Dec. 5, 1961 J. R. WALTON ET AL 3,011,291

EDGE GRINDING MACHINE FOR LENSES

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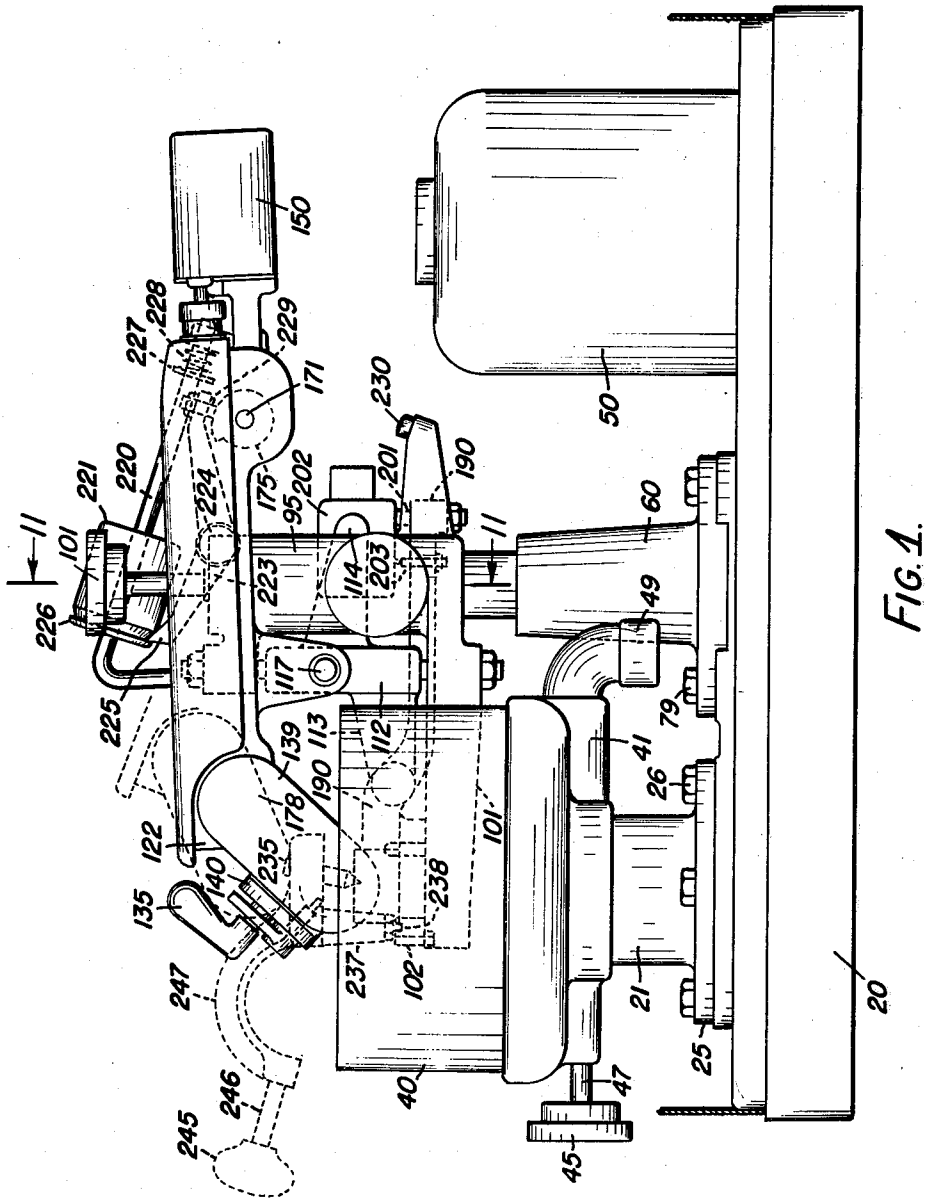


FIG. 1.

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EDGE GRINDING MACHINE FOR LENSES

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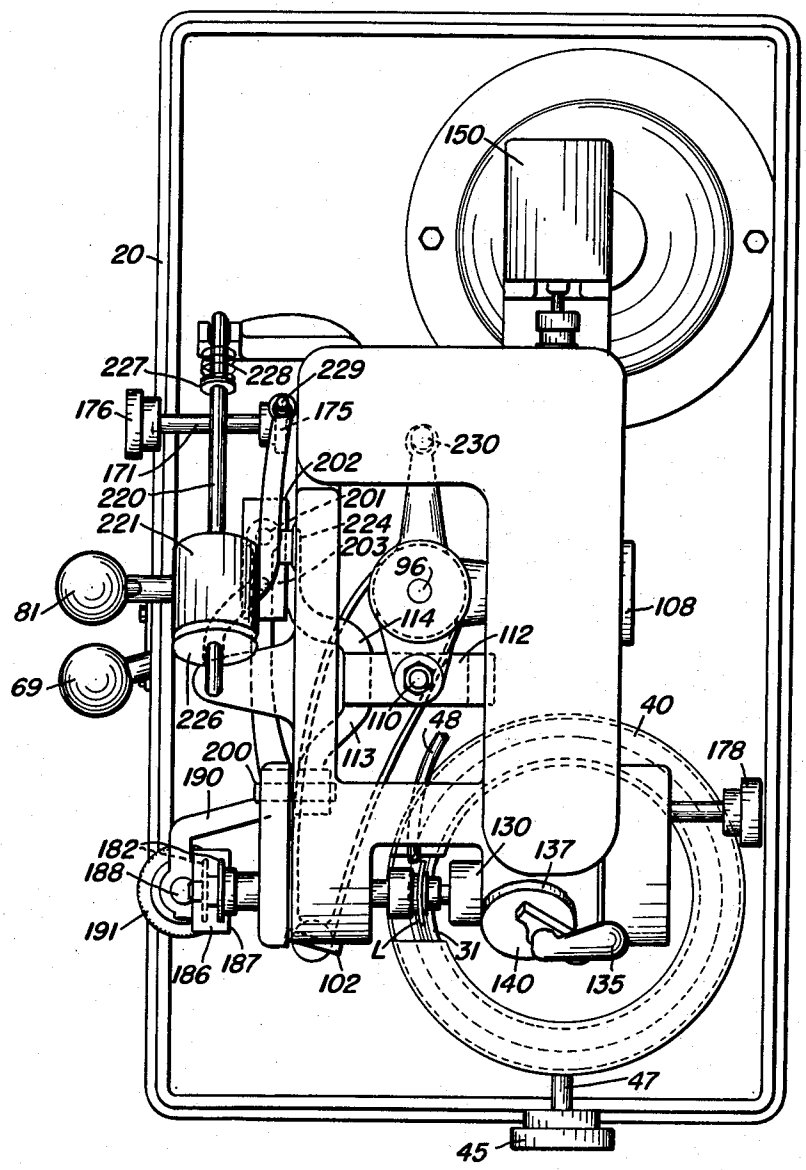


FIG. 2.

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EDGE GRINDING MACHINE FOR LENSES

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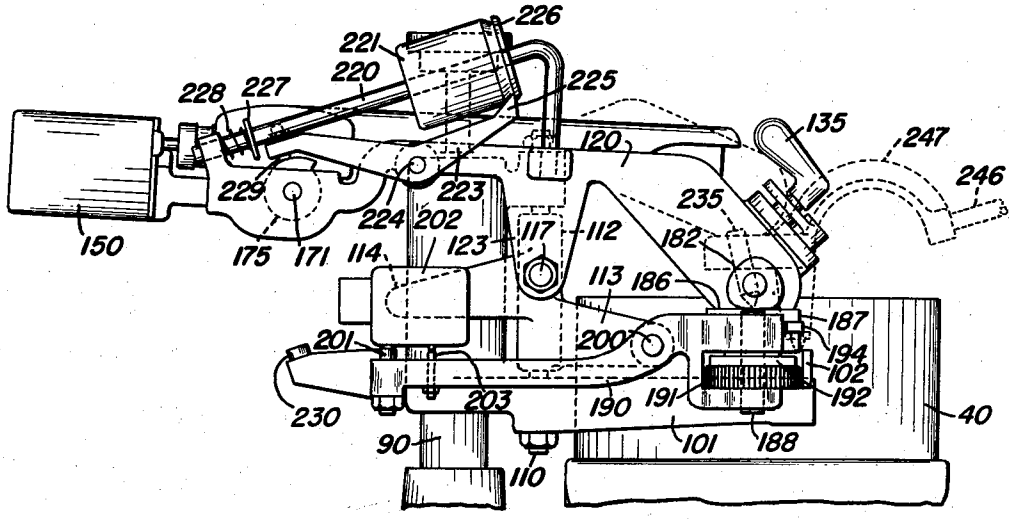


FIG. 6.

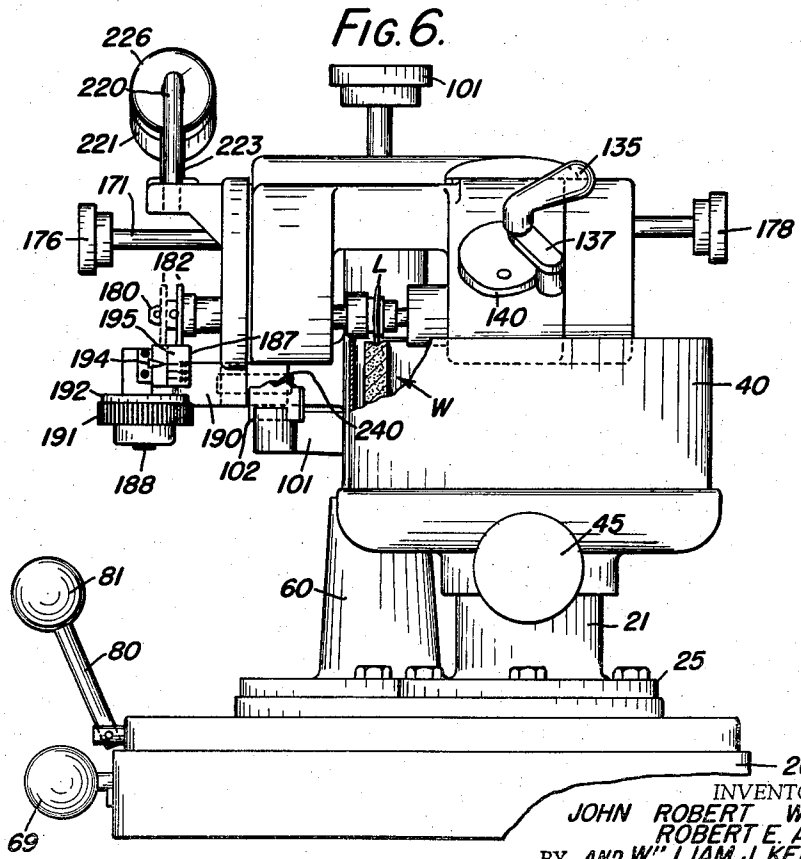


FIG. 3.

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Dec. 5, 1961 J. R. WALTON ET AL 3,011,291

EDGE GRINDING MACHINE FOR LENSES

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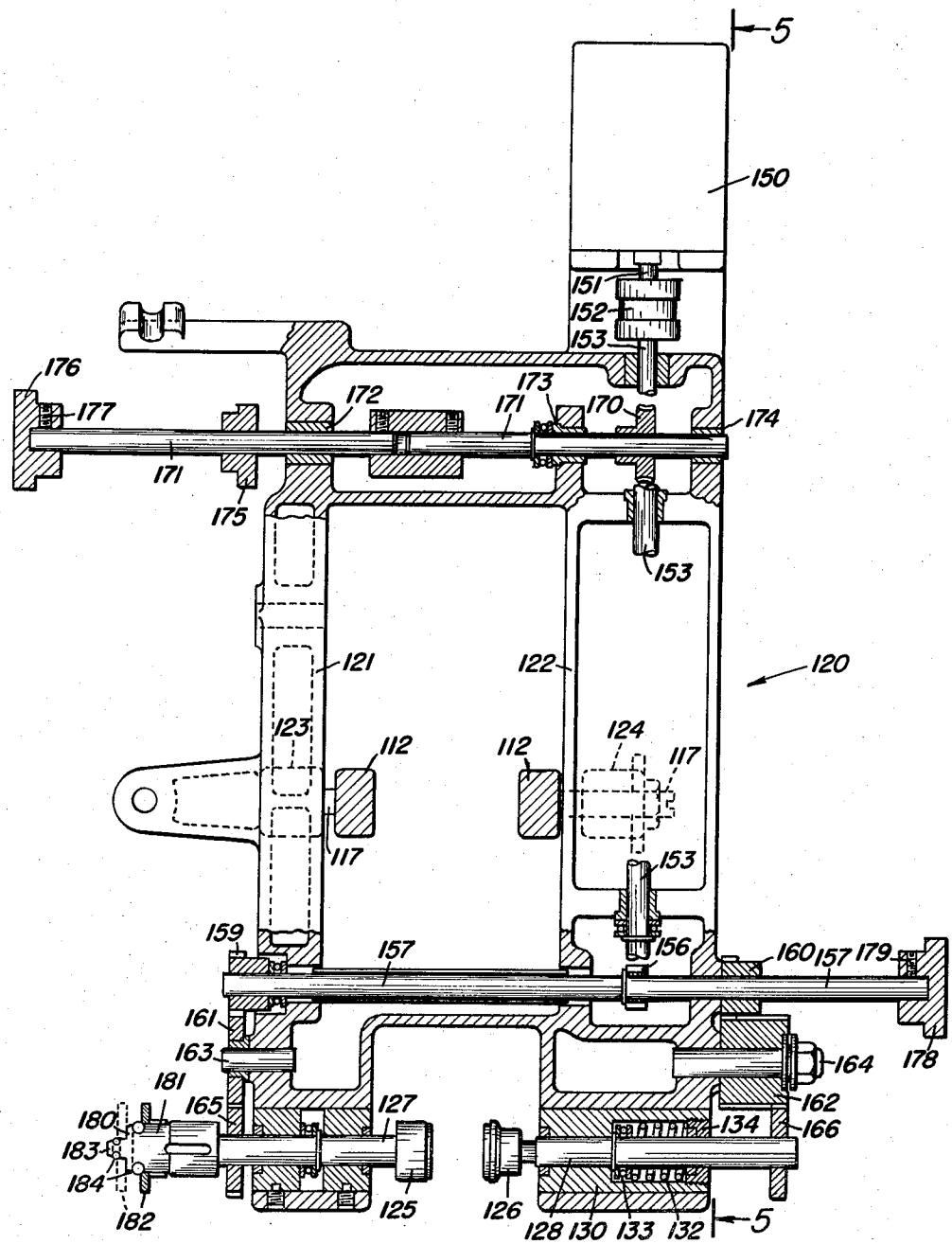


FIG. 4.

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EDGE GRINDING MACHINE FOR LENSES

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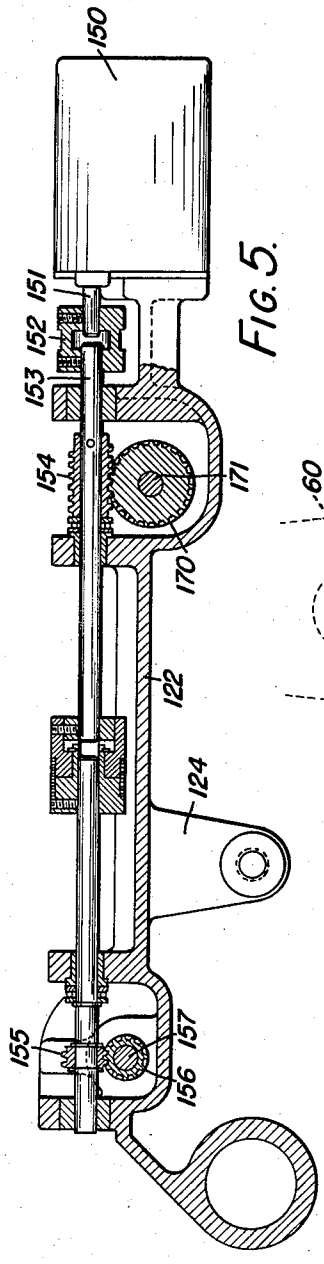


FIG. 5.

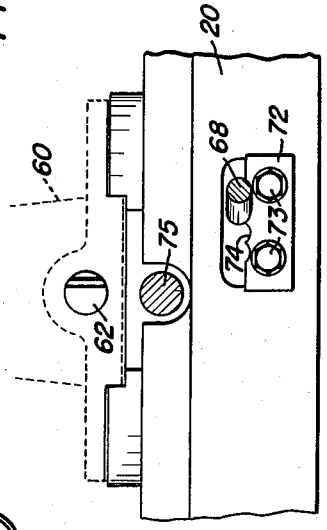


FIG. 10.

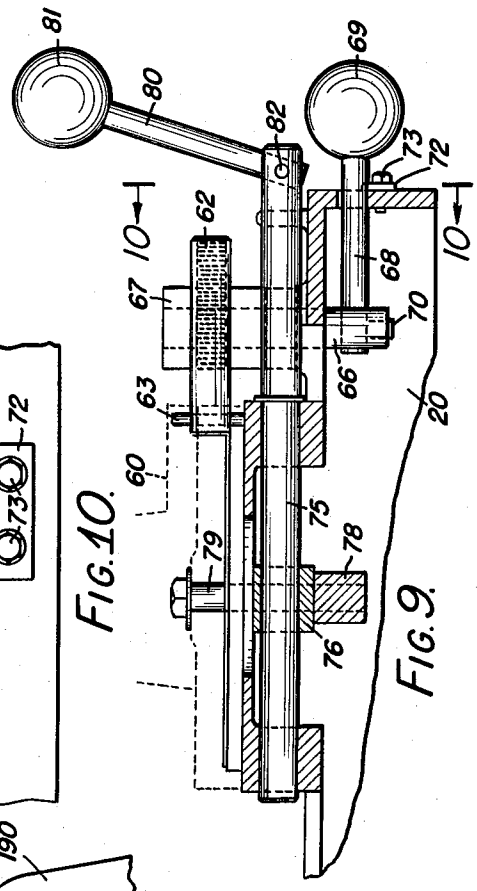


FIG. 9.

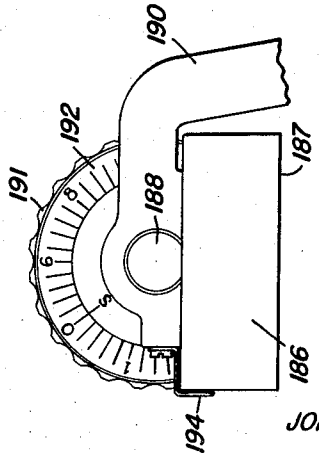


FIG. 14.

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EDGE GRINDING MACHINE FOR LENSES

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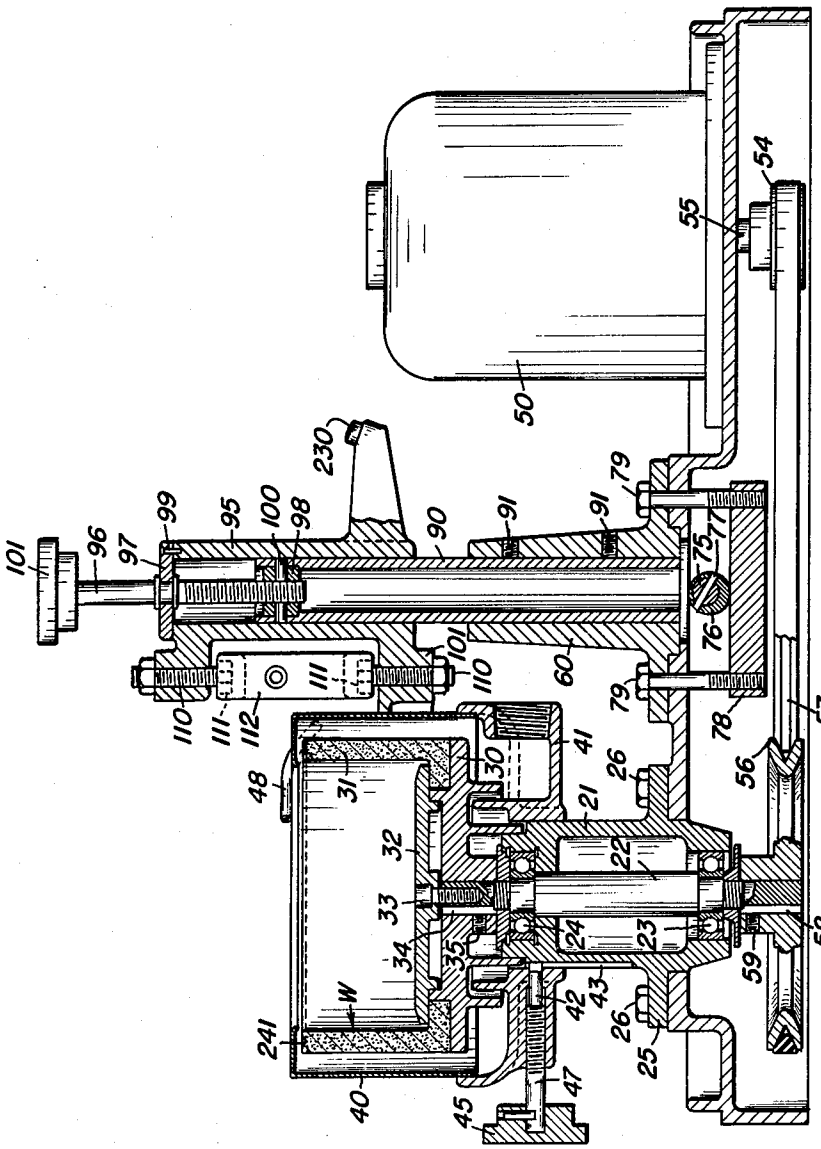


FIG. 7.

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EDGE GRINDING MACHINE FOR LENSES

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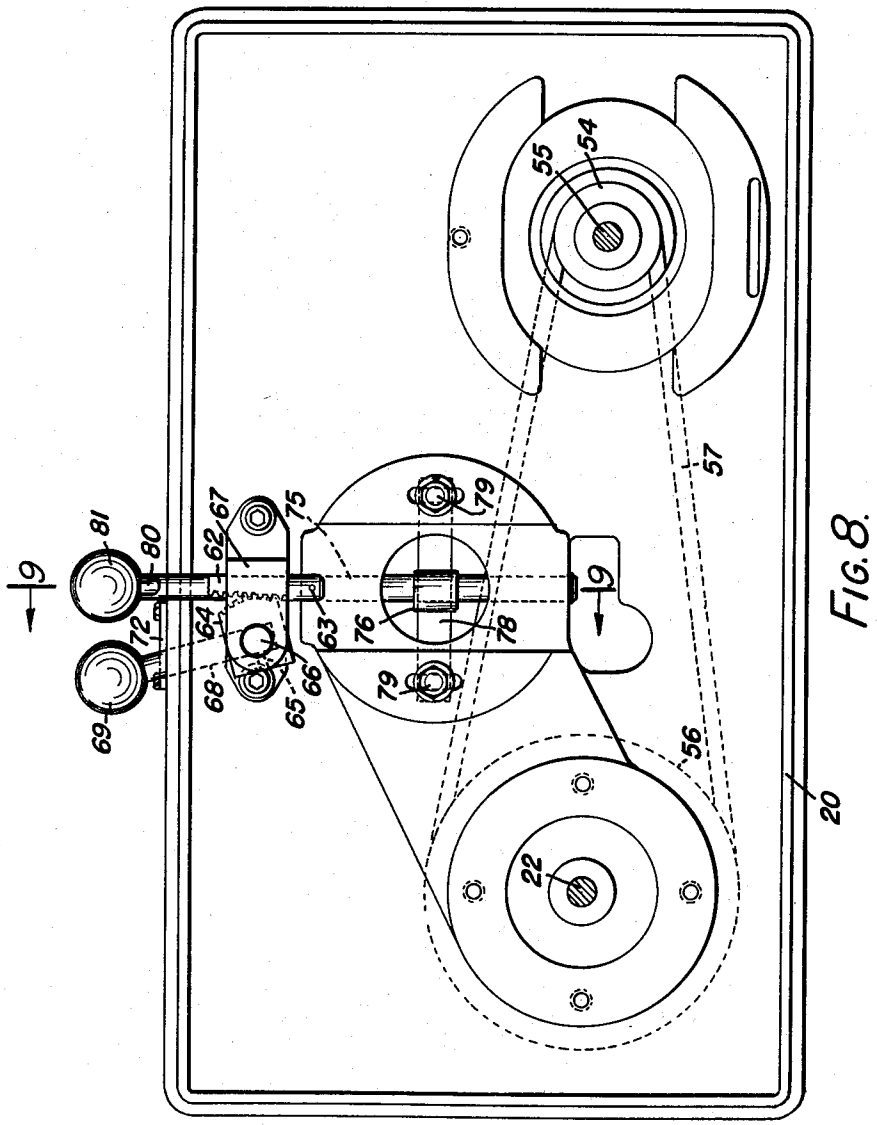


FIG. 8.

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Dec. 5, 1961 J. R. WALTON ET AL 3,011,291

EDGE GRINDING MACHINE FOR LENSES

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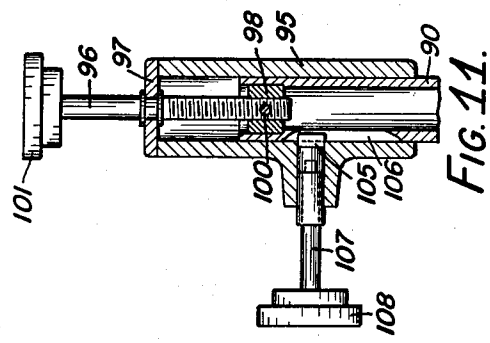


FIG. 11.

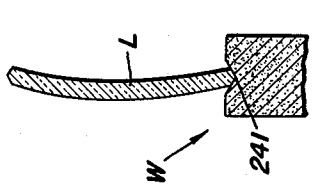


FIG. 15.

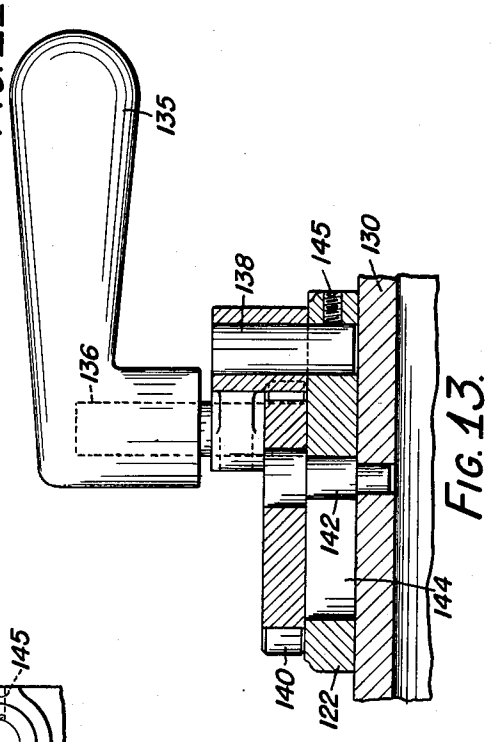


FIG. 13.

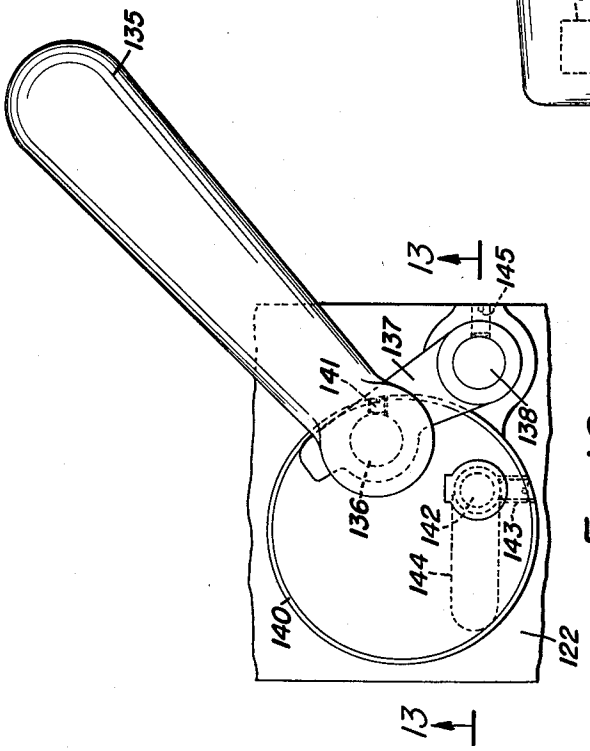


FIG. 12.

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EDGE GRINDING MACHINE FOR LENSES

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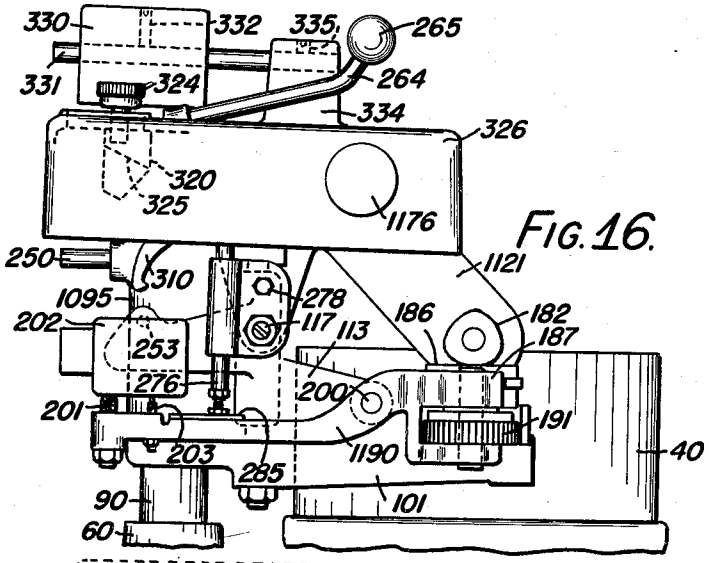


FIG. 16.

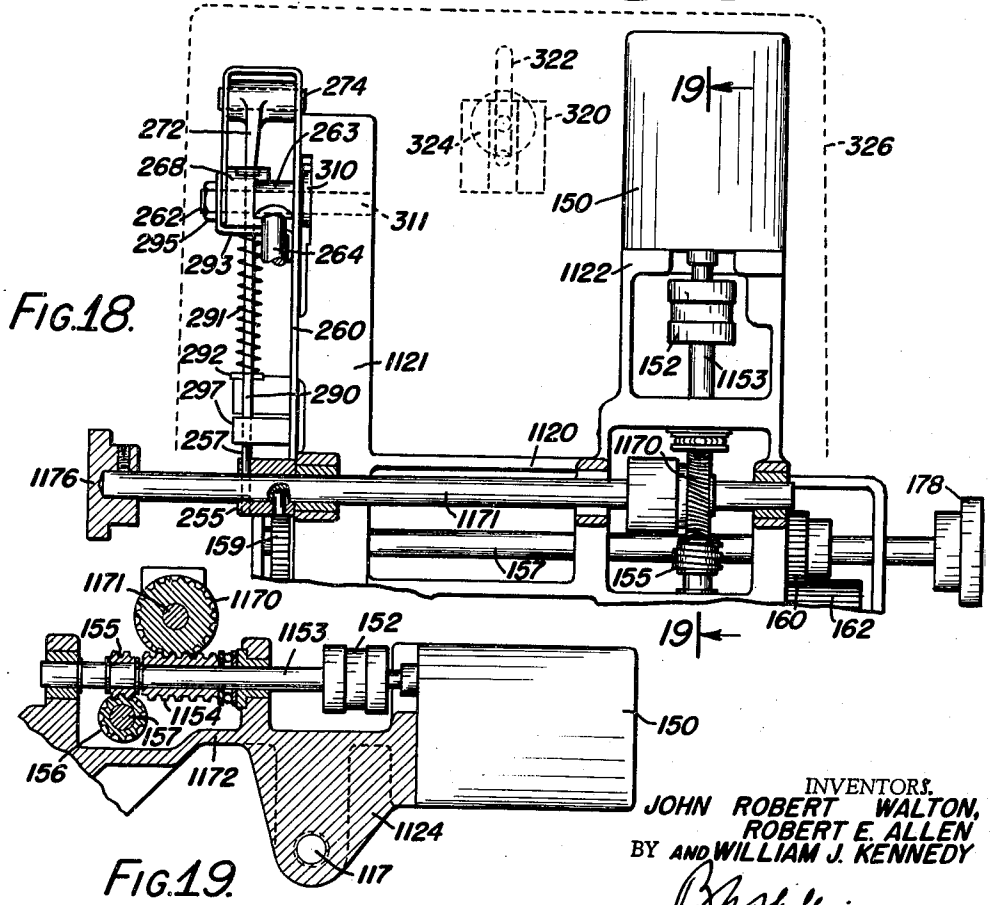


FIG. 18.

FIG. 19.

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EDGE GRINDING MACHINE FOR LENSES

Filed June 10, 1957 10 Sheets-Sheet 10

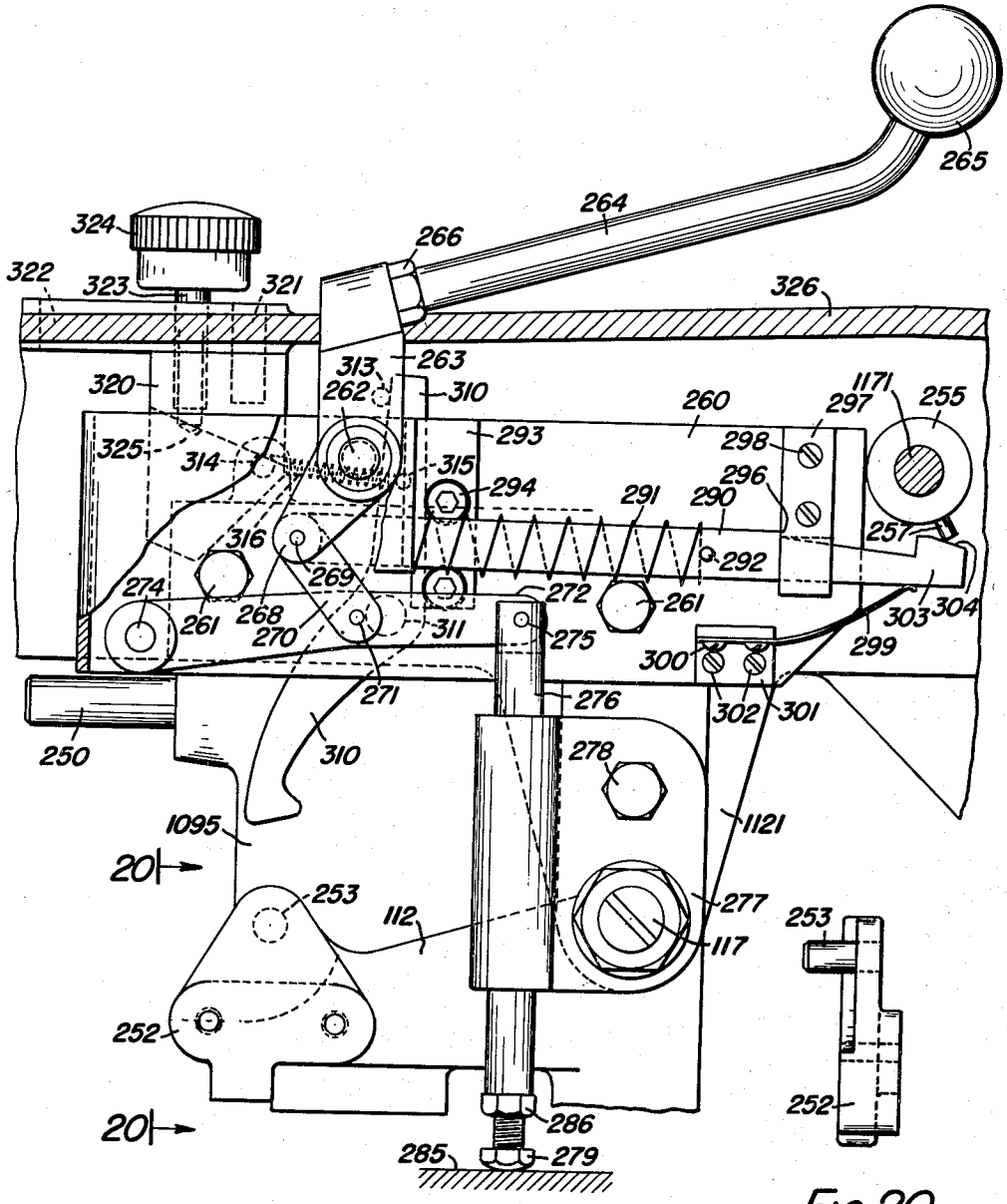


FIG. 17.

FIG. 20.

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United States Patent Office 3,011,291
Patented Dec. 5, 1961

3,011,291

EDGE GRINDING MACHINE FOR LENSES

John Robert Walton, Geneva, Robert E. Allen, Rochester, and William J. Kennedy, Geneva, N.Y., assignors, by mesne assignments, to Textron Inc., Providence, R.I., a corporation of Rhode Island

Filed June 10, 1957, Ser. No. 664,700
22 Claims. (Cl. 51—127)

The present invention relates to edge-grinding machines and more particularly to machines for grinding beveled and/or flat edges on ophthalmic lenses.

Conventional edge grinding machines for ophthalmic lenses are built to use either a disc, or a dished, grinding wheel. The amount of stock to be removed from, and the finished peripheral shape which is to be ground on the lens are controlled by a template having a peripheral shape corresponding to the peripheral shape of the lens to be ground. The template is mounted coaxially with the workpiece. The workpiece is stationary during the actual grinding. When the grinding wheel has ground the lens down, in the area of its engagement with the lens, to the desired size, the template engages an arcuate shoe, or follower, that has the approximate radius of curvature of the grinding wheel and thereby trips a switch which closes a circuit to the drive motor for the work spindle. The workpiece is thereupon rotated through a slight angle, far enough for a new area of the workpiece to be brought into engagement with the wheel, thereby lifting the template clear of the shoe. The work drive motor thereupon is stopped, and remains stopped until after the wheel has ground the lens down in the new area, which has been indexed into engagement with the wheel, to the desired dimension. Then the template engages the shoe again, and again trips the motor start switch to effect indexing of the workpiece into a new position for grinding.

So the process proceeds with alternate grinding and indexing of the work. The peripheral surface of the lens is rough-ground, therefore, in a series of steps; and it is in effect a series of scallops produced by the wheel. The closer the scallops are to one another, the more nearly the peripheral surface of the lens approaches a smooth surface. Usually, in order to produce a truly smooth surface, one or more finish turns are taken on the lens with the grinding wheel after the roughing operation is completed.

At the end of the grinding operation, the workpiece is moved clear of the grinding wheel to permit removal of the completed workpiece and chucking of a new lens blank. With conventional edge grinders, however, there is always a tendency for the wheel to leave a hump on the periphery of the workpiece at the time the work is moved away from the wheel, because conventional machines are so constructed that the drive motor for the workpiece stops before the workpiece is moved clear of the wheel. A hump, like any defect in the peripheral surface of the lens, is objectionable because it makes it hard to fit the eyewire or spectacle frame closely about the lens.

As the disc, or dished, wheel of the conventional machine wears and is dressed, moreover, obviously its diameter decreases. The curved shape of the shoe can correspond directly, therefore, to only one diameter of the wheel. The curved shape should, therefore, theoretically be changed as the wheel wears. However, since this is impractical, the wheel life on a conventional edge grinder is limited; otherwise too great an error would be introduced into the lens being ground.

With the conventional grinding machine, furthermore, the peripheral speed of the wheel varies with the diameter of the wheel. This affects the wear of the wheel, and increases the possibility of "burning."

In the conventional edge grinder, moreover, after each dressing of the wheel, it is necessary to readjust the shoe, or follower, so that the active surface of the shoe or follower will lie in a plane containing the active tip edge of the wheel.

For grinding a beveled edge on a lens, a groove of V-shape in cross-section is dressed in the grinding wheel. Since the lenses ordinarily used for ophthalmic purposes are of meniscus shape, and since the grinding wheel of the ordinary edge grinder is of disc, or dished, shape, difficulty is always experienced in obtaining uniform spacing, all around the lens, of the front and rear surfaces of the lens from the apex of the V-edge of the lens.

For heavy lenses particularly this non-conformity of position of the bevel around the edge of the lens results in a lot of bevel showing at the front when the lens is mounted in a spectacle frame. This is unsightly and, therefore, objectionable.

One object of the present invention is to provide an edge grinder for grinding ophthalmic lenses in which the wheel will have much longer useful life.

Another object of the present invention is to provide an edge grinder which will grind lenses accurately throughout the whole life of the grinding wheel without any change whatsoever in the shape of the shoe or follower that engages the shape-controlling template.

A further object of the invention is to provide a machine for grinding the edges of ophthalmic lenses which will require no adjustment of the follower or shoe after dressing of the wheel.

Another object of the present invention is to provide a machine of the type described in which the wheel speed will be constant throughout the whole of its life.

Another object of the invention is to provide a machine of the character described in which constant and greater accuracy is achieved in the edge-grinding operation.

Another object of the invention is to provide an edge grinder for grinding beveled edges on lenses in which the grinding wheel can always be dressed to the same V-shape regardless of the position of the bevel that is to be ground on a lens.

Another object of the invention is to provide a beveled-edge lens grinder in which any ophthalmic lens can be ground so that when it is mounted in a spectacle frame there will be no unsightly bevel showing at the front of the frame.

Another object of the invention is to provide a beveled-edge lens grinder which will permti the bevel to be placed readily on a lens wherever desired.

Another object of the invention is to provide a bevel-edge grinder in which the V-groove in the grinding wheel will follow the meniscus shape of the lens closely so that uniform spacing of the front and rear surfaces of the lens with reference to the apex of the V being formed on the lens is achieved.

A further object of the invention is to provide a machine having an adjustment for adjusting the work relative to the wheel so as to displace the bevel on the lens either toward the front or back of the lens according to the desire of the operator.

Another object of the invention is to provide an edge grinder with which the peripheral surface of the lens can be ground to acceptable shape in a single revolution of the workpiece and with which in a given number of revolutions of the work a more satisfactory finish can be obtained than is possible with conventional lens edge grinders. To this end it is a purpose of the invention to provide an edge grinder in which the work will continue to rotate, after the grinding operation is completed, until the template or former has broken contact with the shoe or follower.

Still another object of the invention is to provide an edge grinder which will permit grinding lenses with either

a beveled or a flat edge, simply by substituting one wheel for the other, or by dressing the wheel to the desired shape of the edge.

A still further object of the invention is to provide a machine of the type described which will be extremely fast in operation and simple in construction.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims.

In the drawings:

FIG. 1 is a side elevation of an edge grinder built according to one embodiment of this invention, looking at the machine from the right side in FIG. 2;

FIG. 2 is a plan view of this machine;

FIG. 3 is a front view of the machine taken at right angles to the view of FIG. 1, part of the wheel guard being broken away to show the wheel in section;

FIG. 4 is a plan view on an enlarged scale showing the work support, parts being broken away and shown in section;

FIG. 5 is a part side elevation, part sectional view of the work support, the view being taken on the line 5—5 of FIG. 4 looking in the direction of the arrows;

FIG. 6 is a fragmentary side elevation of the machine looking from the left side of FIG. 2;

FIG. 7 is a section through the base of the machine taken in front to rear direction and axially of the wheel spindle;

FIG. 8 is an enlarged view showing details of the wheel drive and of the means for adjusting the work carriage support;

FIG. 9 is a section on a somewhat enlarged scale taken on the line 9—9 of FIG. 8;

FIG. 10 is a fragmentary section on the line 10—10 of FIG. 9 looking in the direction of the arrows;

FIG. 11 is a section on the line 11—11 of FIG. 1 looking in the direction of the arrows;

FIG. 12 is a front view on an enlarged scale showing details of the mechanism for moving the tail spindle of the machine to and from operative position;

FIG. 13 is a section on the line 13—13 of FIG. 12 looking in the direction of the arrows;

FIG. 14 is a fragmentary plan view showing the shoe or follower, which engages the template, and its mounting;

FIG. 15 is a fragmentary sectional view on an enlarged scale showing a lens in engagement with the grinding wheel;

FIG. 16 is a fragmentary side elevation, similar to FIG. 6, of a machine constructed according to another embodiment of the invention;

FIG. 17 is an enlarged detail view of the carriage lift mechanism of this embodiment;

FIG. 18 is a fragmentary plan section, somewhat similar to FIG. 4, of this embodiment;

FIG. 19 is a section on the line 19—19 of FIG. 18; and

FIG. 20 is a detail view taken on the line 20—20 of FIG. 17 looking in the direction of the arrows.

Referring now to the drawings by numerals of reference 20 denotes the base of the machine. Mounted on the base is a hollow support (FIG. 7) which extends vertically; and in which the grinding wheel spindle 22 is journaled on spaced anti-friction bearings 23 and 24. The support 21 is formed with an intermediate, circumferential flange 25, which seats against the upper face of the base 20; and the support 21 is secured to the base by screws 26 which pass through holes in this flange and thread into the base.

The grinding wheel W is cup-shaped, and comprises a conventional backing plate 30 and an annular emery operating portion 31 that is secured to the backing plate in conventional manner. The grinding wheel is secured to the spindle 22 by a clamping disc 32 and a screw 33, the latter threading into the upper end of the spindle 22. The backing plate 30 of the wheel is keyed to the spindle, to rotate with the spindle, by a key 34, which is held in place by the set screw 35.

A guard 40 is provided around the grinding wheel. This is secured to and supported on the trough or basin 41 which is mounted to slide vertically on the support 21 for adjustment of the guard position. The trough 41 is held against rotation with reference to the support 21 by a key 42 which engages in a vertical, axially-extending slot 43 formed on the periphery of the support 21. A screw 47, that threads into the trough 41, holds this key in position. The screw can be rotated by a knob 45 which is pinned to the screw shaft 47. This shaft 47 engages at its inner end against the key 42.

The grinding wheel is driven from a motor 50 mounted on the base 20. There is a drive pulley 54 keyed or otherwise secured to the armature shaft 55 of the motor; and this drive pulley drives a pulley 56, which is secured to the spindle 22, through the belt 57. The pulley 56 is keyed to the spindle 22 by means of a key 58 that is held in place by the set-screw 59, which threads into the hub of the pulley 56.

Mounted for lateral adjustment on the base 20 is a foot member 60. This member has a rack 62 (FIGS. 8, 9 and 10) secured to it by a pin 63 so that the rack projects laterally from one side of the column at the base thereof. Meshing with this rack is a spur gear segment 64, which is fastened by means of the set-screw 65 to a vertical shaft 66. This shaft is journaled in a bracket 67 that is bolted to base 20 and that protrudes upwardly therefrom. The segment 64 is adapted to be rotated by manipulation of the handle 68, which is provided at its outer end with a knob 69. This handle is secured at its inner end in a hole in the shaft 66 by means of a set screw 70. Swinging movement of the handle from left to right in FIG. 8, or vice versa, effects lateral adjustment of the member 60 on the base through operation of the segment 64 and rack 62.

The adjustment of the foot member 60 is preferably a stepwise adjustment; and the handle 68 is locked in the different positions of adjustment by engagement in one of the notches of a notched plate 72 (FIGS. 9 and 10) that is fastened on one side of the base 20 of the machine by screws 73. The handle 68 is lifted up out of the notch, in which it has previously been engaged, and moved laterally to effect the desired adjustment of the column, and then is engaged in another notch to hold it in the adjusted position. Means is also provided for clamping the column in its adjusted position. This means comprises the shaft 75 which is journaled in bearings formed in the base 20, and which has an eccentric 76 (FIGS. 7 and 9) pinned to it intermediate its ends by means of a pin 77. The cam or eccentric 76 is adapted to engage a strap 78 that is secured by means of bolts 79 to the foot member 60. When the eccentric is in the position shown in FIG. 7, the foot member is clamped to the base. By rotating the eccentric through an angle of 90° or so, the clamp will be released and the foot member can be moved laterally on the base by manipulation of the handle 68. The clamping shaft 75 is rotated by a handle 80 that has a ball end 81, and that is pivotally connected to the shaft 75 by the pin 82.

The work supporting column 90 (FIG. 7) is secured in the foot member 60 by set-screws 91.

Mounted on the column 90 for vertical sliding adjustment relative thereto is a supporting bracket 95 which has telescoping adjustment on the column. This adjustment is effected by means of a shaft 96 which is journaled in a cap-plate 97, and which threads into a nut 98. Shaft 96 may be manually rotated by knob 101. The cap-plate 97 is secured to the sliding frame or bracket 95 by means of screws 99, to close the upper end of the bore thereof. The nut 98 is secured in the bore of the column 90 by means of a pin 100. The bracket 95 is held against rotation relative to the post or column 90 by a key 105 (FIG. 11) which engages in a slot 106 in

the post, and which is moved to engaging position by means of a screw shaft **107** that threads into the bracket, and that is manipulated by the knob **108**.

The bracket **95** is formed with an integral arm **101** (FIGS. 3 and 6) which projects laterally to one side of the column or support post **90**. Secured at the outer end of this arm on the upper side thereof is a block or template **102**, which controls the shape to be dressed on the grinding wheel, and which, for grinding bevel edged lenses would be provided with a V-notch **241**, as shown in FIG. 15. This template or block **102** is removably secured to the arm **101** by a screw or other means (not shown).

Journaled on the bracket **95** by means of aligned pins **110** and anti-friction bearings **111** is a bracket **112** (FIGS. 7 and 2), which has the general shape of a hollow rectangle, and which constitutes the pivot member of what in effect is a gimbal joint. It has an arm **113** (FIG. 2) projecting laterally to one side thereof, to the left in FIG. 1, and another arm **114** projecting laterally at the opposite side thereof, to the right as viewed in this figure.

Mounted to swing about a horizontal axis on the bracket **112** by means of pins **117** (FIGS. 4 and 6) is the work carriage **120**. The work carriage is generally H-shaped in plan as viewed in FIG. 4, and has parallel arms denoted at **121**, and **122**, respectively. These arms have depending lugs **123** and **124**, respectively, in which the pivot pins **117** for the work support are carried. Pins **117** extend at right angles to the pins **110** on which the bracket **112** swings.

The lens L, which is to be ground, is clamped between two opposed coaxial clamping heads or collars **125** and **126** (FIG. 4), which are secured, respectively, upon coaxial rotary shafts **127** and **128**. Shaft **128** is suitably journaled in conventional manner in a sleeve **130**. The clamping head **126** is constantly pressed towards lens-clamping position by a coil spring **132**, which is interposed between the thrust-bearing **133**, that is mounted on the shaft **128**, and a nut **134** that threads into the sleeve **130**.

The sleeve or slide **130** is adapted to be moved to inoperative position, to permit removal of a lens from the machine and positioning of a new lens between the clamping heads **125** and **126**, by a lever **135** (FIGS. 3, 12 and 13), which is secured to a shaft **136** that is rotatably mounted at one end of an arm **137**. This arm is pivotally mounted at its other end on a pin **138** that is secured in the arm **122** by a set-screw **145**. The shaft **136** is rotatably mounted in arm **137** and has a disc **140** secured to it by a set-screw **141**; and this disc carries a pin **142**, which is secured to the disc by a set screw **143**. The pin **142** rides in a slot **144** in the arm **122**, and is rotatably mounted at its inner end in the sleeve **130**, so that by rocking the handle **135**, the clamping head **126** can be moved to clamp the lens.

Both shafts **127** and **128** are positively driven. The drive is from a motor **150** (FIGS. 4 and 5), whose armature shaft **151** is connected by a conventional coupling **152** to a shaft **153**, which is journaled in the arm **122**. This shaft carries a worm **154**, and a helical gear **155**. The helical gear **155** meshes with a helical gear **156** on a shaft **157**, which extends transversely of arms **121** and **122** and which is journaled in both. This shaft **157** has a spur pinion **159** secured to it adjacent one end, and a spur pinion **160** secured to it close to its opposite end. The pinion **159** meshes with a gear **161** that is journaled on a stud **163** which is mounted in arm **121**. The gear **161** meshes with a gear **165** that is fastened to the shaft **127**.

The pinion **160** meshes with a gear **162** which is journaled on a stud **164** that is mounted in the carriage **120**. This gear **162** is a wide-faced gear, to permit movement of the clamping head **126** to and from clamping position; and it meshes with a gear **166** which is secured to the shaft **128**. Thus, the two shafts **127** and **128** are driven together from the same source of power.

The worm **154** meshes with a worm wheel **170**, which is secured to a shaft **171** that is journaled in the carriage **120** on bearings **172**, **173** and **174**. This shaft carries a cam **175**, which is adapted, when the cycle of operation of the machine is finished, to engage and release the lock that normally holds the carriage in operative position, so that the carriage can be swung automatically out of operating position, as will be described further hereinafter.

The shaft **171** can be rotated manually by a knurled knob **176** which is secured by means of pin **177** to one end thereof. Similarly the shaft **157** can be manually rotated by means of a knurled knob **178** which is secured by means of a pin **179** at one end thereof.

Secured to the shaft **127** is a block **180** on which there is adapted to be removably mounted the template or lens pattern which controls the shape of the lens. A typical template **182** is shown in full lines in FIG. 6. Block **180** is made with a cylindrical portion **181** of one diameter to receive templates having one size bore and with a cylindrical portion **183** of smaller diameter on which to mount templates having a corresponding smaller diameter bore. Spring-pressed ball detents **184** mounted in the block **180** serve to retain the templates on the block. The templates are pushed over the ball detents which are movable radially in the block and which snap out to hold the templates on the block.

The templates are adapted to engage a follower block or shoe **187** (FIGS. 2, 3 and 6), which has a plane contact face **186** at its upper end and which is secured to a screw stud **188** (FIG. 6). The stud **188** is mounted between the furcations of the furcated end of an arm **190**. It is adjustable for height on that arm by means of a knurled nut **191** which threads onto the stud. There is a graduated sizing dial **192** (FIG. 14) fastened to this nut **191**. A pointer **194**, which is secured to the arm **190** and which reads against graduations on a plate **195**, that is secured to the shoe or follower **187**, permits of setting the block **187** roughly to the desired position to control the amount of stock to be removed from the workpiece; and the graduations on the upper face of the dial **192** permit further fine adjustment of the position of the shoe or follower.

The arm **190** is pivotally mounted by means of stud **200** on the arm **113** (FIG. 6). The shoe or follower **187** is constantly pressed toward a position of engagement with the template **182** by means of a spring-pressed plunger **201**, which is housed in the arm **190**, and which engages a block **202**, that is mounted on the arm **114**.

In previous edge grinding machines, the template was out of contact with the shoe or follower until the lens had been ground down in a particular area of its periphery to the desired size; then the template contacted the shoe tripping the switch that started the work motor; this caused the work to be rotated through a slight angle to bring another portion of the lens periphery into engagement with the grinding wheel. Since this new portion of the lens is not yet ground down to size, its engagement with the grinding wheel lifts the template away from the shoe or follower, and releases the starting switch for the work motor, thus stopping the workpiece in its newly indexed position.

In the machine illustrated, the template **182** is always in contact with the shoe or follower **187**. When the lens has been ground down far enough in a particular position, the pressure of the template on the block **187** rocks the arm **190** about its pivot **200** far enough to cause an adjustable switch-operating screw **203** in the arm **190** to engage a limit switch, which is carried by the block **202**. This starts the motor **105**, causing the lens L to be rotated through a slight angle far enough for an unground portion of the lens to be indexed into engagement with the grinding wheel W. This relieves the pressure of the template on the contact block **187**, thereby permitting the spring-pressed plunger **201** to move the screw **203** out of engagement with the limit switch, stopping the motor.

The template 182, shoe 187 and arm 190 move downwardly together as the lens is ground down in one position. When the grinding of the lens in this position has proceeded to a point where the template has rocked arm 190 through the shoe 187 far enough for the spring plunger 201 to be fully compressed, the adjustable screw 203 will trip the limit switch to start the motor 150 to drive the shafts 127, 128 (FIG. 4), rotating the lens through a sufficient angle for the lens by its engagement with the grinding wheel to lift the template upwardly again, thus permitting the spring-pressed plunger 201 to rock the trip screw 203 away from the limit switch, stopping the motor 150, and thereby stopping the indexing movement of the work. The grinding wheel thereupon resumes grinding of the workpiece, but in the new area which has been indexed into grinding position.

Adjustment of the shoe permits of adjusting the amount of stock to be removed from the work in a grinding operation.

The work carriage 120 is so balanced about its horizontal axis of swing 117 that the weight of the carriage maintains the lens blank in engagement with the grinding wheel. However, means is provided for rocking the work out of engagement with the wheel at the completion of the grinding operation. To this end, the cam 175 (FIGS. 4 and 6), already referred to, is provided.

Mounted on the work carriage 120 is an inclined rod 220 which is bent abruptly downwardly at its front end. Mounted to slide on this rod 220 is a weight 221. When the work is in operative position, this weight is locked in position at the upper end of the rod, as shown in FIG. 6, by a latch or locking lever 223 which is pivoted on the stud 224 in the carriage. This lever has a catch 225 at its front end which engages behind the head or flange 226 formed at the front end of the weight. At its opposite end the lever carries an adjustable screw or follower 229 that is adapted to engage the peripheral surface of the cam 175.

Through the gearing 154, 170 (FIGS. 4 and 5), the cam is driven so that it makes only part of a revolution during a plurality of revolutions of the work shafts 127 and 128. Thus, the work can make a plurality of revolutions during a grinding operation so as to produce a smooth peripheral surface on the lens. After the cam 175 has completed approximately nine-tenths of a revolution, it will rock the lever 223 clockwise, as viewed in FIG. 6, to disengage the catch 225 from the weight. The weight then slides by gravity down the rod 220, shifting the center of gravity of the carriage and swinging the work up out of engagement with the grinding wheel. This is so timed that the work will be rotating at the time it breaks contact with the wheel, thereby avoiding leaving any hump on the surface of the lens.

To cushion the movement of the weight at the end of its downward sliding movement, a bumper 227 is mounted on the rod 220, that is backed up by a coil spring 228. Spring 228 surrounds the rod 220 and is interposed between the bumper and the bearing on carriage 120 in which the rod is supported.

To limit the upward rocking movement of the work carriage 120 as it is swung away from operative position, a stop 230 (FIGS. 1, 6 and 7) is provided. This is mounted in the bracket 95.

For dressing the grinding wheel, a diamond 235 (FIG. 1) is provided. This diamond is mounted on an arm 247 (FIGS. 1 and 6) removably secured to the arm 121 (FIG. 4). Secured to this same arm 247 is an arm 237, which carries a follower 238 (FIG. 1). The follower is adapted to engage the template 102 which controls the dressing. The dressing diamond 235 is brought into operative engagement with the grinding wheel W by swinging the whole work carriage 120 downwardly about the axis of the studs 117. Pressure is applied through the knob 245, which is mounted on the handle 246, that is secured in the arm 247. The diamond is moved across the wheel, as it rotates, in a path controlled by the template 102. For dressing the wheel to grind a beveled edge on a lens, the template 102 will be provided with a V-groove 240 (FIG. 3) corresponding to the shape of the V-groove 241 that is to be dressed in the grinding wheel. When a flat surface, that is, a surface of straight-line profile is to be ground on a lens, the diamond template 102 will have a flat, plane shape.

The operation of this bevel edging machine is as follows:

The machine may be started by a conventional starter switch (not shown). The motor 50 then drives the grinding wheel W through the pulley and belt drive 54—57—56 (FIG. 7). After a lens blank has been chucked in the machine, the blank may be lowered into engagement with the wheel by pulling down on the work carriage. The lens blank being oversized, the template 182 (FIG. 6) at first engages the contact plate 187 very lightly so that the trip screw 203 is held by the spring pressed plunger 201 out of engagement with the limit switch 202. When the lens has been ground down in one position, however, to proper size, the template will be lowered far enough to bear heavily upon the shoe 187 and rock the arm 190 against the resistance of the spring pressed plunger 201 far enough to cause the screw 203 to trip the limit switch 202, thus starting the motor 150. This motor then drives the two work center shafts 127 and 128 through the gearing described, which is illustrated in FIGS. 4 and 5. At the same time, the shaft 171 is driven to advance the cam 175 slightly. The drive from the motor 150 (FIGS. 4 and 5) through the gearing 155, 156, 160, 162, 166 and 159, 161, 165, indexes the work, advancing the lens blank a step to a point where the lens blank lifts the template upwardly again so that the spring pressed plunger 201 can move the screw 203 away from the limit switch to cause the motor 150 to stop.

The lens blank remains stationary during grinding of the area of the lens blank newly indexed into position, but when this is ground down to size, the template again rocks the arm 190 (FIG. 6) against the resistance of the spring-pressed plunger 201 to again trip the limit switch 202; and the work is indexed through a slight angle, as before.

Each time that the workpiece is advanced a step as described, the gearing 154, 170 (FIG. 5) drives the shaft 171 and advances the cam 175 a step. The gear reduction is such, however, that the cam 175 makes slightly less than one revolution while the template is making a plurality of, for instance three revolutions. When the work is being indexed the last time, the cam 175 will have been rotated far enough to disengage the catch 225 (FIG. 6) from the weight 221. The weight will thereupon slide down the rod 220, rocking the work carriage upwardly about its pivot pins 117, to move the lens clear of the grinding wheel. The lens may then be removed from the machine; and a new lens blank may be chucked in place.

The cam 175 operates in such way that the work will be rotating when it breaks contact with the grinding wheel. This insures against any hump being ground on the lens at the end of the grinding operation.

While, when the machine is geared as illustrated, the work makes three revolutions in the grinding operation, the second and third revolutions are relatively very fast because most of the stock is removed in the first indexing revolution of the work. When the grinding operation is completed, the lens will have been provided with a very smooth peripheral surface. In the second and third revolutions of the work, the work rotation is continuous.

For grinding a flat edged lens, the grinding wheel may be dressed to have a plane tip surface perpendicular to its axis. The workpiece may be reciprocated axially to prevent wear of the wheel in one place.

By mounting both the template and the follower on the work support, the relationship of these parts remains

constant at all times, whereas in conventional machines, after each dressing of the wheel, it is necessary to readjust the follower relative to the template, that controls the lens shape, by the amount of stock which is removed from the wheel. In the machine of the present invention, the whole work carriage is adjusted vertically upon dressing of the wheel, to compensate for wheel wear, but the relationship between the template **182** and the shoe or follower **187** remains unchanged during this adjustment. Size control is maintained accurate, also, because as the wheel is dressed, the relationship of all of the other parts remains constant.

With the machine of the present invention the speed of rotation of the wheel, moreover, can remain constant regardless of wear.

With the machine of the present invention, because a flat follower **187** is used with the template **182**, the accuracy is constant during the whole of the life of the wheel; and, therefore, much longer wheel life can be attained than is possible with conventional machines.

Furthermore, with the machine of the present invention, the radius of the groove **241** dressed in the wheel, where a bevel edge is to be ground on a lens blank, approximates the radius of the meniscus surface of the lens, so that the wheel surfaces, which are grinding the bevel on the lens will follow the lens shape. This means that with the present machine uniform spacing of the front and rear surfaces of the lens from the apex of the V-shaped edge surface, which is ground on the lens, will be uniform. This means that the lens can be accurately held in a split eye-wire. The mounting of the work carriage **120** on the bracket **112**, which is able to swing about the vertical axis of the studs **110** (FIG. 7), permits the workpiece to swing so that it more readily follows the groove of the wheel. By adjustment of the work supporting column **90** (FIG. 7) laterally on the base **20** of the machine through rack **62** (FIGS. 8 and 9) and gear segment **64**, the position of the apex of the V-groove relative to the front and rear faces of the lens blank can be controlled. This makes it possible to avoid having any unsightly bevel edge showing at the front when the lens is mounted in a spectacle frame.

Thus outstanding advantages are achieved with the machine of the present invention which are not attainable with any prior art machine.

The embodiment of the invention illustrated in FIGS. 16 to 20 inclusive, provides a more compact machine than that shown in FIGS. 1 to 15 inclusive. Many of the parts used in the machine of FIGS. 16 to 20 inclusive may, however, be identical with parts used in the machine illustrated in FIGS. 1 to 15 inclusive; and identical parts in FIGS. 16 to 20 are designated by the same reference numerals as employed in FIGS. 1 to 15. Other parts similar to parts used in the machine of FIGS. 1 to 15 are designated in FIGS. 16 to 20 by numerals increased by 1000 over like parts in FIGS 1 to 15. Parts of the machine of FIGS. 16 to 20 which are new in that embodiment of the invention, as distinguished from the embodiment of FIGS. 1 to 15, are designated by new reference numerals. Only those parts of the machine are shown in FIGS. 16 to 20 which are necessary to an understanding of the construction and operation of this embodiment of the invention; otherwise this machine is similar to that shown in FIGS. 1 to 15 inclusive.

The work carriage of the machine of FIGS. 16 to 20 is denoted at **1120**. It is generally H-shaped in plan and has parallel arms designated **1121** and **1122**, but it is shorter from front to rear than carriage **120** (FIG. 4) because shaft **1171** (FIGS. 18 and 19), which carries the trip member **255** for the carriage lift mechanism in this second embodiment of the invention, is mounted above motor shaft **1153** and but slightly to the rear of shaft **157** which drives the heads between which the work is clamped.

The drive to shaft **1171** is from motor **150**, which is mounted on arm **1122** of the work carriage, through a conventional coupling **152**, shaft **1153**, worm **1154** and wormwheel **1170**. The work itself is held as in FIG. 4, between clamping heads **125** and **126**. These clamping heads and part of the drive thereto are omitted in FIG. 18 because FIG. 18 shows its work carriage broken off just ahead of shaft **157**. Head **125** is driven in a manner similar to the drive in FIG. 4, its drive being from shaft **1153** through worm **155** (FIGS. 18 and 19) wormwheel **156**, shaft **157**, and gearing **159**, **161**, **165** (FIG. 4). Head **126** is driven from shaft **157** through gearing **162**, **166** exactly as in FIG. 4.

Trip member **255** is here in the form of a collar or disc that is secured to shaft **1171** and that has a trip pin **257** (FIGS. 17 and 18) projecting radially therefrom. A knurled knob **1176** is provided for rotating shaft **1171** manually.

A principal difference between the machine of FIGS. 1 to 15 inclusive and the machine of FIGS. 16 to 20 is in the carriage lift mechanism.

Secured to the arm **1121** (FIGS. 18 and 17) of the work carriage by bolts or screws **261** is a U-shaped bracket **260**, the inner leg of which seats flat against arm **1121** and is longer than the outer leg. Pivotally mounted on bracket **260** by means of stud **262** is an arm **263** in the free end of which there is threaded a lever **264**. This lever carries a knob **265** at its free end and is secured in arm **263** by lock-nut **266**.

Arm **263** is secured to pivot stud **262**; and pivot stud **262** has a second, depending arm **268** also secured to it, so that when lever **264** is rocked in one direction or the other, arm **268** will be rocked also. Arm **268** is connected by pin **269** to a link **270** which, in turn, is connected by pin **271** with a lever **272**.

Lever **272** is pivotally mounted by means of pin **274** on bracket **260**, and is pivotally connected at its opposite end by means of pin **275** to the trip plunger **276**. This plunger slides in a bracket **277** that is secured by screws **278** to arm **1121** of the work carriage. Bracket **277** also carries one of pins **117** (FIGS. 4 and 6) by means of which work carriage **1120** is pivotally mounted on bracket **112**.

An adjustable trip member **279** is threaded in the lower end of plunger **276**. This member is adapted to engage a plate **285** that is mounted on the upper face of an arm **1190** which corresponds to arm **190** (FIG. 6). Arm **1190**, like arm **190**, carries shoe or follower **187** and is pivotally mounted by means of stud **200** on arm **113** of bracket **112**.

Pivotally connected to arm **268** and link **270** by means of pin **269** is a catch member **290** (FIG. 17). A coil spring **291** surrounds this catch member. This spring is interposed between a pin **292**, which is secured in the catch member, and a plate **293**, which is generally Z-shaped in plan (see FIG. 18). Plate **293** is secured at one end to the longer leg of bracket **260** by screws **294**, and is secured at its opposite end to the shorter leg of bracket **260** by the nut **295** which threads onto stud **262**.

Catch member **290** has a shoulder or ledge **296** (FIG. 17) which is adapted to engage one end face of a keeper **297** that is secured by screws **298** to bracket **260**. The catch member **290** is constantly urged upwardly to the position shown in FIG. 17 by a leaf spring **299** which is secured by screws **300** to an angle bracket **301** that is fastened by screws **302** to bracket **260**. The free end of the catch member **290** passes through a slot in the keeper **297** and terminates in a head **303** which has a downwardly inclined upper face **304**.

As in the first described embodiment of the invention, during the rough-grinding operation the workpiece is stationary, but when the grinding wheel has ground the lens down, in the area of its engagement with the lens, to the desired rough size, the template **182** (FIG. 16) through its engagement with the upper face **186** of the

follower or shoe 187 will have rocked the arm 1190 about its pivot 200 far enough to cause screw 203 to trip the limit switch. This starts motor 150, as before, causing the lens to be rotated through a slight angle far enough for an unground portion of the lens to be indexed into engagement with the grinding wheel. As before, this relieves the pressure of the template on the contact block or follower 187, thereby permitting the spring-pressed plunger 201 to move the screw 203 out of engagement with the limit switch, stopping the motor.

After the workpiece has been rough-ground all around its periphery, it is preferably rotated one or more revolutions in continuous engagement with the grinding wheel to clean up the stock and produce a smooth peripheral surface. The number of revoltuions, which the workpiece makes before grinding is completed, is determined by the ratio of the gearing 1154, 1170 (FIGS. 18 and 19). When the grinding operation is completed the trip member 255 (FIG. 17) will have rotated into position to engage the head of catch member 290.

FIG. 17 shows the positions of the parts just as the trip member is about to engage the head of the catch member. In the next instant of rotation of the trip member, the ledge 296 of the catch member is disengaged from the keeper 297. Then the spring 291 shoots the catch member to the right as viewed in FIG. 17, straightening out the toggle linkage 268, 270, rocking the lever 272 downwardly, forcing plunger 276 downwardly, and causing plunger 276 to rock arm 1190 counterclockwise about its pivot 200 as viewed in FIG. 16. This causes shoe or follower 187, through its engagement with template 182 to rock the work carriage upwardly about its pivot 117 to disengage the workpiece from the grinding wheel, at the same instant the screw 203 will be rocked away from the limit switch carried by block 202, and the motor 150 will be stopped to stop rotation of the work.

The movement of the work away from the wheel thus effected is only sufficient for the work to clear the wheel. To remove the completed workpiece and to chuck a new workpiece, the operator can push the work carriage up further manually to provide sufficient clearance.

The work carriage is locked in its upper position by a catch lever 310 (FIG. 17) which is pivoted on pin 311 and which is adapted to engage a pin 253 (FIGS. 17 and 20) that projects laterally from bracket 112. This lever is constantly urged into engagement with a pin 313, that is carried by arm 263, by a coil spring 316. This spring is secured at one end to a pin 315 and at its opposite end to a pin 314. Pin 315 is fastened to lever 310; and pin 314 is fastened to bracket 260. When a new workpiece has been chucked in the machine, the work carriage is rocked down to operating position by pressing on knob 265. This cocks catch member 290 and causes its ledge 296 to engage keeper 297. It also causes pin 313 (FIGS. 17 and 18) to engage the tail of lever 310 and rock that lever out of engagement with pin 253.

When the work carriage is in up position, it is held against rocking sidewise about vertical pivots 110 (FIG. 7) by a keeper 320 (FIGS. 16, 17 and 18). This keeper depends from the cover or guard 326 that is secured on the work carriage. This keeper is adjustable forwardly and backwardly in this guard 326. It is guided in its adjustment by a pin 321 which engages in a slot 322 in the guard; and it may be secured in any adjusted position by rotating the knurled head 324 of screw 323 to draw the keeper up against the guard. The keeper has a slot in it which has an inclined bottom 325. This slot is adapted to receive the pin 250 which projects laterally from bracket 1095. Bracket 1095, like bracket 95 (FIG. 7), is mounted adjustably on column 90.

In this second embodiment of the invention, the pressure of the work on the grinding wheel can be controlled by adjustment of a weight 330 slidably along a rod 331. Weight 330 is secured to rod 331 in any adjusted position by a set-screw 332. Rod 331 is secured in a lug 334, that projects upwardly from guard 326, by a set-screw 335.

While the invention has been described in connection with the different embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains, and as may be applied to the essential features hereinbefore set forth, and as fall within the scope of the invention or the limits of the appended claims.

Having thus described our invention, what we claim is:

1. An edge-grinding machine for lenses, comprising a base, a rotary tool support journaled in said base, a grinding wheel secured to said tool support to rotate therewith, a rotary work holder for holding a workpiece in edgewise engagement with the grinding wheel during rotation of said tool support, supporting means movably mounted on said base and on which said holder is rotatably mounted, means for rotating the tool support, indexing means for rotating the work holder intermittently, and means for determining the intervals when said indexing means becomes operative comprising a template mounted coaxial with the work holder to rotate therewith, a follower engaging the periphery of said template, said template having a peripheral shape corresponding to the edge shape desired on the work, both said template and said follower being mounted on said supporting means, and means positioned to be operated, when said supporting means has moved a predetermined distance, to actuate said indexing means.

2. An edge-grinding machine for forming a beveled edge on an article such as a lens, comprising a rotary tool support, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces coaxial with said tool support and an end surface connecting said inside and outside surfaces and having a groove therein which as of V-shape in cross section, the sides of said groove being coaxial with said tool support, a work support, a bracket mounted on said work support to swing about an axis parallel to the axis of rotation of said tool support, a work holder rotatably mounted on said bracket for holding a workpiece in edgewise engagement with the groove of said grinding wheel during rotation of said grinding wheel, the axis of rotation of said work holder being at right angles to the axis of swing of said bracket, means for rotating said tool support and means for rotating said work holder intermittently.

3. An edge-grinding machine as claimed in claim 2 having control means for determining the intervals of rotation of said work holder comprising a template mounted coaxial with the work support to rotate therewith, and a follower for engaging the periphery of said template, said follower having a plane active surface, and said template having a peripheral shape corersponding to the edge shape desired on the work.

4. An edge-grinding machine as claimed in claim 3 in which the follower is mounted on said bracket.

5. An edge-grinding machine as claimed in claim 3 in which the follower is mounted on said bracket to swing about an axis perpendicular to the axis of swing of said bracket, and means is provided for constantly urging said follower into engagement with said template.

6. An edge-grinding machine for lenses comprising a rotary tool support, a cup-shaped grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces and an end surface connecting said inside and outside surfaces, said end surface containing the active surface of said wheel, a work support, a bracket pivotally mounted on said work support, a rotary work holder mounted on said bracket for holding a work piece in edgewise en-

gagement with the grinding wheel during rotation of the grinding wheel, said bracket having portions extending at opposite sides of its pivotal axis, means for rotating the tool support, means for intermittently rotating said work holder through small angles, and means for shifting the center of gravity of said bracket from one side of said pivotal axis to the other automatically after a predetermined number of revolutions of said work holder to swing said bracket automatically on its pivotal axis to move the work out of engagement with the grinding wheel.

7. An edge-grinding machine for lenses according to claim 6 in which there is weight normally mounted on said bracket at one side of the pivotal axis of said bracket, and in which a detent is provided for normally holding said weight at said one side of said pivotal axis, and in which means is provided for disengaging said detent to allow said weight to shift to the other side of said pivotal axis when said work holder has completed a predetermined number of revolutions to effect the swing of said bracket to disengage the work from the wheel.

8. An edge-grinding machine for lenses comprising a rotary tool support, a cup-shaped, annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces coaxial with said tool support and an end surface connecting said inside and outside surfaces, said end surface containing the active surface of said wheel, a work support, a bracket pivotally mounted on said work support, a rotary holder mounted on said bracket for holding a workpiece in edgewise engagement with the grinding wheel during rotation of the grinding wheel, a weight slidably mounted on said bracket and constantly urged to one side of the pivotal axis of said bracket, a detent for normally holding said weight at the opposite side of said pivotal axis to urge the workpiece into engagement with the grinding wheel, means for rotating the tool support, means for intermittently rotating said work holder through small angles, and means for disengaging said detent to permit said weight to slide to the first-named side of said pivotal axis and comprising a cam rotated intermittently in time with the intermittent rotation of said work holder.

9. An edge-grinding machine for lenses comprising a rotary tool support, a rotary cup-shaped annular grinding wheel secured to said tool support, said wheel having cylindrical inside and outside surfaces which are coaxial with said tool support and having an end surface which connects said inside and outside surfaces and which contains the active surface of said wheel, a work support for holding a workpiece, a carriage pivotally mounted on said work support, a work holder mounted on said carriage for rotation about an axis parallel to the pivotal axis of said carriage, said carriage being normally urged in one direction about its pivotal axis to hold the workpiece in edgewise engagement with said end surface of the grinding wheel during rotation of the grinding wheel, a template secured to said work holder coaxially with said work holder to rotate therewith, a follower engaging said template and having a plane active face, a support for said follower mounted on said work support to pivot about an axis parallel to the pivotal axis of said carriage, means constantly urging said follower support in a direction about its pivotal axis opposite to the normal direction of movement of said carriage about its pivotal axis to urge said follower constantly into engagement with said template, means for rotating said tool support, means including a motor for intermittently rotating said work holder, a switch controlling said motor, and means mounted on said follower support for tripping said switch when said follower support is swung about its pivotal axis a predetermined distance in a direction opposite to that to which it is constantly urged.

10. An edge-grinding machine for lenses comprising a base, a rotary tool support rotatably mounted on said base, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces which are coaxial with said tool support and an end surface which connects said inside and outside surfaces and which contains the active surface of said wheel, a work support adjustably mounted on said base for lateral adjustment in a direction at right angles to the axis of said tool support, a carrier adjustable on said work support axially of said tool support, a bracket pivotally mounted on said carrier for swinging movement about an axis parallel to the axis of said tool support, a carriage mounted on said bracket for pivotal movement about an axis at right angles to the axis of swing of said bracket, a work holder rotatably mounted on said carriage for rotation about an axis parallel to the axis of pivotal movement of said carriage, a template secured to said work holder coaxially thereof to rotate therewith, a follower support mounted on said bracket for pivotal movement about an axis parallel to the axis of pivotal movement of said carriage, a follower mounted on said follower support, said follower having a plane active face and said template having a peripheral shape corresponding to the edge shape desired on the workpiece, means constantly urging said follower into engagement with said template, means for rotating said tool support, means for intermittently rotating said work holder, and means for controlling the last-named means including an electric switch, and means carried by said follower support for tripping said switch.

11. An edge-grinding machine for lenses, comprising a rotary tool support, a cup-shaped annular abrading member secured to said tool support to rotate therewith, said abrading member having cylindrical inside and outside surfaces coaxial with said tool support and an end surface connecting said inside and outside surfaces and containing the active surface of said member, a rotary work support for holding a workpiece in edgewise engagement with the end surface of said abrading member during rotation of said tool support, said work support being movable toward and from said tool support to move the workpiece into and out of engagement with the abrading member, means for rotating the tool support, means for rotating the work support, control means for said work support rotating means, a template mounted coaxial with the work support to rotate therewith, an arm pivoted intermediate its ends, a follower mounted at one side of the pivot of said arm to engage said template, a trip member carried on said arm at the opposite side of said pivot to operate said control means, spring-actuated means for constantly urging said arm about its pivot in a direction to move said trip member away from said control means, and means driven in time with the rotation of said work support for positively moving said arm about its pivot in said direction upon completion of an abrading operation upon the workpiece to cause said follower through said template to move the work support away from said abrading member to move said work support to inoperative position.

12. An edge-grinding machine for lenses comprising a base, a tool support rotatably mounted on said base, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces and having an end surface connecting said inside and outside surfaces and constituting the active surface of said wheel, a rotary work holder for holding a workpiece in edgewise engagement with said end surface of said wheel during rotation of said tool support, the axis of rotation of said work holder extending at right angles to the axis of rotation of said tool support, supporting means pivotably mounted on said base and on which said holder is rotatably mounted, means for rotating said tool support, means for rotating the work holder intermittently, means determining the intervals when the holder-rotating means

becomes operative comprising a template mounted coaxial with the work holder to rotate therewith, and a follower mounted on said supporting means and engaging the periphery of said template, said template having a peripheral shape corresponding to the edge shape desired on the work, and means for adjusting said supporting means and tool support relative to one another in the direction of the axis of rotation of the tool support to compensate for wear of the wheel.

13. An edge-grinding machine according to claim 12 in which the holder rotating means includes a motor, a normally-open switch in the circuit to said motor, a trip member carried by said supporting means for closing said switch, and means operated by said template and follower for actuating said trip member.

14. An edge-grinding machine for lenses comprising a base, a tool support rotatably mounted on said base, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical outside and inside surfaces coaxial with said tool support and having an end surface connecting said outside and inside surfaces which constitutes the active surface of said wheel, a carriage pivotally mounted on said base for swinging movement toward and from said end surface, a work holder rotatably mounted on said carriage for holding a workpiece in edgewise engagement with said end surface during rotation of said tool support, the axis of rotation of said work holder being parallel to the axis of said carriage and being disposed at right angles to the axis of rotation of said tool support, and means for controlling the rotation of said work holder comprising a template secured to said work holder to rotate therewith, and a follower having a plane face engaging said template.

15. An edge-grinding machine for lenses as claimed in claim 14 wherein said carriage is mounted on a bracket which, in turn, is mounted on said base to swing about an axis parallel to the axis of said tool support.

16. An edge-grinding mechine as claimed in claim 15 wherein said template is mounted on said bracket to swing about an axis parallel to the axis of swing of said carriage.

17. An edge-grinding machine for lenses as claimed in claim 15 wherein said bracket is mounted on column which in turn is mounted on said base and which is adjustable on said base laterally to vary the offset of the point of engagement of the workpiece with the wheel relative to the axis of the tool support.

18. An edge-grinding machine for lenses comprising a base, a tool support rotatably mounted on said base, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical outside and inside surfaces coaxial with said tool support and having an end surface connecting said outside and inside surfaces and which constitutes the active surface of said wheel, a column adjustable on said base in a direction parallel to the axis of rotation of said tool support, and a carriage swingable on said column, a work holder rotatably mounted on said carriage for rotation about an axis parallel to the axis of swing of said carriage, means for intermittently rotating said work holder, and means controlling the operation of the last-named means comprising a template secured to said work holder to rotate therewith, and a follower mounted on said carriage, and means for adjusting said carriage in a direction parallel to the axis of said tool support to compensate for wear of the grinding wheel.

19. An edge-grinding machine for forming a beveled edge on an article such as a lens, comprising a rotary tool support, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having inside and outside cylindrical surfaces coaxial with said tool support and an end surface connecting said inside and outside surfaces, said end surface having an annular groove therein which is of approximately V-shape in cross section and which is coaxial with said tool support, the sides of said V being surfaces of revolution coaxial with said tool support, a rotary work support for holding a workpiece in edgewise engagement with said wheel during rotation of said tool support, said work support having its axis of rotation disposed at right angles to the axis of rotation of said tool support, means for rotating said tool support, means for intermittently rotating said work support, and means controlling the shape ground on the workpiece and the rotation of the work support comprising a template mounted coaxial with said work support to rotate therewith, and a follower having a plane surface for engaging the periphery of said template.

20. An edge-grinding machine for lenses comprising a base, a tool support rotatably mounted on said base, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces coaxial with said tool support and an end surface connecting said inside and outside surfaces, said end surface containing the active surface of said wheel, a work support rotatably mounted on said base for holding a workpiece in edgewise engagement with said end surface during rotation of said wheel, said work support having its axis of rotation disposed at right angles to the axis of rotation of said tool support, one of said supports being adjustable on said base in a direction at right angles to the axis of rotation of said tool support to offset the axis of rotation of said tool support from the axis of rotation of said work support a selected distance, means for rotating said tool support, and means for rotating said work support.

21. An edge-grinding machine for lenses comprising a rotary tool support, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces coaxial with said tool support and an end surface connecting said inside and outside surfaces, said end surface containing the active surface of said wheel, a rotary work support for holding a workpiece in edgewise engagement with said end surface during rotation of said wheel, said work support having its axis of rotation disposed at right angles to the axis of rotation of said tool support, means for rotating the tool support, means for rotating the work support intermittently, and control means for determining the intervals when the means for rotating the work support becomes operative comprising a template mounted coaxial with said work support to rotate therewith, and a follower for engaging the periphery of said template, said follower having a plane surface which lies in a plane perpendicular to the axis of said tool support at such intervals, said template having a peripheral shape corresponding to the edge shape desired on the workpiece.

22. An edge-grinding machine for lenses, comprising a base, a rotary tool support journaled on said base, a cup-shaped annular grinding wheel secured to said tool support to rotate therewith, said wheel having cylindrical inside and outside surfaces which are coaxial with said tool support and an end surface connecting said inside and outside surfaces and which contains the active surface of said wheel, a rotary work holder for holding a workpiece in edgewise engagement with said end surface during rotation of said tool support, supporting means movably mounted on said base and on which said holder is rotatably mounted, means for rotating the tool support, indexing means for rotating the work holder intermittently, and means determining the intervals when said indexing means becomes operative comprising a template mounted coaxial with the work holder to rotate therewith, a follower engaging the periphery of said template, said template having a peripheral shape corresponding to the edge shape desired on the workpiece, and said follower having a plane active face, both said template and said follower being mounted on said supporting

means, and means positioned to be operated, when said supporting means has moved a predetermined distance, to actuate said indexing means.

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