

Aug. 19, 1969

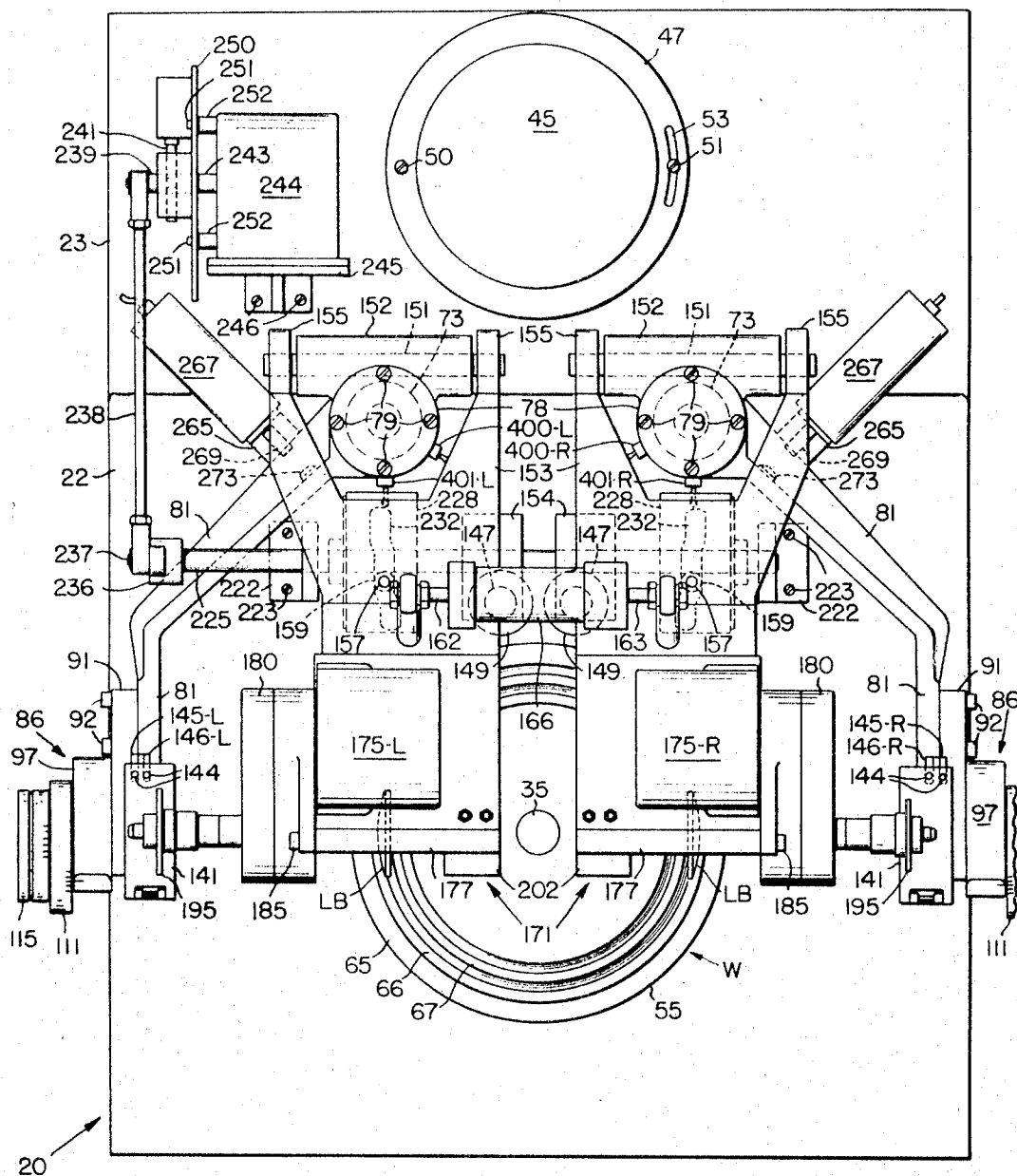
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3,461,619

EDGE-GRINDING MACHINE FOR LENSES

Filed May 10, 1966

6 Sheets-Sheet 1



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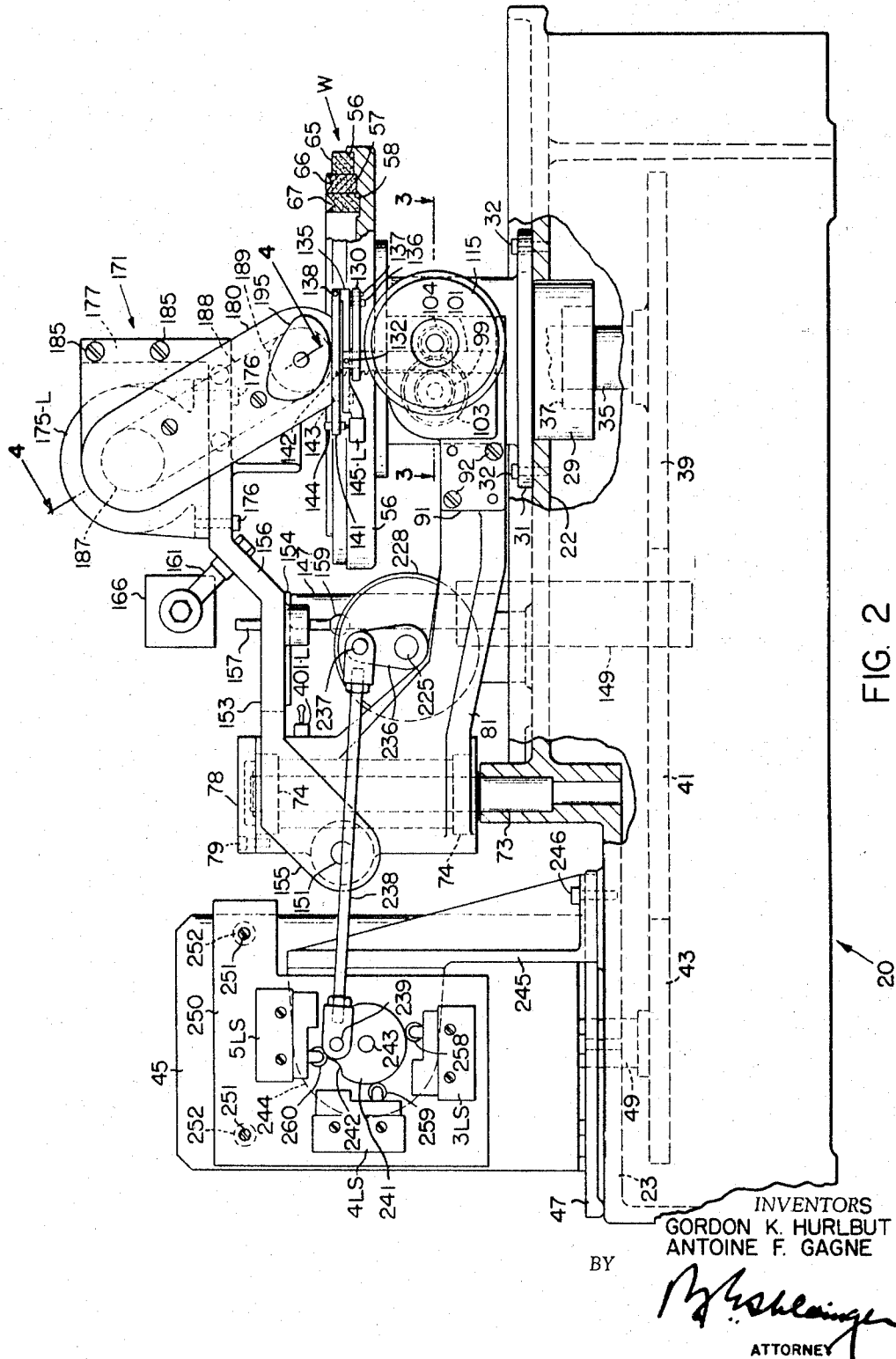
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EDGE-GRINDING MACHINE FOR LENSES

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FIG. 3

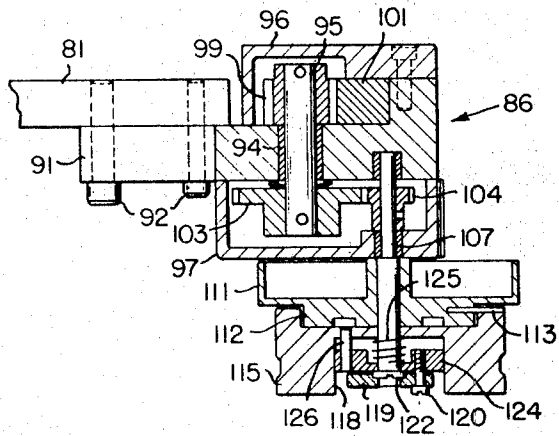


FIG. 4

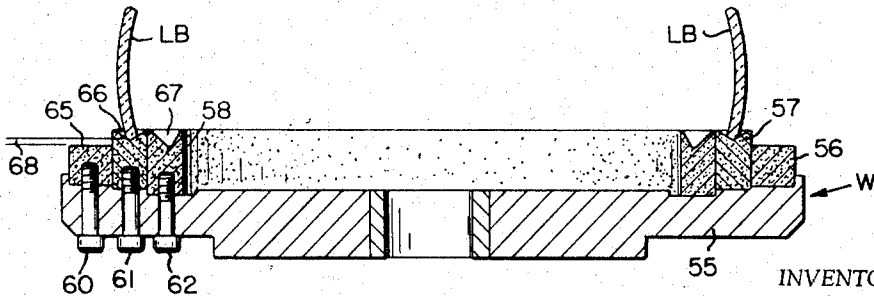
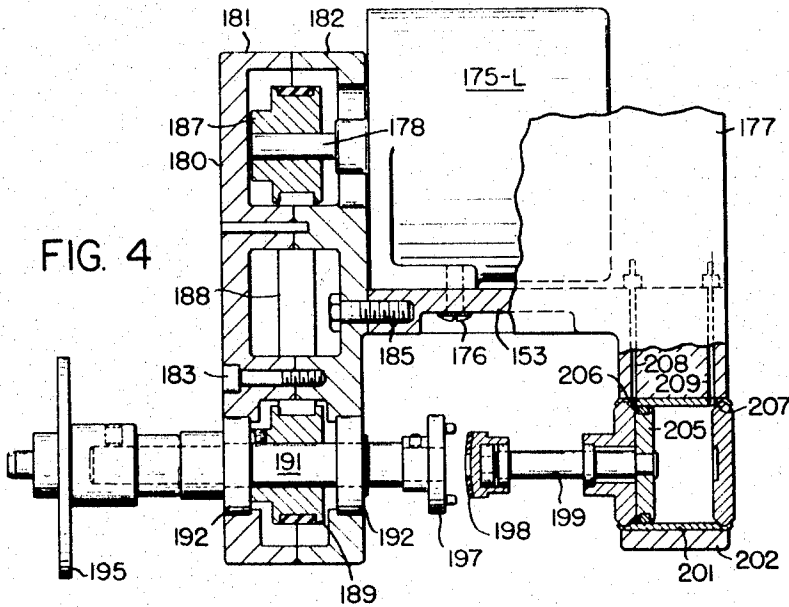


FIG. 5

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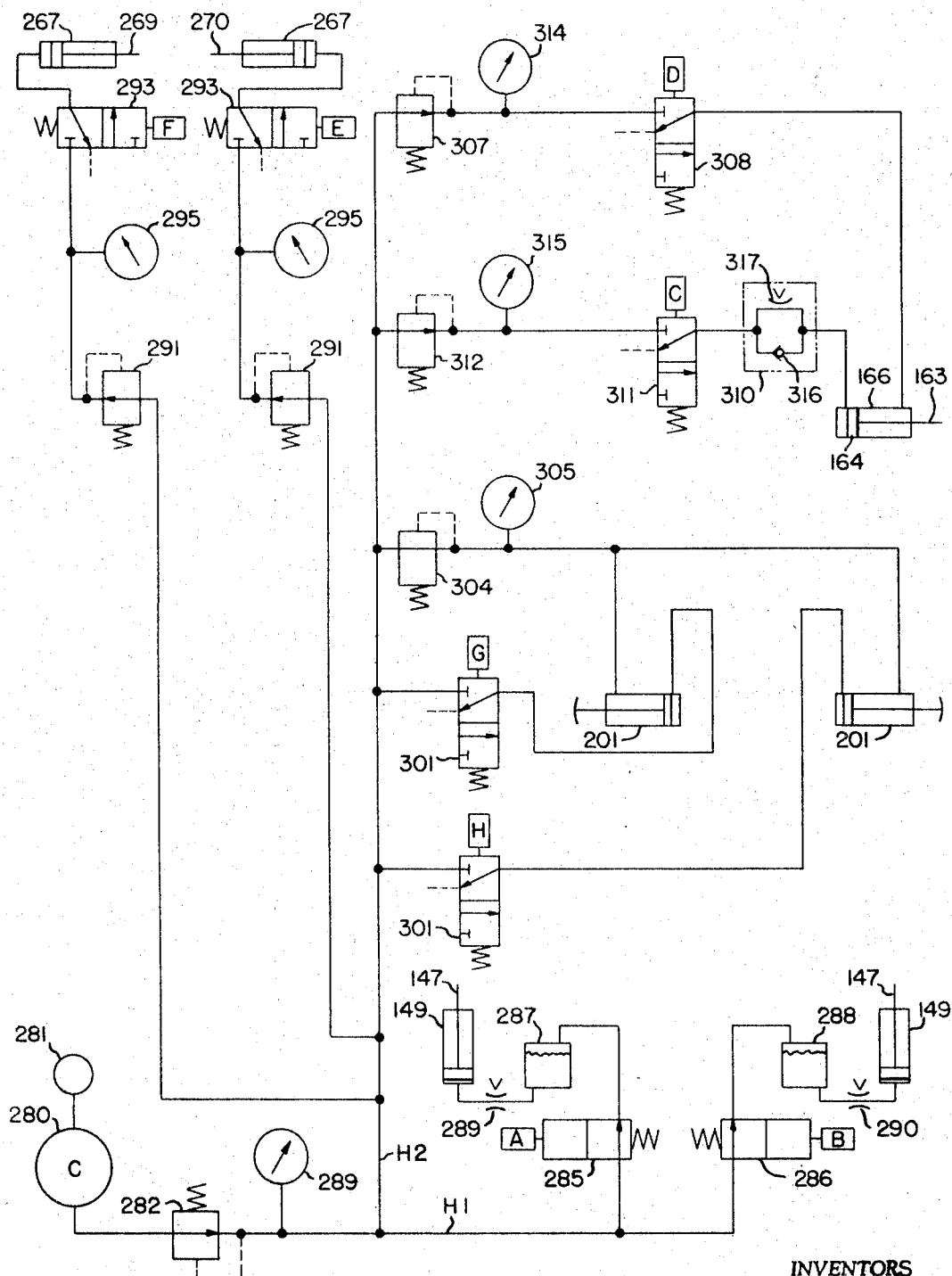


FIG. 6

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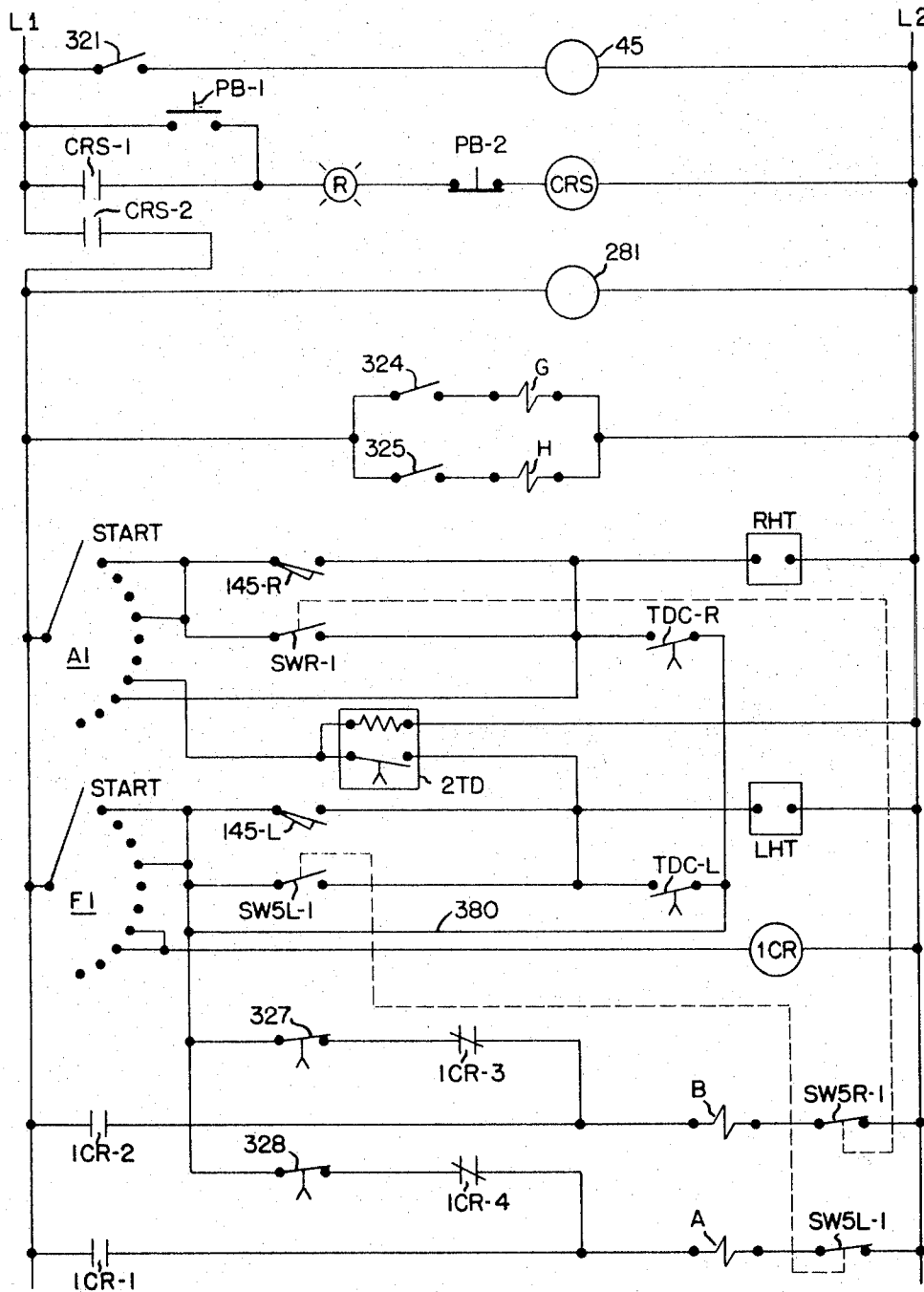


FIG. 7A

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EDGE-GRINDING MACHINE FOR LENSES

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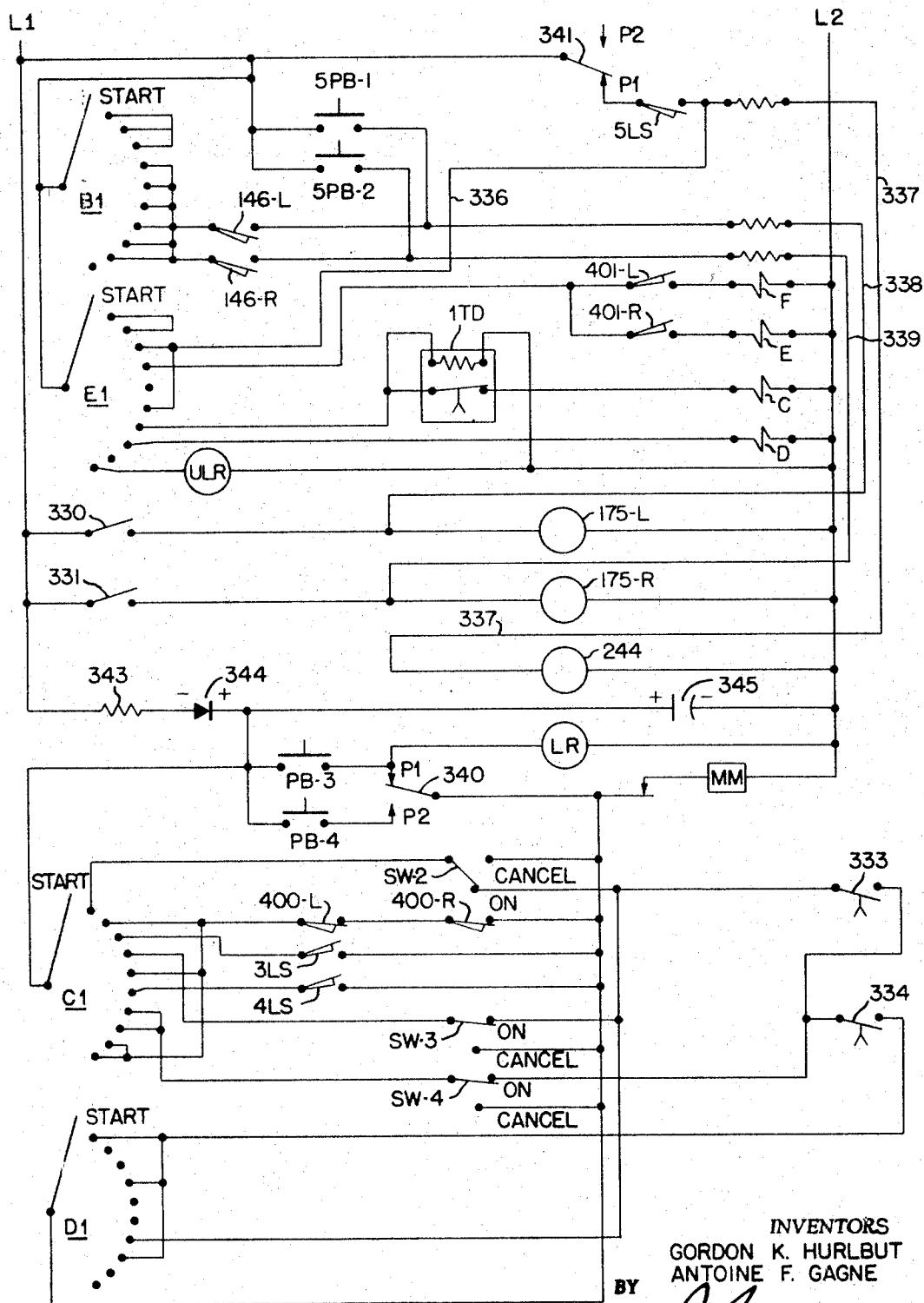


FIG. 7B

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3,461,619

EDGE-GRINDING MACHINE FOR LENSES

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U.S. Cl. 51—127

16 Claims

ABSTRACT OF THE DISCLOSURE

In this machine two lens blanks can be ground simultaneously with a grinding wheel comprising three removable, annular, coaxial grinding sections. The outermost section has a plane top surface perpendicular to the axis of the wheel for rough grinding the blanks to size or for grinding rimless lens blanks. The middle section has a symmetrical V-shaped groove for rough grinding blanks which are to be mounted in frames. The innermost section is for finish grinding the last-named blanks. The two lenses during grinding are supported at opposite sides of a plane containing the axis of the wheel and are generally coaxial. They are swung out of engagement with the wheel to move them from one section of the wheel to another thereof.

This invention relates to edge-grinding machines, and more particularly to machines for grinding beveled edges on ophthalmic lenses.

Prior edge-grinding machines have been capable of grinding only one lens blank at a time. With prior machines for edge-grinding lenses with a bevel edge, moreover, it has ordinarily been necessary to perform first a rough edge-grinding operation with a grinding wheel having a V-shaped groove conforming in shape to the V-shaped edge to be produced on the lens, to take off stock to reduce the blank to approximately its finished size and bevel edge shape, and then to finish grinding the edges of the lens to final form with the same wheel. For grinding a lens with a flat edge a separate wheel had to be used.

The bevel of the edges of the lenses for one spectacle frame may, however, differ from the bevel of the edges of the lenses for another spectacle frame. This requires wheels dressed with different V-grooves.

The primary object of the present invention is to provide an edge-grinding machine for ophthalmic lenses which will have increased productive capacity. To this end one object of this invention is to provide an improved lens edger which is capable of simultaneously grinding a pair of lens blanks.

Another object of this invention is to provide an improved edger which is capable of performing in a single cycle, size grinding, beveling and safety grinding of a pair of lens blanks simultaneously.

Another object of the invention is to provide a machine of the character described which will remove any burrs left on the lenses by the grinding operations, will provide them with a smoothly finished edge, and eliminate any necessity for manual touching up.

Another object of the invention is to provide a machine which will grind lenses more accurately, with a better finish and without any burrs.

Other objects of the invention will be apparent herein-after from the specification and from the recital of the appended claims, particularly when read in conjunction with the accompanying drawings.

In the drawings:

FIG. 1 is a plan view of an edge-grinding machine for lenses made in accordance with one embodiment of this invention;

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FIG. 2 is a side elevational view of this machine with parts thereof cut away and shown in section;

FIG. 3 is an enlarged, fragmentary sectional view taken along the line 3—3 in FIG. 2 looking in the direction of the arrows;

FIG. 4 is an enlarged, fragmentary sectional view taken generally along the line 4—4 in FIG. 2 looking in the direction of the arrows;

FIG. 5 is an enlarged axial sectional view of the grinding wheel and illustrating diagrammatically, also, how this wheel may be employed for edge-grinding simultaneously two lenses;

FIG. 6 is a diagram of the pneumatic system of this machine; and

FIGS. 7A and 7B constitute an electrical wiring diagram illustrating one way in which this machine may be wired to perform its functions.

The machine illustrated has an annular, cupped grinding wheel, which is mounted to rotate about a vertical axis. The wheel comprises three, removable, annular, coaxial grinding sections or portions, the radially outermost of which has a flat upper surface, and the remaining two of which have generally V-shaped grooves in their upper surfaces. The V-groove in the middle section of the wheel is symmetrical in cross-section, that is, its opposite sides are of equal inclination. The V-groove in the upper face of the radially innermost section of the wheel has two sides which are inclined at different angles to the axis of the wheel. This last-named section of the wheel effects the finishing operation and the removal of any burrs.

Mounted to pivot at their rear ends independently of one another about a common horizontal axis, and about a pair of spaced vertical axes, respectively, are two work supporting carriages, the forward ends of which overlie the upper face of the grinding wheel. Rotatably mounted in the forward end of each carriage is a work holder comprising two axially-spaced, coaxial spindles between which a lens blank is clamped by conventional means. Thus, a pair of blanks may be supported by the carriages in engagement simultaneously with one of the annular grinding sections of the grinding wheel at diametrically opposite sides thereof.

Electro-pneumatic control means is provided for controlling the cycle of the machine. The control mechanism may be programmed, so that during a cycle, the arms will move the two blanks into engagement successively with the radially outermost, the middle, and then the radially innermost of the annular grinding sections, after which the blanks are returned and swung away from the wheel for removal, and for chucking of new blanks.

During its engagement with the outer or flat grinding section of the wheel, each blank is indexed periodically through a small angle about its axis until the blank has been ground down to the desired size. After this size grinding operation the blanks are shifted into engagement with the V-groove in the middle grinding section, where each is again indexed periodically until its edge is ground all around its periphery to a bevel shape by the inclined sides of said middle grinding section. Thereafter each blank is shifted into engagement with the groove in the radially innermost grinding section where a safety bevel grinding operation takes place, to remove any burrs formed in the preceding operations. Then each blank is returned to starting position to permit its removal from the machine, and chucking of new blanks.

Referring now to the drawings by numerals of reference, the machine comprises a base 20 having horizontal upper surface or walls 22 and 23 (FIG. 2), vertically spaced slightly one above the other.

Mounted on the base is a vertically disposed sleeve or support 29, in which the grinding wheel spindle 35 is

journalled on spaced, anti-friction bearings 37 (only one of which is shown in FIG. 2). The support is formed with an intermediate, circumferential flange 31, which seats against the upper surface 22 of the base and is secured thereto by screws 32. Secured to the lower end of the spindle 35 is a pulley 39, which is connected by a belt 41 to a drive pulley 43. Pulley 43 is driven by the shaft 49 of an electric motor 45, which is secured to a horizontal plate 47 which is fastened on the wall 23 of the base by screws 50 and 51 (FIG. 1). The screw 51 passes through an arcuate slot 53 in the plate 47, so that upon loosening these screws, the plate 47 may be pivoted about screw 50 to increase or decrease tension on the belt 41.

Secured to the upper end of the spindle 35 is the grinding wheel W (FIGS. 1, 2 and 5). Wheel W comprises a conventional backing plate 55, and three annular emery rings, or operating sections 56, 57 and 58 (FIGS. 2 and 5). These rings are removably secured one within the other by screws 60, 61 and 62 (FIG. 5), respectively, on concentric annular lands formed on the upper face of plate 55. The outer ring 56 has a flat, horizontal grinding surface 65 for sizing, or flat grinding the edge of a lens blank. The center and radially innermost rings 57 and 58, respectively, have grooved grinding surfaces 66 and 67, respectively, which are generally V-shaped in cross section. The sides of V-shaped groove 66 are, in the instance shown, inclined an obtuse angle to one another; and the inclined sides of groove 67 are disposed, in the case shown, at approximately right angles to one another. The inclined surfaces defining the grooves 66 and 67 are conical surfaces coaxial with spindle 35.

The flat surface 65 on the outer section 56 is disposed at a controlled distance 68 below the bottom of groove 66 in section 57 to leave stock to be ground off the lenses in the grinding operation using section 66 of the wheel. The height of surface 65 above its seat on plate 55 can be adjusted by inserting shims of the required thickness between the bottom face of section 56 and the plate.

Secured in base 20 are two, parallel vertically disposed, spaced posts 73 (FIG. 1). Rotatably journaled at its rear end on each post 73 by spaced, anti-friction bearings 74 is an arm 81. A cap 78 is secured by screws 79 to each arm 81 and overlies the upper end of the associated post 73 to protect the adjacent bearing 74, and to limit downward movement of the arm on the post. From the posts 73 the two arms 81 extend first to the left and right, respectively, of base 20 as viewed in FIG. 1, and then forwardly over surface 22 of the base, adjacent and parallel to opposite sides thereof.

Mounted on the forward end of each arm 81 is a unit 86 which constitutes part of known means for controlling the size and shape of a lens blank. These units 86 are substantially identical in construction; and for this reason, and because the units form no part of the present invention, only one such unit, the left hand unit (FIG. 1) will be described in detail, and then only briefly.

The unit 86 comprises a bracket 91 (FIGS. 1, 2 and 3) which is secured by screws 92 to the forward end of its arm 81 at the outer side thereof. Bracket 91 projects beyond the forward end of the arm 81, and has a shaft 95 (FIG. 3) journaled in it on bearing 94 to rotate about a horizontal axis. A spur pinion 99 is secured to the inner end of shaft 95 to mesh with the teeth of a rack 101, which is reciprocable vertically in a guideway in the forward end of the bracket 91. Secured to the opposite end of shaft 95 is a spur gear 103, which meshes with a spur pinion 104 that is secured to a shaft 107 which is parallel to shaft 95. Shaft 107 is journaled in bearings in bracket 91, and in a guard cover 97, respectively. Another guard cover 96 encloses the opposite end of shaft 95 and the gearing 99, 101.

As its outer end, shaft 107 projects out of cover 97 and has secured thereon a dial 111, which is rotatable with shaft 107. Dial 111 has a reduced diameter hub

portion 112, which carries a radially outwardly projecting pin 113. Mounted on the outer end of the shaft 107 for limited axial sliding movement relative thereto is a knob 115, whose inner face is recessed to accommodate the hub 112. Mounted in a recess 118 in the outer face of knob 115, and secured by a cap 119 and screws 120 over the head 122 of shaft 107, is a spring-retaining plate 124. Interposed between the plate 124 and the bottom of recess 118 is a coiled spring 125, which urges the knob 115 against dial hub 112. A guide pin 126, fixed in the plate 124 engages slidably in a hole in knob 115. On its inner face the knob 115 has a plurality of radial notches which are angularly spaced about the axis of the shaft 107, and any one of which can be engaged selectively with pin 113 to prevent relative rotation between knob 115 and dial 111.

Secured to the upper end of rack 101 is a plate 130 (FIG. 2). Pivoted intermediate its ends on plate 130 by a pin 132, is a plate 135. Pivotal adjustment of plate 135 on plate 130 is effected by a screw 137, which threads through plate 130 and against the under side of plate 135, and is limited by screw 136 which passes through plate 130 and threads into plate 135.

Hinged on a pin 138 (FIG. 2) on plate 135 is a shoe or platform 141, which has a flat upper surface. Seated at opposite ends in registering recesses formed in the confronting faces of plate 135 and shoe 141 is a coiled spring 142, which urges shoe 141 away from plate 135. This pivotal movement is limited by a screw 143, which passes through an opening in plate 135, and threads into shoe 141. Adjustably threaded into platform 141 are two, spaced screws 144 (FIGS. 1 and 2), the lower ends of which register with the plungers of two normally-open limit switches 145-L and 146-L, which are secured to opposite sides of plate 135.

Mounted to swing on coaxial trunnions 151 (FIGS. 1 and 2) disposed in enlarged portion 152 at the rear of arms 81 are the two arms or work carriages 153. Each carriage is furcated at its rear end; and is journaled by its furcations 155 (FIG. 1) on the associated trunnion 152. Intermediate its ends each work carriage 153 is formed with an upwardly inclined portion 156. Secured to the underside of each arm 153 rearwardly of its inclined portion 156 is a hardened plate 154. When the arms 153 are disposed as illustrated in FIG. 2, each plate 154 rests upon the upper end of a vertically reciprocable piston rod 147 (FIGS. 1 and 2). Rods 147 are reciprocable in cylinders 149, which are fixed in wall 22 of the base.

Secured to and projecting downwardly from each arm 153 rearwardly of its inclined portion 156 is a pin 157. At its lower end each pin 157 is provided with a generally spherical head 159.

Secured at its lower end to the inclined portion 156 of each carriage 153, and projecting at its opposite end diagonally upwardly and rearwardly therefrom is a pin 161 (FIG. 2). Supported between the upper end of the two pins 161, and extending transversely between the carriages 153 is a biasing cylinder 166 (FIG. 1). Fixed in one end of this cylinder is a rod 162, which is gimbaled to the upper end of one of the pins 161. A piston rod 163, which projects slidably from the opposite end of cylinder 166, is gimbaled to the upper end of the other pin 161.

Mounted on the forward end of each carriage 153 is a work-holding and indexing unit 171. Since these units 171 are substantially identical in construction, only one such unit, the left-hand unit, will be described in detail below.

This unit 171 (FIG. 4) comprises a motor 175-L, which is secured by screws 176 on its carriage 153 rearwardly of a vertical portion 177 of the carriage. Motor 175-L has an output shaft 178 (FIG. 4), which projects into an elongate, hollow housing 180, which is mounted on the outer side of the carriage, and which comprises

two separable sections 181 and 182 that are secured to one another by screws 183. Screws 185 secure the housing 180 to the work carriage 153 with the lower end of the housing extending downwardly and forwardly, as illustrated in FIG. 2.

Secured to shaft 178 is a drive sprocket 187 (FIG. 4), which is connected by a chain or belt 188 to a sprocket 189 secured on a shaft 191 that is journaled in spaced, anti-friction bearings 192 in the lower end of the housing. Shaft 191 projects through opposite sides of the housing 180, and has removably secured to its outer or left end (FIG. 4) a template 195, which is adapted to engage the upper surface of the left shoe 141 (FIG. 1) and which corresponds in shape to the shape to be ground on a lens blank.

Removably secured to the opposite, or inner end of the shaft 191 is a clamping head or collar 197 (FIG. 4). Mounted in spaced, confronting, coaxial relation to the clamping head 197 is a cooperating clamping head 198. The lens blank LB (FIGS. 1 and 5) to be ground is clamped between heads 197 and 198. Head 198 is rotatably mounted on the outer end of a piston rod 199, which is secured to a piston 205 that reciprocates in a cylinder 201. The cylinder 201 is mounted in an arm 202, which is integral with and depends downwardly from the forward end of carriage 153 in spaced relation to housing 180.

Ports 206, 207 adjacent opposite ends, respectively, of cylinder 201, and ducts 208 and 209, respectively, in arm 202 supply hydraulic fluid to opposite ends, respectively, of the cylinder 201.

Rotatably journaled adjacent opposite ends thereof in the upstanding legs of a pair of spaced, right angular brackets 222 (FIG. 1), which are secured by screws 223 on the forward wall 22 beneath the arms 153, is a horizontal rocker shaft 225. Shaft 225 extends parallel to the shafts 151, and has keyed or otherwise secured thereto between the brackets 222 a pair of axially spaced cams 228. Each cam 228 comprises an arcuate plate, and has in its periphery a slot 232 which extends for approximately 180° about the axis of shaft 225. Each slot 232 has a central dwell portion connected by two oppositely disposed helical portions with two terminal, axially offset dwell portions, respectively, as shown in FIG. 1. When the carriages 153 are disposed as illustrated in FIG. 2, the heads 159 of pins 157 extend into the cam slots 232 to be shifted when the cams 228 are rotated by the shaft 225.

At one end thereof (the left end in FIG. 1) the shaft 225 has secured thereto an arm 236 (FIGS. 1 and 2), which is connected by a pin 237 to a rod 238. Rod 238 is, in turn, pivotally connected by a pin 239 with a cam 241 in radially offset relation to the axis of rotation of this cam. Cam 241 has in its periphery a notch 242 (FIG. 2), and is secured to the output shaft 243 of a motor 244. Motor 244 is secured to the rear face of a bracket 245 that is fixed by screws 246 on the base 20. The motor shaft 243 extends through a vertical plate 250, which is secured by screws 251 and spacers 252 (FIG. 1) to motor 244.

Secured to the outer face of the plate 250 at angularly spaced points about the axis of the shaft 243 are three micro switches 3LS, 4LS and 5LS, the actuating plungers of which carry roller followers 258, 259 and 260, respectively, which have rolling engagement with the periphery of the cam 241.

Secured on base 20 adjacent the rear ends of the arms 81 are two right annular brackets 265 (FIG. 1) to each of which is fastened a biasing cylinder 267. Projecting from each cylinder 267 is a piston rod 269 which is engageable with a resilient stop 273, that is secured to the outer face of the associated arm 81. The piston rods 269 are disposed so that when they are advanced, they engage the stops 273 to urge the arms 81 toward one another about the axes of posts 73 (FIG. 2). This movement may occur

when the work carriages are lowered about pins 151 to shift the lens blanks into engagement with the groove 66 of the wheel section 57.

From the structure so far described, it will be seen that each lens blank is clamped for grinding between two cooperating clamping members 197, 198 (FIG. 4) in one of the work-holding units 171. One of these two clamping members is secured to a spindle 191, which is positively driven intermittently by a motor, as below described, when the unit 171 is in its lowered, or operative position. This indexes the blank and brings successive parts of its periphery into engagement with wheel W, to grind the blank progressively around its periphery. Each spindle, moreover, is journaled on a carriage which is swung up and down about a horizontal trunnion 151 (FIG. 2). This is to move the lens blank in and out of operative engagement with the grinding wheel, as will be described further later. Each carriage is further swingable about a vertical post 73 by a cam 228 and follower 159 to shift each lens blank laterally into registry with different sections of the grinding wheel, and by the piston in cylinder 166 (FIG. 1) to control the inclination of the sides of the V ground around its blank edge by the groove 66 in the wheel W.

FIG. 6 is a schematic illustration of a pneumatic system for operating the air pressure actuated parts of the machine. The output of a compressor 280, which is driven by a motor 281, passes through a conventional regulator 282 to headers H1 and H2. Header H1 is connected through conventional solenoid-operated, spring-return, two way valves 285 and 286 with hydraulic fluid reservoirs 287 and 288, respectively. Reservoirs 287 and 288 are connected through throttle valves 289, 290 to the two cylinders 149 (FIGS. 1 and 2), respectively, to elevate the associated pistons and their rods 147 when the valves 285 and 286 are in the positions illustrated. Valves 285 and 286 are controlled by the solenoids A and B, respectively. The regulator 282 is adjustable manually to set the system pressure in the headers H1 and H2 as indicated by the gauge 289.

Header H2 is connected through regulators 291, and the two-way, solenoid-operated valves 293 with the biasing cylinders 267. Valves 293 are operated by the solenoids F and E, respectively. The regulators 291 are manually adjustable, and limit the pressure, which can be applied to the cylinders 267, and which is indicated by the gauges 295.

At one end thereof the cylinders 201 (FIGS. 4 and 6) are connected to header H2 through two-way valves 301, which are operated by solenoids G and H, respectively. The opposite end of each cylinder 201 is connected through a self-relieving regulator 304 with the header H2. The pressure in cylinders 201 is readable on the gauge 305.

Header H2 is also connected through a self-relieving adjustable regulator 307, and a two-way valve 308 with one end of the cylinder 166 (FIGS. 1 and 6). The opposite end of the cylinder is connected through a bleeder 310, a two-way valve 311 and a further self-relieving adjustable regulator 312 with the header H2. Air pressure on opposite sides of piston 164 is indicated by gauges 314 and 315, respectively. The valves 308 and 311 are operated by solenoids D and C, respectively. The bleeder 310 contains a check valve 316, through which air under pressure flows into one end of cylinder 166, and a throttle valve 317, which causes air to be bled slowly from this end of the cylinder 166.

FIGS. 7A and 7B illustrate schematically one way in which the machine may be wired electrically to accomplish its purpose. Connected to main lines L1 and L2, are a plurality of stepping switches A1, B1, C1, D1, E1 and F1, which are indexed in unison from their start or idle positions (shown) successively through ten different contacts and back to the START positions by a stepping relay MM (FIG. 7B). This relay MM is adapted to be energized by direct current supplied from a

rectifier 344 (FIG. 7B), which with a resistor 343 and filtering capacitor 345 is connected between lines L1 and L2.

In the idle or START positions of the stepping switches, valves 285 and 286 are in the positions shown in FIG. 6, so that the left and right hand work carriage units 171 are held elevated as shown in FIG. 2 by the pistons in cylinders 149 (FIGS. 1 and 2). As a result, the two cam follower heads 159 are elevated and lie between the edges of their associated cam slots 232 (FIG. 1). At this time arm 236 (FIG. 2) is in approximately its extreme clockwise position about the axis of shaft 225; and the notch 242 in the disc 241 registers with the roller follower 260. Therefore, the switch 5LS (FIGS. 2 and 7B) is open; and followers 159 register with the upper ends of the cam slots 232 as shown in FIG. 1, so that blanks supported in the units 171 will register with diametrically opposite sides of the flat grinding surface 65. The other switches shown in FIGS. 7A and 7B are in the positions illustrated.

At the start of a cycle switch 321 (FIG. 7A) is closed to energize the grinding wheel motor 45. When pushbutton PB-1 (FIG. 7A) is depressed, then, the ready light R is turned on, and the starting control relay CRS is energized through normally-closed pushbutton PB-2. Relay CRS closes the holding switch CRS-1 so that although pushbutton PB-1 be released light R and relay CRS remain energized until stop pushbutton PB-2 is depressed. The now-energized relay CRS also closes the switch CRS-2, thereby energizing compressor motor 281 to supply compressed air to the pneumatic system.

The two lens blanks that are to be edge ground are then centered between the clamping heads 197 and 198 (FIG. 4) of the left and right hand units 171; and the manually operable switches 324 and 325 are closed to energize the solenoids G and H, respectively. The valves 301 are thus shifted to supply compressed air to the cylinders 201 to advance the clamping heads 198 in each unit into clamping engagement with the associated lens blank.

The pushbutton PB-3 (FIG. 7B) is then pushed to energize momentarily the latching relay LR between the rectifier 344 and line L2. This moves each of the switches 340 and 341 which form part of relay LR, from its position P1 to its position P2, where it remains latched until the subsequent energization of the unlatching relay ULR as below described. Button PB-3 also energizes momentarily the stepping relay MM, which in turn advances each of the stepping switches A1 through F1 one step, or from its START position into engagement with the first of its ten contacts.

As a result of this, solenoid B is energized, the circuit being from line L1 through the first contact of switch F1, a time-delayed opening switch 327, a normally-closed relay switch 1CR-3 and a now-closed, manually operable switch SW5R-1 to line L2. Also at this time the solenoid A is energized from the first contact of switch F1 through a time-delayed opening switch 328, a normally-closed relay switch 1CR-4, and a now-closed, manually operable switch SW5L-1 to line L2. Valves 285 and 286 (FIG. 6) are thus shifted to exhaust compressed air from the reservoirs 287 and 288 whereby the units 171, and the carriages 153 upon which they are supported, are swung downwardly by gravity about the pins 151 to engage the edges of the lens blanks in the units 171 with the rotating, flat grinding surface 65 at diametrically opposite sides thereof. This also causes followers 159 to descend below the slots 232 in the cams 228, so that opposite sides of each slot now flank the associated pin 157 rather than the follower 159 thereon.

At this time each template 195 (FIGS. 2 and 4) is held by the corresponding lens blank slightly above the shoe or platform 141 of the associated left or right hand sizing unit 86. However, as surface 65 of the grinding wheel grinds away the edges of the two lens blanks, the

associated templates 195 descend toward their associated platforms 141.

When the desired amount of stock has been removed from the portion of each blank then in contact with the grinding wheel, the associated platforms 141 are forced into engagement with the plungers of the limit switches 145-L and 145-R (FIGS. 1 and 7A), thereby energizing right and left hand timers RHT and LHT (FIG. 7A) from the first contacts of the stepping switches A1 and F1, respectively. The now-energized timers RHT and LHT close switches 331 and 330 (FIG. 7B), respectively, which in turn energize the right and left hand spindle motors 175-R and 175-L, respectively. This rotates the shaft 191 in each unit 171 far enough to index a new, unground portion of the edge of each lens blank into contact with the rotating grinder surface 65, thereby in turn causing the associated templates 195 to be elevated upwardly out of engagement with the corresponding plates 141, with the result that the limit switches 145-R and 145-L are once again allowed to open and deenergize the timers RHT and LHT.

The interval during which the timers are energized is not sufficient to permit the timer-responsive switches 327 and 328 (FIG. 7A) to open, or to permit the time-delayed closing switches 333 and 334 (FIG. 7B), which also are responsive to the timers LHT and RHT, respectively, to close.

When the right and left hand timers are deenergized, the associated switches 330 and 331 once again open to deenergize the spindle motors 175-L and 175-R until portions of the lens blanks newly indexed into contact with the grinding surface 65 are ground down to the desired size. When the associated templates 195 once again engage the plate 141, the lens blanks are once again indexed as above described; and alternate grinding and indexing continue until both blanks have been edge ground around their peripheries to a size or configuration equivalent to the associated templates 195. When the templates 195 descend into contact with the plates 141 for the last time—i.e., there remains no undesirable material on the blanks which must be ground therefrom by the surface 65—the spindle motors 175-R and 175-L will be able to rotate long enough to revolve each blank and its associated template 195 for at least one full revolution or more (depending on the timer settings) without interrupting the operation of the timers RHT and LHT as by the opening of either of the limit switches 145-R and 145-L. Once the timers are allowed to remain energized for at least one full revolution or more of the templates 195, the associated switches 327 and 328 finally open, and the switches 333 and 334 finally close.

The now-open switches 327 and 328 deenergize the solenoids B and A so that the spring-return valves 285 and 286 return to the positions of FIG. 6 in which they effect the raising of the carriages 153. This movement raises the lens blanks clear of the wheel W so that they can be moved radially of the wheel.

Also at this time the closing of the switches 333 and 334 (FIG. 7B) causes the stepping relay MM to be energized from line L2, relay MM, the first contact of the stepping switch D1, through the now-closed timer switches 334 and 333, manually operable switch SW2, which is in its ON position, and the first contact of the stepping switch C1 to the rectifier 344. This causes all of the stepping switches to be indexed into engagement with their second contacts.

When the templates 195 are elevated out of contact with plates 141 the switches 145-R and 145-L deenergize the timers so that the switches 327, 328, 330, 331, 333 and 334 return to the positions illustrated in FIGS. 7A and 7B.

If it were desired to skip the sizing operation, the operator would place switch SW2 (FIG. 7B) in its CAN-CEL position prior to pushing button PB-3. As a result, the stepping relay MM would have been energized a second time through switch SW2 immediately upon the movement of switch C1 into engagement with its first

contact, thereby eliminating the grinding operation on the flat surface 65.

Mounted on arms 81 are two normally-open limit switches 400-L and 400-R (FIGS. 1 and 7B), which are open when the carriages 153 (FIGS. 1 and 2) are in their lowered positions, and which are held closed by these carriages when the latter are in their elevated positions. Arms 81 also carry two normally-closed limit switches 401-L and 401-R (FIGS. 1 and 7B) which are held open by the carriages 153, when the latter are down in their lowermost positions, and which close when these carriages are moved to their upper positions.

After the stepping switches have been advanced to their second contacts, as above described, the carriages 153 and units 171 are swung to their uppermost positions by cylinder rods 147. The carriages 153 thereby allow the limit switches 401-L and 401-R to close, and close switches 400-L and 400-R, thereby once again energizing the stepping relay MM from rectifier 344 through the second contact of the stepping switch C1, the now-closed switches 400-L and 400-R, and the stepping relay MM to the line L2.

As soon as the stepping switch E1 engages its third contact, the traversing motor 244 (FIGS. 1, 2 and 7B) is energized, the circuit being from line L1 through the third contact of the stepping switch E1, lines 336 and 337, and the motor 244 to the line L2. This causes cam 241 to be rotated clockwise in FIG. 2, thus closing switch 5LS, which has no immediate effect on the circuit since switch 341 is latched in its position P2. The cam 241 rotates until the notch 242 registers with the follower 258, thereby permitting the limit switch 3LS to close and index all the stepping switches to their fourth contacts by energizing the stepping relay MM from the rectifier 344 through the third contact of the stepping switch C1, the now-closed limit switch 3LS and the stepping relay MM to the line L2. Assuming that the manually operable switch SW3 is in its ON, rather than CANCEL position, this partial revolution of the cam 241 is sufficient to cause the connecting rod 238 to pivot arm 236 until the center portions of the slots 232 engage the elevated cam followers 159 as illustrated in FIG. 2. This causes the carriages 153 to be swung inwardly toward one another about the axes of the posts 73 (FIG. 2) until the lens blanks are positioned above and register with the diametrically opposite sides of the bevel edge grinding surface 66 on the wheel W.

As soon as the stepping switch E1 is thus moved from its third to its fourth contact, it interrupts the circuit to the motor 244 so that the latter stops; and it energizes the solenoids F and E through the now-closed switches 401-L and 401-R, thereby shifting the valves 293 so that compressed air at a moderate pressure is admitted to the cylinders 267. As stepping switch F1 is advanced into engagement with its fourth contact, it reenergizes the solenoids B and A (FIGS. 6 and 7A) through the switches 327, 1CR-3, SW5R-1, and 328, 1CR-4, SW5L-1, respectively. As a result, the lens blanks are lowered into engagement with the grinding surface 66 as shown in FIG. 5.

When they first engage the surface 66, the edges of the lens blanks are flat, so that the blanks support their associated templates above the contact plates 141. Also at this time the carriages 153 have not lowered far enough to permit the reopening of the switches 401-L and 401-R (FIG. 7B). As a result the solenoids E and F remain energized; and the piston rods 269 (FIG. 1) are advanced to engage the stops 273, thereby to urge the carriages 153 toward one another about the axes of the posts 73 to the extent permitted by the cam slots 232. The inner faces of the lens blanks are thus urged by the pressure in cylinders 267 against the radially inner face of the groove 66. This causes the radially inner (relative to the wheel W) sides of the blanks to be ground at greater or steeper angles to the horizontal than the radially outer sides. When

the desired quantity of material has been ground from the portion of each blank then engaged with the wheel W, the associated template 195 engages its associated platform 141, thereby to close the switch 145-L or 145-R and cause a new portion of the blank to be indexed into contact with the wheel W in a manner similar to that above-described with respect to the flat grinding operation.

When the bevel edge grinding of the blanks is completed, the right and left hand timers RHT and LHT will again time out, thereby opening switches 327 and 328 (FIG. 7A), and closing switches 333 and 334. This indexes the stepping switches to their fifth contacts by energizing momentarily the stepping relay MM (FIG. 7B) from Line L2 through the MM the fourth contact of the stepping switch D1, the now-closed switches 334, 333 and SW3, and the fourth contact of stepping switch C1 to the rectifier. At the same time the now-open switches 327 and 328 deenergize the solenoids B and A so that the carriages 171 are elevated, thus deenergizing the right and left hand timers RHT and LHT so that the switches 327, 328, 333 and 334 return to the positions illustrated in the drawings.

When the heads 171 reach their uppermost positions, they once again close the switches 400-L and 400-R, so that the stepping relay MM is once again energized through the fifth contact of the switch C1, thereby to index the stepping switches into engagement with their six contacts.

When switch E1 engages its sixth contact, it energizes the traverse motor 244 (FIG. 1) through the lines 336 and 337 (FIG. 7B). This causes the carriages 171 to be swung about posts 73 to shift the lens blanks into registry with the surfaces 67 of the grinding wheel. It also causes the cam 241 (FIG. 2) to be rotated until the notch 242 in the cam registers with the follower 259 on limit switch 4LS. This permits switch 4LS to close, thereby energizing momentarily the stepping relay MM through the sixth contact of the stepping switch C1 and the now-closed switch 4LS, so that the stepping switches are indexed into engagement with their seventh contacts.

At this point the traverse motor 244 is deenergized by the movement of the switch E1 from its sixth to its seventh contact, whereby the lens blanks are halted above and in registry with diametrically opposite sides, respectively, of the safety bevel edge grinding surface 67.

Assuming that the switch SW-4 is on its ON rather than CANCEL position, the next indexing of the stepping switches will occur only after the subsequent closing of the timer responsive switch 333, rather than instantly upon the movement of switch C1 into contact with its seventh contact, as would be the case where switch SW4 is in its CANCEL position.

When switch F1 is moved into engagement with its seventh contact, it energizes the relay 1CR, thereby opening switches 1CR-3 and 1CR-4, and closing the normally-open switches 1CR-2 and 1CR-1. The latter two switches energize the solenoids B and A, respectively, to lower the blanks into engagement with the grinding surface 67 at diametrically opposite sides thereof. Since there is little excess material left on the blanks, their associated templates 195 almost immediately engage the platforms 141 to close the limit switch 146-L or 146-R. These switches, which are less sensitive than the switches 145-L and 145-R, now energize the motors 175-L and 175-R, respectively, from the seventh contact of switch B1, through lines 338 and 339 (FIG. 7B), respectively. Although switches 145-L and 145-R are also closed at this time, they have no effect on the circuit.

As switch E1 moves from its sixth to its seventh contact, it energizes the solenoid C through a normally-closed, time-delayed opening switch 1TD, thereby shifting valve 311 (FIG. 6) so that compressed air is applied to the biasing cylinder 166. This causes piston rod 163 to spread the carriages 153 apart, and urges the outer sur-

faces of the now rotating lens blanks against the inclined, outer face or surface of the generally V-shaped grinding surface 67, thereby to remove any burrs or sharp edges which may have formed on the outer face of each blank during the bevel grinding thereof on the surface 66.

The stepping of switch A1 into engagement with its seventh contact energizes a normally-open, time-delayed closing switch 2TD. After grinding of the safety bevel on the blanks has commenced, this switch 2TD closes to energize the timer LHT. This interval of time, plus the time it takes for the left hand timer LHT to close the switch 333 is sufficient to assure that the safety bevel will be properly ground on the outer faces of the blanks.

After the now-energized timer LHT has timed out, the switch 333 closes, to index the stepping switches into engagement with their eighth contacts by energizing momentarily the stepping relay MM from line L2, the stepping relay MM, the seventh contact of switch D1, the now-closed switches 333 and SW4, and the seventh contact of switch C1 to rectifier 344. At this time the relay 1CR (FIG. 7A) remains energized through the eighth contact of the switch F1, thereby maintaining the heads 171 in their lowered positions; and the switch E1 deenergizes solenoid C and energizes solenoid D through its eighth contact. Solenoid D shifts the valve 308 (FIG. 6) so that compressed air is now applied to the cylinder 166 to retract its piston rod 163, thereby drawing the carriages 153 toward one another so that the inside faces of the blanks are urged against the radially innermost of the inclined surfaces defined in the V-shaped grinding surface 67.

Also, at this time switch A1, upon movement from its seventh to its eighth contact, deenergizes timer LHT and energizes the right hand timer RHT. The lens blanks, which have remained in their lowered positions, thus maintaining the switches 146-L and 146-R (FIGS. 1 and 7B) closed, continue to be rotated by the motors 175-L and 175-R until the timer RHT times out. This period of time is sufficient to complete the grinding of the safety bevel on the inner face of each blank by the grinding surface 67. When the timer RHT times out, it closes switch 334, thereby indexing the stepping switches into engagement with their ninth contacts by energizing momentarily the stepping relay MM from line L2, through the stepping relay, the eighth contact of switch D1, the now-closed switches 334 and SW4, and the eighth contact of stepping switch C1 to the rectifier.

As the switches A1 and F1 move into engagement with their ninth contacts, the right hand timer RHT and the relay 1CR, respectively, are deenergized. This opens the switches 1CR-2 and 1CR-1, thereby deenergizing the solenoids B and A so that the carriages 171 are elevated.

Switch E1 upon movement to its ninth contact deenergizes the solenoid D, thus removing the pressure from the cylinder 166. When the carriages 171 reach their uppermost positions, they again close the limit switches 400-L and 400-R, thereby indexing the stepping switches into engagement with their tenth contacts by energizing momentarily the stepping relay MM from line L2, through the stepping relay, the now-closed switches 400-L and 400-R, and the ninth contact of switch C1 to the rectifier.

As switch E1 engages its tenth contact, it energizes the unlatching relay ULR so that the switches 340 and 341 return to the positions illustrated in FIG. 7B. This energizes the traverse motor 244 from line L1 through switch 341, the now-closed switch 5LS and line 337, thus rotating the cam 241 (FIG. 2) until its notch 242 once again registers with the follower 260, thereby permitting switch 5LS to open and stop the traverse motor 244. During this movement of the motor 244 the elevated heads 171 are traversed outwardly away from one another by the cam slots 232 until the now completely edge-ground lens blanks once again are disposed above, and register with, diametrically opposite sides, respectively, of the flat grinding surface 65.

As the switch C1 is moved into engagement with its tenth contact, it once again momentarily energizes the stepping relay MM through the still-closed switches 400-L and 400-R, so that by the time the carriages 171 have returned to their starting positions, all of the stepping switches will have been indexed back to their START positions.

The cycle is now complete; the switches 324 and 325 may be opened to permit removal of the ground blanks; and a new pair of blanks may be substituted therefor.

If it is desired to cancel the cycle at any time after it is started, this may be done by pushing button PB-4, which, through the switch 340, then in its position P2, causes the stepping switches A1 through F1 to be returned by conventional means (not illustrated) to their START positions.

If it is desired to skip or cancel the bevel grinding and/or safety bevel grinding operations, the manually operable switches SW-3 and/or SW-4 is moved from its ON to its CANCEL position. Moreover, either or both of the pushbuttons 5PB-1 and 5PB-2 may be pushed to energize either or both of the spindle motors 175-L and 175-R independently of the limit switches 145-L, 145-R, 146-L and 146-R.

To skip the flat or size grinding operation of the blank held in either (or both) of the heads 171, the operator may open the manually operable double pole, double through switch SW5R-1 and/or SW5L-1. This prevents energization of the associated solenoids B or A, respectively, upon the movement of the stepping switches into engagement with their first contacts. Upon being opened, each of these switches simultaneously closes its associated switch SW5R-2 or SW5L-2. These latter two switches are connected in series with the right and left hand timers RHT and LHT, respectively, so that whenever the stepping switches A1 and F1 are in engagement with either their first or fourth contacts, and one or the other of the last-named switches (or both) is closed, both of the timer switches 333 and 334 must be closed before the stepping switches can be indexed into engagement with their next successive contacts. This assures that the stepping switches will be indexed in unison, despite the fact that the grinding operation on one or the other (or both) of the lens blanks may have been cancelled.

Associated with the timers RHT and LHT are two further normally open, time-delayed closing switches TDC-R and TDC-L (FIG. 7A), respectively. These are holding switches, which close simultaneously with the opening of the switches 327 and 328 upon the counting out of the timers RHT and LHT, respectively. For example, if when the stepping switches are engaged with their first or fourth contacts for flat or bevel edge grinding operations, respectively, one of the counters RHT or LHT should count out in advance of the other, thereby closing its associated indexing switch 333 or 334, the associated holding switch TDC-R or TDC-L will also close to maintain the associated timer energized from either the first or fourth contact of switch F1, through line 380, the holding switch, and the respective timer to line L2. Thus, when one, but not both, of the timers has counted out and has opened its associated switch 327 or 328 to effect the raising of its corresponding unit 171, and the consequent opening of the template operated switch 145-R or 145-L, the timer nevertheless remains energized to hold closed its associated indexing switch 333 or 334 until the other of the two last-named switches closes upon the counting out of the other timer. The result is that during the flat or bevel grinding of two blanks, the stepping switches cannot be indexed until the flat or bevel grinding operations of both blanks are complete.

During the safety bevel grinding operation, the simultaneous elevation and lowering of both units is effected by the single relay 1CR, and the grinding times for the inner and outer faces, respectively, of a pair of blanks, as determined by the left and right hand timers LHT and

RHT, respectively, are identical, so that during this operation the grinding of one blank cannot possibly be completed before the other.

From the foregoing it will be apparent that the apparatus disclosed herein provides a novel and expeditious means for simultaneously edge grinding a pair of lens blanks. The apparatus has the obvious advantage that two lens blanks may be edge ground during the period of time heretofore require for the edge grinding of a single blank. Moreover, since the apparatus is substantially completely automatic, there is little opportunity for the introduction of operator error during the grinding of the blanks. The apparatus is extremely versatile, since the adjustable pneumatic and electrical systems permit various types of edges to be ground on lens blanks. The platforms 141, for example, may be adjusted vertically by rotation of the knobs 115, thereby to increase or decrease, respectively, the quantity of material that is to be removed for a pair of blanks during the flat grinding thereof; and the pressure regulators that form part of the pneumatic system may be adjusted to control the shape of the bevel and safety bevel edges that are to be ground on the blanks. In addition to being replaceable, each of the annular grinding rings or sections 56, 57 and 58 has cylindrical inside and outside surfaces, which are disposed coaxially of the axis of rotation of wheel W, and between which the active grinding surfaces 65, 66 and 67, respectively, of the rings are formed at one end thereof. In the case of the V-shaped surfaces 66 and 67, this is particularly advantageous, since they may be dressed repeatedly without altering the coaxial relationship of these grooves relative to the axis of wheel W. Moreover, the sides of the bevel edging groove 66 are ground so as to be symmetrical in cross section, or of equal inclination to the vertical, as illustrated in FIGS. 2 and 5, while the sides of the groove 67 are inclined at different angles to the vertical, and hence to the axis of wheel W.

While the invention has been described in connection with a specific embodiment 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 rotatable abrading wheel mounted on said base having an annular grinding section which has inner and outer cylindrical surfaces disposed coaxially of said wheel, and an end surface connecting said inner and outer surfaces and containing the active grinding surface of said wheel,
 - means for rotating said wheel, and
 - rotatable work supports on said base for supporting a pair of lens blanks for engagement simultaneously with said active grinding surface at angularly spaced points thereabout and at opposite sides, respectively of a plane containing the axis of said wheel and perpendicular to the axis of said work supports.
2. An edge grinding machine as defined in claim 1, wherein said wheel comprises
 - a plurality of said annular grinding sections mounted in coaxial relation, and
 - the end surfaces of the respective sections have, respectively, different configurations, and
 - means is provided for moving said work supports to shift the blanks supported thereby from engagement with one to another of said grinding sections.

3. An edge grinding machine as defined in claim 2, including

means for periodically indexing each work support a partial revolution about its axis, to bring successive parts of said blanks successively into engagement with a grinding section, and

means operative, after said blanks have been indexed a predetermined number of times, to actuate said moving means to disengage the blanks from the grinding wheel and shift said blanks out of engagement with one grinding section and to bring said blanks back into engagement with said wheel in engagement with the next adjacent grinding section.

4. An edge grinding machine as defined in claim 2, wherein

one of said grinding sections has a generally V-shaped groove in its end surface, and having

means operative on each work support during engagement of the blank carried thereby with said groove to urge the blank first against one side and then against the other side of said groove.

5. An edge grinding machine as defined in claim 1, including

a pair of arms mounted on said base for pivotal movement about an axis transverse to the axis of said wheel, and for pivotal movement about a pair of axes parallel to said wheel axis, and

means rotatably mounting said work supports on said arms.

6. An edge grinding machine as defined in claim 2 including control means for said moving means operative to effect movement of said work supports in a cycle away from a starting position, in which the blanks are spaced from said wheel, to bring the blanks successively into engagement with said grinding sections successively commencing with the radially outermost section and ending with the radially innermost section and then returning the work supports to starting position,

a pair of arms mounted on said base for pivotal movement about an axis transverse to the axis of said wheel and for pivotal movement about a pair of axes parallel to said wheel axis,

means rotatably mounting said work supports on said arms, and

means for periodically indexing each work support about its axis when the blank carried thereby is in operative relation with a section of said wheel.

7. An edge grinding machine as defined in claim 6, wherein said moving means comprises

(a) means for selectively pivoting said arms independently of one another about the first-named axis between operative and inoperative positions, respectively, and

(b) means operable, when the arms are in said inoperative positions, to pivot each arm about one of said pair of axes to move the blank carried thereby from registry with one to another of said grinding sections.

8. An edge grinding machine as defined in claim 2, wherein

one of said grinding sections has a flat end surface in a plane perpendicular to the axis of rotation of said wheel,

the end surfaces of two other of said grinding sections have V-shaped grooves therein, and

the V-shaped groove in one of said two other sections has sides of equal inclination, and the other V-shaped groove has sides of different inclination.

9. An edge grinding machine as defined in claim 8, including means interposed between said base and said work supports and operable, when the blanks carried by said supports are engaged with the first-named of said V-shaped grooves, selectively to urge said supports in opposite directions, thereby to cause greater pressure to be exerted by one than the other of the inclined sides

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of said first-named V-shaped groove against the confronting sides of said blanks.

10. An edge grinding machine as defined in claim 8, having means connected to said work supports and operable, when the blanks carried by said work supports are engaged with the second-named of said V-shaped grooves, successively to urge said work supports toward and away from one another, selectively, thereby to cause greater pressure to be exerted first by one and then by the other of the inclined sides of said second-named V-shaped groove against the confronting sides of said blanks.

11. An edge grinding machine for lenses comprising a base, a rotatable abrading wheel mounted on said base and comprising a plurality of annular grinding sections mounted in coaxial relation, each section having inner and outer surfaces, disposed coaxially of said wheel, and an end surface connecting said inner and outer surfaces and containing the active grinding surface of said wheel, the end surfaces of the respective sections having different configurations, means for rotating said wheel, rotatable work supports for supporting a pair of lens blanks for engagement simultaneously with the active grinding surface of a section at angularly spaced points thereabout, a pair of arms mounted on said base for pivotal movement about an axis transverse to the axis of said wheel, and for pivotal movement about a pair of axes parallel to said wheel axis, means rotatably mounting said work supports in said arms, means for periodically indexing each work support about its axis when a blank is in operative relation with a section of said wheel, means for selectively pivoting said arms independently of one another about said transverse axis to move said work supports between operative and inoperative positions, respectively, and means operable, when said arms are in inoperative position to pivot each arm about one of said pair of axes to move the blank carried by the respective arm from engagement with one to another of said grinding sections, including control means for said moving means operative to effect movement of said arms in a cycle away from a starting position, in which the blanks are spaced from said wheel, to successive positions, in which the blanks successively engage said grinding sections commencing selectively with one of the radially outermost and the radially innermost thereof, respectively, and then return to said starting position again, the first-named pivoting means comprising a pair of reciprocable members on said base, each of said members being connected to one of said arms to move the latter from its operative to its inoperative position upon movement of said member in one direction, and means responsive to a predetermined number of revolutions of said work supports on said arms to move said members in said one direction.

12. An edge grinding machine as defined in claim 11, wherein the second-named pivoting means comprises

- (a) movable cam means mounted on said base,
- (b) means operatively connecting said arms to said cam means, when said arms are in said inoperative positions, and operatively disconnecting said arms from said cam means, when said arms are in said operative positions, and
- (c) means for moving said cam means in opposite directions, when said arms are in said inoperative positions,
- (d) said cam means being operative upon movement

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thereof in one direction to swing said arms toward one another about said pair of axes, and being operative upon the movement thereof in the opposite direction to swing said arms away from one another.

13. An edge grinding machine as defined in claim 12, wherein

- (a) there are three of said grinding sections on said wheel, the radially outermost of which has a flat end surface disposed in a plane transverse to the axis of rotation of said wheel, and the remaining two of which each has in its end surface an annular groove which is generally V-shaped in cross section, and
- (b) said cam moving means includes means responsive to said control means to effect intermittent movement of said cam means in said one direction, during movement of said work supports away from said starting position, and continuous movement in the opposite direction during the return of said supports to said starting position.

14. An edge grinding machine as defined in claim 13, wherein

- (a) said pair of members are mounted on said base beneath said arms to reciprocate between first positions, in which they support said arms in said inoperative positions, and second positions, in which they permit said arms to move by gravity to said operative positions, and
- (b) means normally urges said members to their first positions, and is operable between the intermittent movements of said cam means for selectively reciprocating said members from their first positions to their second positions and back to their first positions.

15. An edge grinding machine as defined in claim 14, wherein said control means comprises

- (a) means connected to the last-named reciprocating means and operable, when said work supports are in said starting position, for selectively effecting the movement of said members from their first to their second positions, and
- (b) means operative, each time one of said members is moved to its second position, to cause said member to dwell in its second position.

16. An edge grinding machine for lenses comprising a base,

a grinding wheel mounted for rotation on said base and comprising three separate annular grinding sections, one section having a flat active end surface lying in a plane transverse to the axis of said wheel, and the remaining two sections having annular grooves in their end surfaces that are generally V-shaped in cross section,

one of said V-shaped grooves being symmetrical in cross section, and the other being asymmetrical, means for adjusting said one section of said wheel axially of said wheel independently of the two other sections,

means for rotating said wheel about its axis,

a first member movably mounted on said base,

means for removably mounting a lens blank on said first member for rotation about a second axis transverse to the axis of said wheel,

means for intermittently moving said first member to engage a blank, which is mounted thereon, successively with said sections, commencing selectively with one of the radially outermost and radially innermost, respectively, of said sections,

indexing means operative, when the blank is in operative relation with a section, to effect intermittent rotation of the blank about said second axis,

means interposed between said base and said first member and operative, when a blank is engaged with said symmetrical groove to urge said first member in a direction to press the blank with greater force against one side of said groove than against the other side thereof, and

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means interposed between said base and said first member and operative, when a blank is engaged with said asymmetrical groove to urge said first member successively in opposite directions to press the blank with greater force first against one and then against the other side of said groove.

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