at its inner end with a resilient lens-engaging material **86**. As stated, the shafts **70** and **80** share a common axis **88** and are adapted to secure a lens blank therebetween. The outer end of shaft **80** is equipped with a double-acting air cylinder **90** for causing reciprocating motion in shaft **80** along axis **88**. Shaft **70** is substantially longitudinally stationary along axis **88** except for slight chucking variations which are accounted for. Air is supplied to either side of a piston head **93** via conduits **92** and **94**. As seen in FIG. 9, pressure in conduit **94** has urged facing **86** to a lens-gripping position with facing **74**. Air pressure chucking and air pressure biasing is uniquely adapted for these purposes because of its uniformity and its infinite adjustability.

When the chuck shafts **70** and **80** securely grip a lens therebetween they are caused to rotate as a unit through a power train comprising gears **96**, **96'**, **98**, and **98'**. The power train may be of any conventional design and is operated from the power source **97**.

The carriages **32** and **50** are, through adjustment of screws **42** and **54**, set to position the center of chuck face **74** a precise distance F from the apex of groove **27**.

Since the lense blank must be positioned precisely with respect to the groove, and since the precise position of the apogee **100** of a blank will vary depending on the

curve of the convex surface, means are provided to detect this position. This means is comprised of a sensing rod 102 slidably journaled within the extension 66, along the axis 88. The rod is biased by spring 104, through a dowel pin 106, to engagement with the apogee 100 of a blank centered between the chuck shafts. The apogee location sensing rod 102 is a constant length, and as the convex curve of the lens varies, the pin 106 will move accordingly in turn moving an attached slide collar 108 toward and away from the lens blank. About the exterior of the collar is a circumferential groove 110. A cam 112 rides in the cam groove 110, and is connected to a shaft 114 by way of an eccentric 116. Shaft 114 is rotatably journaled in housing 22 by way of bearing 118 and at its outer end is terminated by a position indicating arm 120. FIG. 9a shows the member 121, which is comprised of cam 112, shaft 114, eccentric 116, and arm 120. Therefore, a movement of rod 102 produces a proportionate movement in arm 120. When the indicia marks 122 and 124 are matched there is no curve on what would be the convex side of the lens. When, through a movement of rod 102, caused by the apogee displacement the indicia become mismatched, the handle 126 is rotated until they are rematched. The handle 126 is fixedly secured to a threaded sleeve 127 and a threaded bushing thereof 129 receives a threaded end 131 of the sleeve 127. The thrust bearing 78 absorbs the chucking pressure as chucking takes place when and if any movement occurs in shaft 70 with sensing rod 102. This causes a movement of indicator 120. Therefore, as handle 126 is moved in opposition to the previous movements, shaft 70 is moved back accordingly until indicator 120 is aligned with the hash mark 124. When this is accomplished, the apogee 100 is the distance F from the apex 27. The displacement distance of the apogee 99 (the sagitta) for all lens, is determined by the distance L between the plane defined by the diametric opposing points of contact on the convex surface of the annular bushing 75, and the particular curve of the lens being chucked.

After carriages 24 and 50 are adjusted to position the center of the chuck face 101 a distance F from the apex 27, and after accounting for the displacement caused by the convex curve, it is necessary to position the housing 22 relative to the upper carriage 50 so that the crest of the bevel will be at a selected distance from the convex surface. The housing 22 is mounted to carriage 50 via dovetail slides 126. A shaft 128 with a knob 130 at its outer end is threaded through assembly 22 and is threadedly received in a block 132 of carriage 50. A rotation of shaft 128 will therefore move 22 with respect to 50. A rack 135 on carriage 50 receives a pinion gear 137 which has a shaft 139 journaled through the side of housing 22. A rotation of shaft 128 causes a movement in carrier 22 which is reflected on a diopter scale dial 141. The dial is disposed opposite a bevel location scale 143 which is divided in lens thickness increments in millimeters. If the lens has a base curve of 5 diopters, the lens to be ground is 2 mm. thick, and it is desired to locate the bevel crest 1 mm. from the periphery of the convex surface at the base curve, the 1 mm. hash mark is disposed opposite the 5 diopter (see FIG. 12) setting by shaft 128. It can be seen that the bevel location can therefore be infinitely selected for any given base curve.

All pattern cams, such as 72, have a lens size diameter S (FIG. 13). S is the horizontal diameter of the pattern when it is mounted on positioning lugs 71 and 73 at the end of shaft 70. In order to insure the proper size of the finished lens as well as the proper peripheral configuration, further adjustment mechanism is provided to adjust for varying lens sizes. This structure is best seen in FIGS. 1 and 13.

The cam surface 73 is movable with respect to base 18 on dovetail slides 180. Extending upwardly from base 18 is a journal 182 which receives a threaded shaft 184. Shaft 184 is connected to and rotatable with a micrometer knob 186. The varying diameters of patterns can thus be made to contact with the surface 73 at the correct point for a particular size. For instance, the solid line position of FIG. 13 could be for a 35 mm. lens and the dotted lines for a 56 mm. position. The scale on the knob and its relation to the rest of the apparatus are preset so that the movement of the lens blank will closely follow the contour of the pattern.

Therefore, the mechanism is provided with means to accurately position the apogee of the lens at an initial point. Carriages 32 and 50 are accurately related to base 18 by set screws 42 and 54. The housing 22 is positioned with respect to carriages 32 and 50 via shaft 128 for bevel location, and the curvature of the lens on its convex support is accounted for via the sensing rod 102 and its associated structure. Now the structure for moving the lens into the tool along a desired path from this accurately pre-determined point will be described.

The machine is set so that there is a fixed distance F between the apex of groove 27 and the point 101 when the chuck is supporting a lens having a flat surface. Under present conditions, a distance of 1¼ inch has been found desirable for this distance.

A slide block 144 is received by tracks 146 along one side of base 18. A depending journal 148 is slidably received by a groove 150 in the base. The journal threadedly receives a shaft 152 which has its outer end terminated by hand-wheel 154. The block is provided with an indicia mark 156 which is adjacent a diopter scale 158 on the base. Therefore, block 144 is movable with respect to scale 158 by a rotation of shaft 152.

A radius arm 160 is pivotally mounted in block 144 via pin 162. The arm is grooved at 164 throughout the major portion of its length. A pin 166 riding in the groove 164 is pivotally received by a journal extension 168 of upper carriage 50. A lock handle 170 is provided at the upper end of pin 166 and is equipped with a conventional lock mechanism to secure the pin 166 at any selected point along arm 160. At the initial position, the distance F is selected between pivot pins 162 and 166. Since carriages 22 and 50 are fixed with respect to a point on arm 160, once the handle is locked, the carriage 22 will move laterally only that amount permitted by an arcuate movement of arm 160.

The amount of lateral movement permitted in carriage 50, for a given movement in carriage 32, is, of course, dependent on the distance between pins 162 and 166 and the angle the radius arm makes with the direction of movement of the upper carriage 50. Therefore, the scale 158 is measured in diopters and the position of mark 156 with respect thereto will determine the lateral movement of carriage 34 with each concurrent movement in carriage 32.

In operation, air pressure is imparted to cylinder 60 in an operative direction to pull the pattern cam 72 in engagement with the bearing surface 73. The pattern cam is selected for the particular peripheral configuration desired in the lens. The chuck shafts are then rotated and the lower carriage 32 will move longitudinally an amount permitted by the varying diameters defined by the peripheral contour of the cam. With each longitudinal movement, a lateral movement occurs in upper carriage 50 an amount permitted by the radius arm 160. For example, if a lens was ground according to the peripheral shape of that shown by the dotted line in FIG. 5, there would be a plurality of diameters from the center C to each point on the periphery. Assuming that D is the least diameter and D′ is the greatest diameter, for the movement between D′ minus D, a concurrent movement would be imparted as a result of the arcuate movement of the radius arm. This can best be seen by referring to FIG. 11 which is an enlarged view of this rectilinear progression.

It can be seen that by sliding block 156 along the diopter scale 158, the distance between pivot points 162

and 166 is varied. This, in turn, varies the magnitude of increment M for each variation in the pattern cam's diameter. Since this setting is dependent on the convex curve (normally selected as the mean between the major and minor axes), the lens blank is fed into the wheel along this mean regardless of other considerations.

In a general manner, while we have, in the above description, disclosed what we deem to be practical and efficient embodiments of our invention, it should be well understood that we do not wish to be limited thereto, as there might be changes made departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

We claim:

1. A bevel edge grinder comprising in combination, a base, a lens carrier supported on said base, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, a pattern cam for controlling the movement of the carrier in said first direction, an arm pivotally mounted about a point on said base, means pivotally connecting said second carriage to said arm whereby for each movement in said first direction of said first carriage, a second movement in said second direction is caused in said second carriage as controlled by the pivoting of said arm.

2. A bevel edge grinder comprising in combination, a base, a lens carrier supported on said base, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, and a chucking shaft mounted on said second carriage, a pattern cam mounted at one end of said shaft, a cam abutment surface mounted on said base, means keeping said pattern cam against said surface thereby controlling the movement of the carrier in said first direction, an arm pivotally mounted about a point on said base, means pivotally connecting said second carriage to said arm such that for each movement in said first direction of said first carriage, a second movement in said second direction is caused in said second carriage as controlled by the pivoting of said arm.

3. A bevel edge grinder comprising in combination, a support, a lens carrier supported on said support, said carrier comprised of a base and two upstanding legs defining a saddle therebetween, a grinding wheel in said saddle, a first carriage for reciprocation in a first direction across said support, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage and supporting said carrier, a pattern cam on said carrier for controlling the movement thereof in said first direction, an arm pivotally mounted about a point on said support, means pivotally connecting said second carriage to said arm whereby for each movement in said first direction by said first carriage, a second movement in said second direction is caused in said second carriage as controlled by the pivoting of said arm.

4. A bevel edge grinder of a type to bevel the edge of a lens blank comprising in combination, a base, a lens carrier supported on said base, a shaft rotatably secured in said carrier, said lens blank supported at one end of said shaft, a pattern cam at the other end thereof having a peripheral configuration of that desired for said blank at the end of a grinding operation, a cam abutment surface stationary with respect to base, means maintaining said pattern cam in engagement with said surface as said shaft rotates, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, an arm pivotally mounted about a point on said base, means pivotally connecting said second carriage to said arm whereby for each movement in said first direction by said first carriage, a second movement in said second direction is caused in said second carriage as controlled by the pivoting of said arm.

5. A bevel edge grinder of a type to bevel the edge of a lens blank comprising in combination, a base, a grinding wheel supported on said base, a lens blank carrier supported on said base, said lens blank supported by said carrier, means to move said blank into engagement with said wheel, said means comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, a pattern cam for controlling the movement of the carrier in said first direction, an arm pivotally mounted about a first point on said base, means pivotally connecting said second carriage to said arm at a second point whereby for each movement of said first carriage in said first direction, a second movement in said second direction is caused in said second carriage as controlled by the pivoting of said arm, and means to vary the distance of said second point with respect to said first point.

6. A bevel edge grinder of a type to bevel the edge of a lens blank having a particular convex surface curve comprising in combination, a base, a carrier supported on said base, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, a rotatable pattern cam for controlling the movement of the carrier in said first direction, an arm pivotally mounted about a first point on said base, means pivotally and adjustably connecting said second carriage to a selected point on said arm whereby for each movement in said first direction, a second movement in said second direction is given to said second carriage and the combined movement is an arc.

7. A bevel edge grinder of a type to bevel the periphery of a lens blank comprising in combination, a base, a grinding wheel, a carrier supported on said base, first means to accurately position said carrier with respect to said wheel, a shaft rotatably mounted in said carrier, first means mounting said blank to said shaft with the convex surface of said blank adjacent one end of the shaft, second means for detecting the distance of the apogee of said surface from said one end, and to move said carrier an amount equal to said distance, third means for moving said blank into engagement with said wheel, comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for back and forth movement in a second direction normal to said first carriage, a pattern cam mounted on the other end of said shaft for controlling the movement of the carrier in said first direction, an arm pivotally mounted about a point on said base, means pivotally connecting said second carriage to said arm whereby for each movement of said first carriage in said first direction, a second movement in said second direction is caused in said second carriage as controlled by the pivoting of said arm.

8. A bevel edge grinder of a type to bevel the edge of a lens blank having a particular convex surface comprising in combination, a base, carrier supported on said base, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, a cam abutment surface mounted on said base, a rotatable pattern cam mounted on said carrier, means causing said pattern cam to engage said surface as said pattern cam rotates for controlling the movement of the carrier in said first direction, an arm pivotally mounted about a first point on said base, means pivotally and adjustably connecting said second carriage to a

selected second point on said arm whereby for each movement in said first direction, a second movement in said second direction is given to said second carriage and the combined movement is an arc dependent on the position of said first and second points.

9. A bevel edge grinder comprising in combination, a support, a lens carrier supported on said support, said carrier comprised of a base and first and second upstanding legs defining a saddle therebetween, a grinding wheel in said saddle, a first carriage for reciprocation in a first direction across said support, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage and supporting said carrier, a rotatable shaft mounted in said first leg and having one end extending into said saddle, a second shaft having one end in said saddle and rotatably mounted in said second leg coaxial with said first shaft, and means for moving said second shaft axially toward and away from said first shaft whereby a lens blank can be secured between said shafts, a pattern cam on the other end of said shaft for controlling the movement of said carrier in said first direction, an arm pivotally mounted about a point on said support, means pivotally connecting said second carriage to said arm such that for each movement in said first direction by said first carriage, a second movement in said second direction by said second carriage is accomplished and controlled by the pivoting of said arm.

10. A bevel edge grinder comprising, in combination, a base, a lens carrier supported on said base, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, a rotatable pattern cam mounted on said lens carrier for controlling the movement of the carrier in said first direction, an arm pivotally mounted about a first point on said base, means pivotally connecting said second carriage at a selected point along the length of said arm such that for each movement in said first direction, a second movement in said second direction is caused in said second carriage as controlled by the pivoting of said arm, and second means for adjustably selecting the distance between said first and second points.

11. A bevel edge grinder comprising, in combination, a base, a lens carrier supported on said base, an abrading wheel having a V-groove mounted on said base, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first means, and a rotating chucking shaft mounted on said second carriage, a pattern cam mounted at one end of said shaft, a cam abutment surface mounted on said base, means maintaining said pattern cam in engagement with said surface as said shaft rotates, thereby controlling the movement of said carrier in said first direction, an arm pivotally mounted about a point on said base, means pivotally connecting said second carriage to said arm such that for each movement in said first direction, a second movement in said second direction is accomplished as controlled by the pivoting of said arm, said carrier receiving a combined movement toward said V-groove, and the path of said movement determined by the extent of said first and second movements.

12. A bevel edge grinder for beveling the periphery of a lens blank comprising, in combination, a support, a lens carrier on said support and carrying said lens blank, said carrier comprised of a base and two upstanding sections defining a saddle therebetween, a grinding wheel having a V-groove disposed in said saddle, means for moving the edge of said lens blank toward and away said V-groove along a selected path, said carrier comprising a first carriage for reciprocation in a first direction across said support, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, and said second carriage supporting said carrier to adjust said carrier with respect to said first carriage, a rotating pattern cam on said carrier for controlling the movement of said first carriage in said first direction, an arm pivotally mounted about a first point on said support, means pivotally connecting said second carriage to said arm at a second point along the length of said arm whereby for each movement in said first direction, a second movement by said second carriage in said second direction is accomplished and controlled by the pivoting of said arm, the combined movement being said selected movement as determined by the distance between said first and second points.

13. A bevel edge grinder adapted to grind the edge of a lens blank comprising, in combination, a base, a lens carrier supported on said base, a shaft rotatably secured in said carrier, said lens blank supported at one end of said shaft, a pattern cam at the other end thereof having a peripheral configuration of that desired for said blank at the end of a grinding operation, a cam abutment surface stationary with respect to base, an air cylinder operatively connected between said base and said carrier, keeping said cam pattern in engagement with said surface as said shaft rotates, means for adjusting the initial distance between said pattern cam and said surface, said carrier comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, an arm pivotally mounted about a point on said base, means pivotally connecting said second carriage to said arm whereby for each movement in said first direction by said first carriage, a second movement by said second carriage in said second direction is accomplished and controlled by the pivoting of said arm.

14. An edge grinder for beveling a lens blank comprising, in combination, a base, a grinding wheel supported on said base, a lens blank carrier supported on said base, a chuck supporting said blank on said carrier, said chuck comprised of a pair of shafts having chuck surfaces in opposed face-to-face relationship securing a lens blank therebetween, air pressure means for moving one of said shafts toward and away from the other of said shafts, means to move said blank into engagement with said wheel, said means comprising a first carriage for reciprocation in a first direction across said base, a second carriage mounted on said first carriage for reciprocation in a second direction normal to said direction of movement of said first carriage, a pattern cam for controlling the movement of the carrier in said first direction, an arm pivotally mounted about a point on said base, means pivotally connecting said second carriage to said arm whereby for each movement in said first direction by said first carriage, a second movement in said second direction by said second carriage is accomplished and controlled by the pivoting of said arm.

15. A bevel edge grinder for edging a meniscus-shaped article such as a lens, comprising, in combination, a base, an abrading wheel supported on said base and rotatable about a first axis and having a peripherally disposed substantially V-shaped abrading surface, a lens carrier on said base having means supporting the lens in edgewise engagement with said V-shaped surface, said means being mounted for rotation about a second axis disposed at an angle to said first axis about which the abrading wheel is rotated whereby the plane defined by the apex of the V-shaped surface is angularly disposed with respect to said second axis to cause the V-shaped surface to be effectively curved in the direction of the curvature of the meniscus-shaped lens and said lens, when properly mounted by said means, having a predetermined center coaxial with said second axis, said carrier comprising a

first carriage for reciprocation in a first direction generally perpendicular to said second axis, a second carriage mounted on said first carriage for simultaneous reciprocation in a second direction generally parallel to said second axis, control means for converting said first and second directions to a curvilinear path for said article toward and away from said V-shaped abrading surface.

16. The bevel edge grinder described in claim 15 wherein said control means is comprised of a cam means mounted on said first carriage, an arm pivotally secured to said first mentioned base and securing means for adjustably connecting said second carriage to a point along the length of said arm.

17. The bevel edge grinder described in claim 15



wherein the center of curvature of said path is on one side of said plane defined by the apex of said V-shaped surface and the center of curvature of said meniscus-shaped article is on the other side of said plane.

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