United States Patent [19]

Cottom

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[54] CONTACT LENS EDGE FINISHING MACHINE

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[52] **U.S. Cl.** .....**51/5,** 51/217 L, 51/284

[51] **Int. Cl.** **B24b 13/00**

[58] **Field of Search**..51/5, 101 LG, 105 LG, 216 LP, 51/217 L, 284

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Primary Examiner—Donald G. Kelly
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[57] **ABSTRACT**

A portable machine used to accomplish the final operations in the sequence of fabricating a contact lens. The machine includes a pair of rotating inwardly directed spindles, each having a rubber tip and can be bindingly brought together to firmly support the rotating contact lens while the final operations are effected. A feature of the machine is the lens centering device which accurately positions the geometrical center of the lens in coincident alignment with the rotating axes of the spindles. The machine also includes a movable guidably supported cutting tool for concentrically reducing the diameter and the thickness of the lens at the periphery thereof, a movable guidably supported rotating polishing wheel for blending the newly cut surfaces with the previously ground optic surfaces and polishing the periphery of the lens, a unique mechanical oscillator which cyclically shifts the rotating axis of the polishing wheel so as to automatically and uniformly polish all the newly cut surfaces, i.e., the terminal edge, the convex surface and the concave surface of the lens, and a workpiece enlarger which presents a visual blow-up of: the lens, the cutting tool, and the polishing wheel to the operator.

1 Claim, 12 Drawing Figures

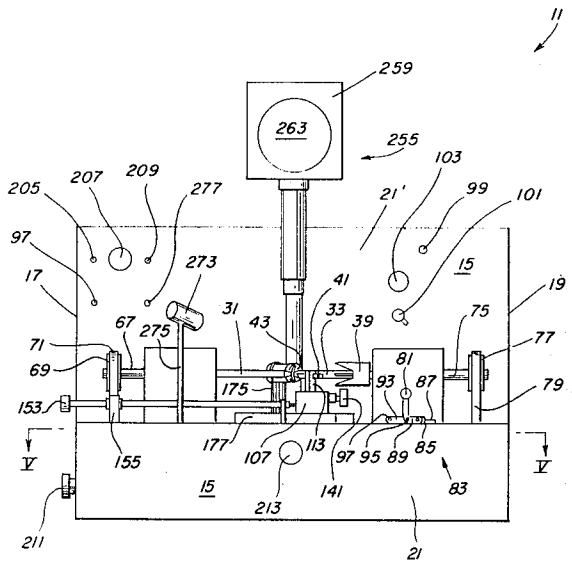


FIG. 2

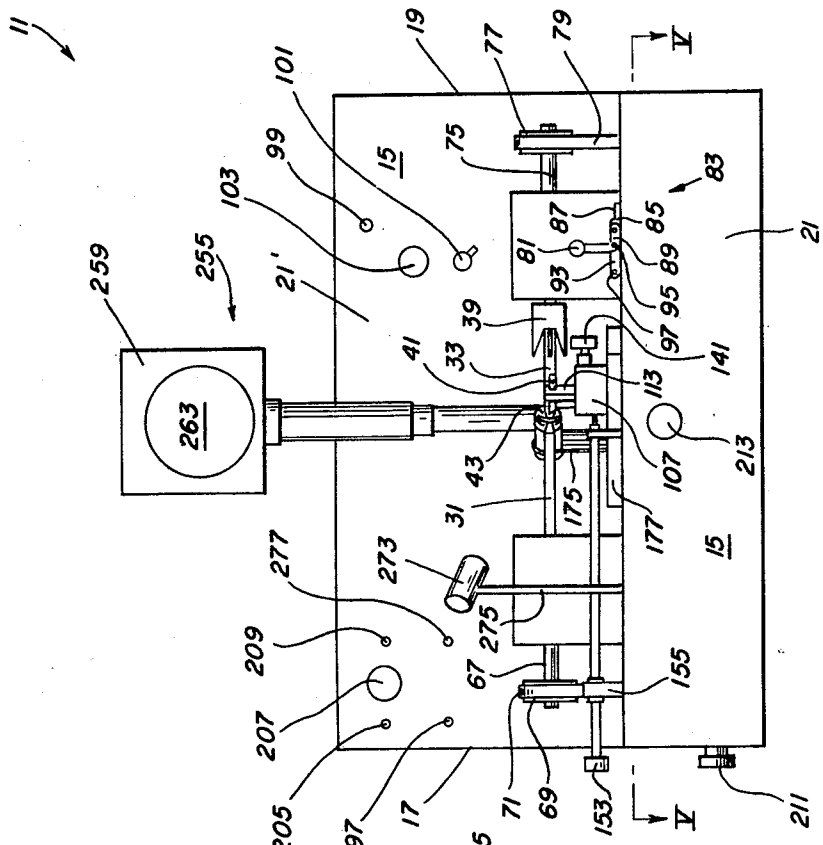
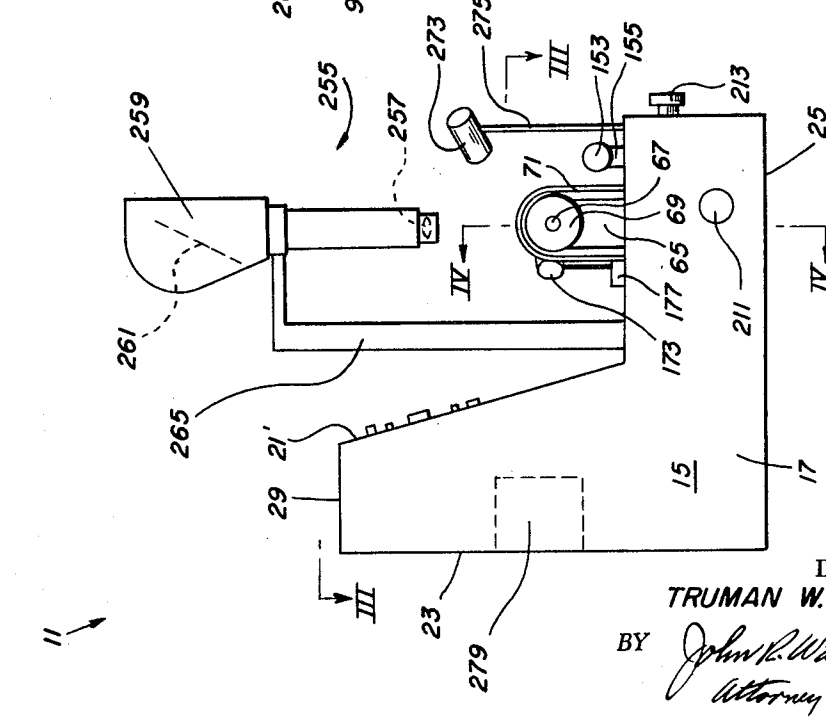


FIG. 1



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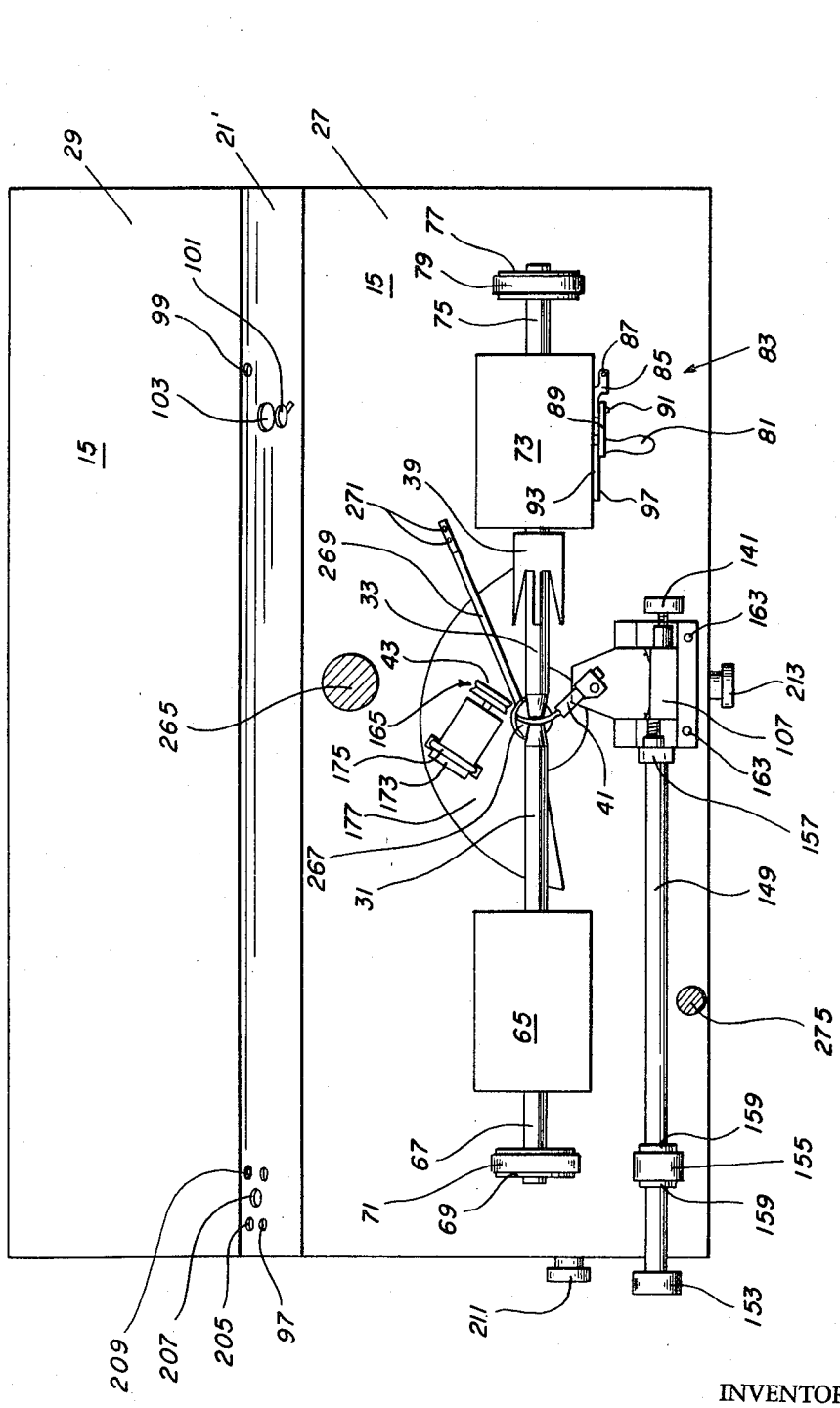


FIG. 3

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FIG. 4

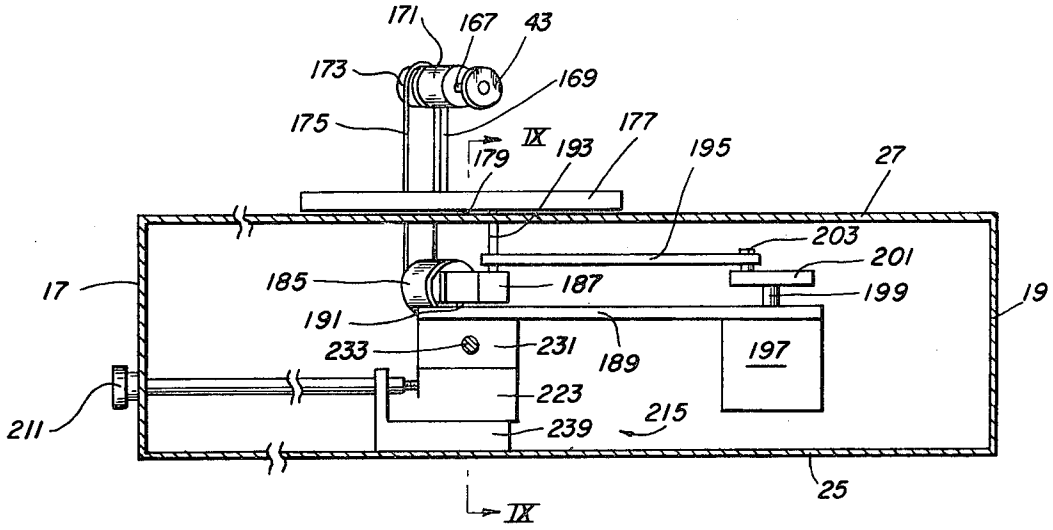
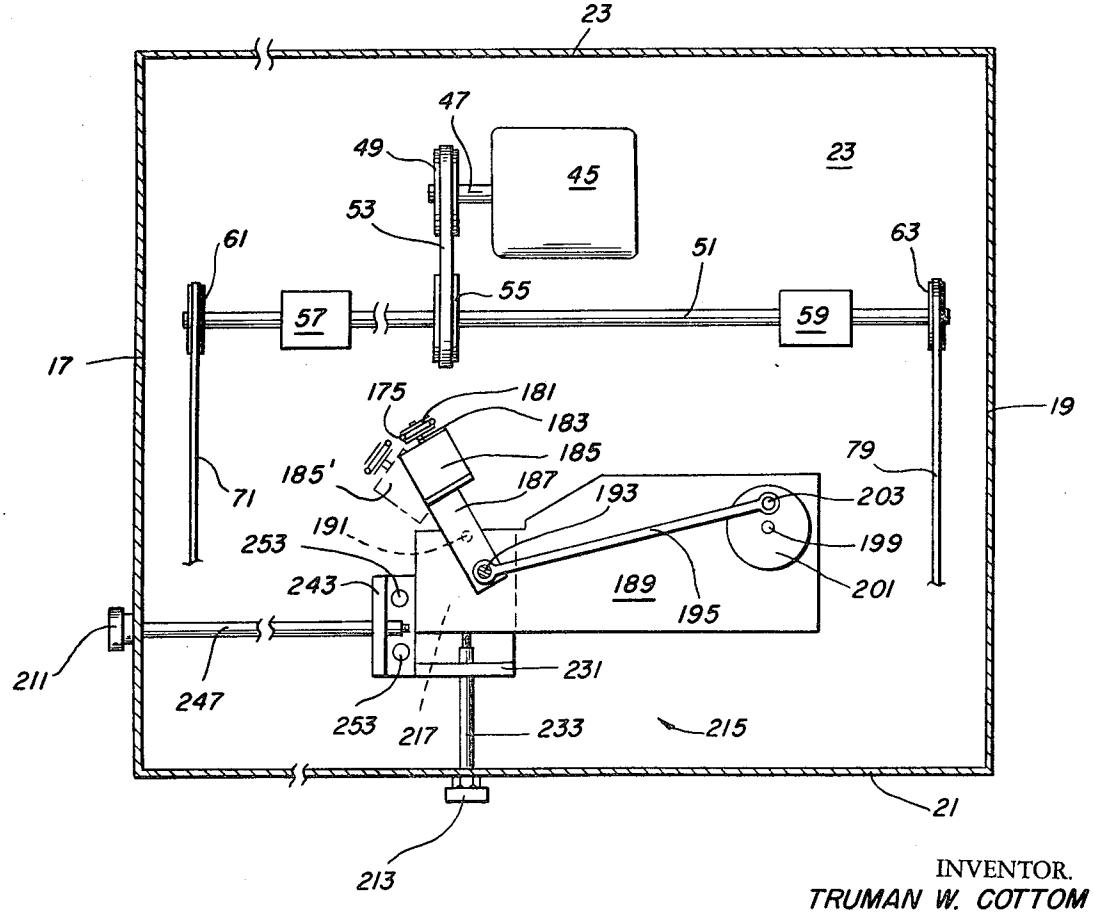


FIG. 5



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FIG. 6

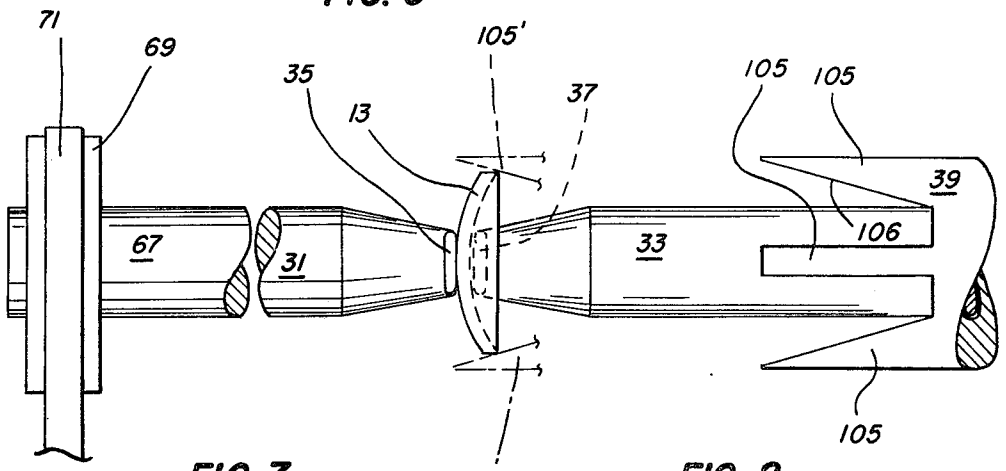


FIG. 7

FIG. 8

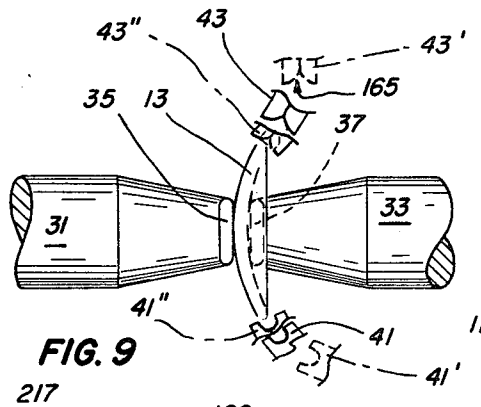
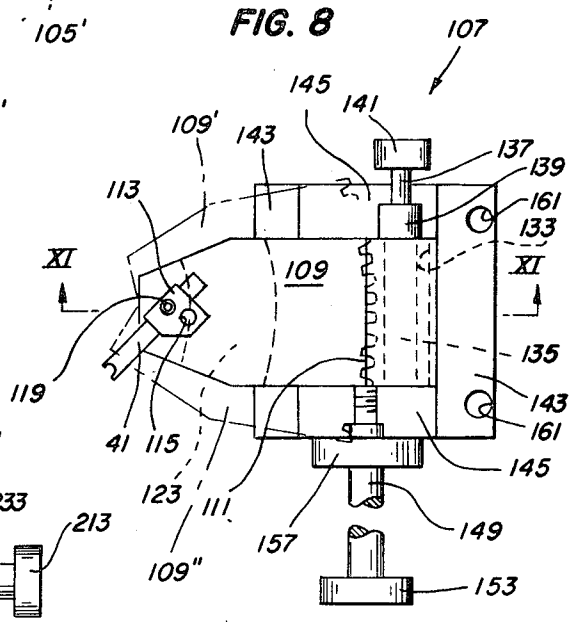


FIG. 9



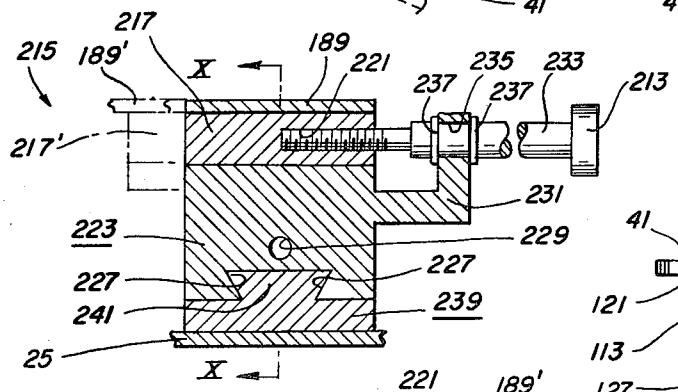


FIG. 10

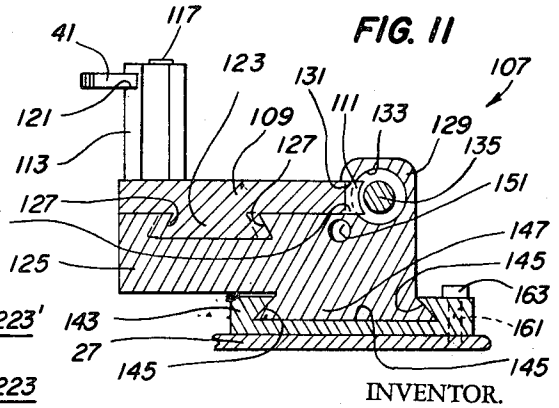
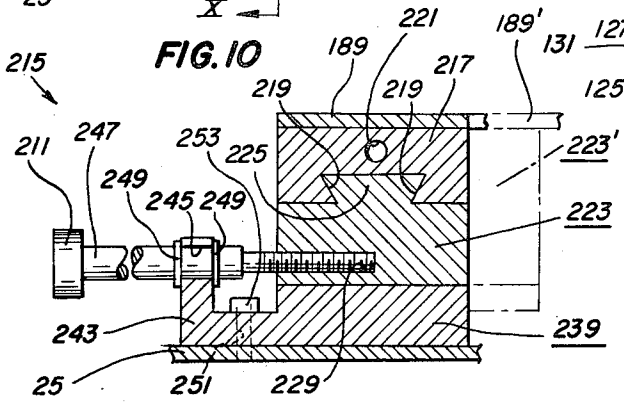


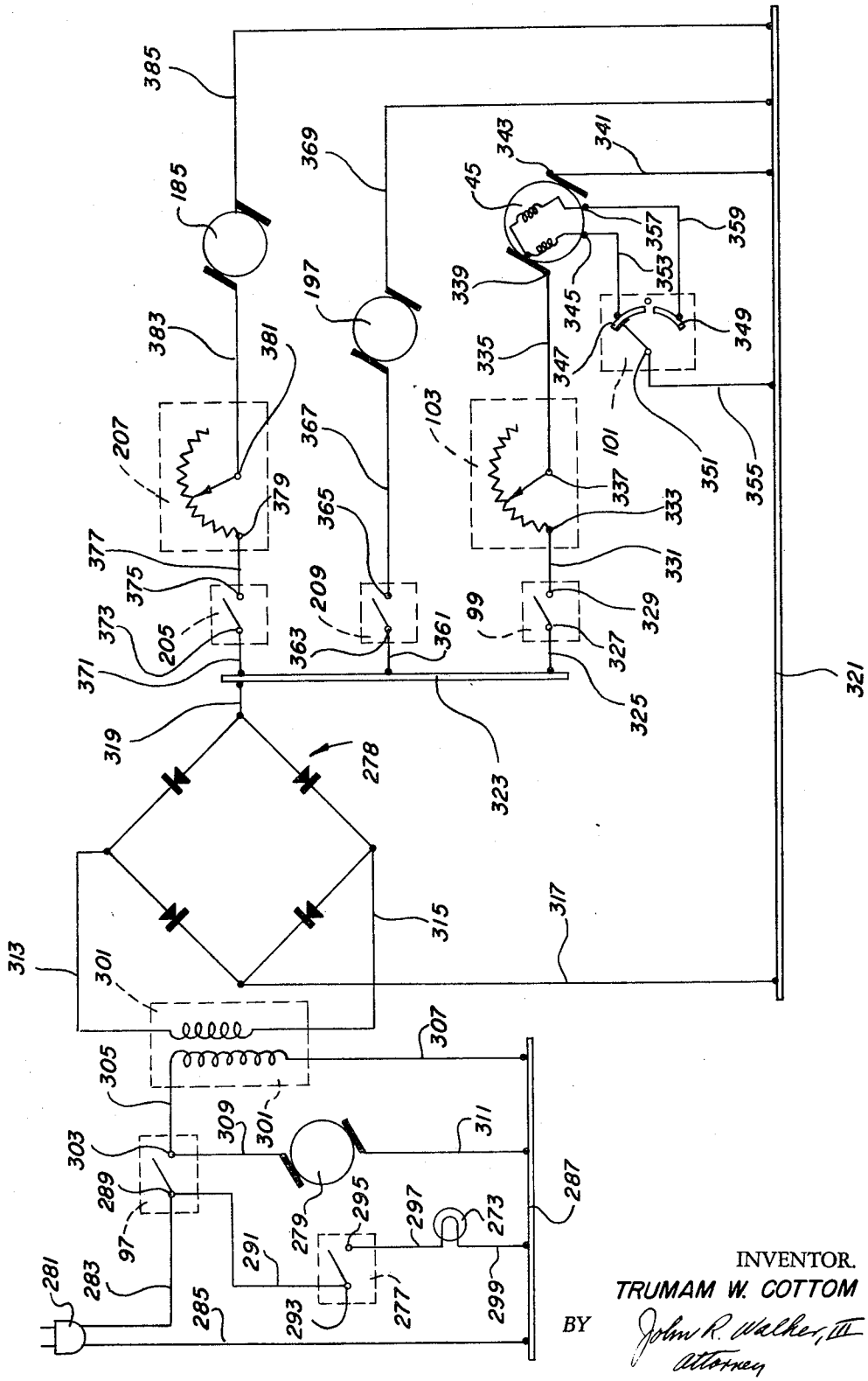
FIG. 11



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FIG. 12



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CONTACT LENS EDGE FINISHING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to the art of cutting and finishing contact lenses and more particularly, to a portable contact lens machine having means for cutting and polishing contact lenses.

2. Description of the Prior Art

The majority of the patents pertaining to grinding edges of optical lenses which are known to the applicant are specifically directed toward grinding an edge of a lens for the normal eyeglasses, i. e., an edge which facilitates installing the lens into frame structure. The principal problem for grinding an edge for a lens of the above type appears to be that the lens is seldom, if ever, a perfect circle, the object being to continually update the fashion of the shape of a lens for ordinary eyeglasses principally for aesthetic purposes. This continual changing of the shape of a lens presents a problem unique to fabricating such a lens as opposed to finishing the edge of a contact lens. Patents known to the applicant which teach the art of grinding edges of optical lenses for ordinary eyeglasses are: the Eaves U.S. Pat. No. 2,674,068; the Ellis U.S. Pat. No. 2,685,153; the Connell U.S. Pat. No. 2,748,541; the Gursch U.S. Pat. No. 2,855,734; the Reaser U.S. Pat. No. 3,158,967 and the Stern Pat. Nos. 3,332,172 and 3,353,303.

The techniques taught for grinding the edge of a lens for the ordinary eyeglasses has little or no application in solving the problems peculiar to grinding an edge for a contact lens. It might appear that finishing an edge of a contact lens is a mundane task, particularly in view of the above art and since the contact lens is preferably a perfect circle. However, certain problems are peculiar to the art of finishing the edge of a contact lens: first, the contact lens is formed from a plastic substance as opposed to glass for the ordinary eyeglasses. Since plastic is a rather soft and easily marred substance when compared to the hardness of glass, the mere problem of holding the plastic lens differs greatly. Secondly, the contact lens is minute in size when compared to the ordinary eyeglass, e. g., a typical diameter of a contact lens is 8.5 mm as compared to 40 mm to 50 mm for ordinary eyeglasses. Thirdly, at least a portion of the posterior concave surface of the contact lens must conform to the surface of the eyeball of the person wearing the lens. Fourthly, the anterior or convex surface of the contact lens preferably has a very smooth gently curved surface, and the terminal edge of the lens preferably terminates with a very small radius so that the eyelids of the person wearing the lens will not become irritated as is customary when any foreign object is in one's eye.

Patents directed particularly toward the art of contact lens finishing which are known to the applicant are: The Kratt U.S. Pat. No. 3,087,284; the Vegors et al. U.S. Pat. No. 3,111,790 and the Hoffman U.S. Pat. No. 3,112,581. It should be appreciated by those skilled in the art that in theory there is general agreement concerning the criteria for finishing a contact lens. However, the problem of correlating the theoretical knowledge into actual practice is a current problem, even in view of the above art. The practitioners known to the applicant are currently relying to a great extent on manual operations, and, by and large, the end product leaves much to be desired, as evidenced by the book CONTACT LENS PRACTICE BASIC AND ADVANCED, by Assistant Professor, Physiological Optics and Optometry at the University of California in Berkeley. The book is published by Charles C. Thomas of springfield, Illinois, and on pages 191–200 the subject and/or the problems encountered with current contact lenses is/are discussed. Briefly, the result of his study revealed that considerable variability was found to exist in the edges of the various lenses used in the experiment, and less than 20 percent of the lenses sampled were satisfactory or comfortable to wear.

SUMMARY OF THE INVENTION

The present invention is directed towards overcoming the problems relative to contact lens finishing. The concept of the present invention is to provide: First, a pair of synchronized rotating inwardly directed spindles, each terminating with a resilient tip for contiguously engaging and firmly holding, without marring, the contact lens.

Second, a lens centering device. This device accurately positions the geometrical center of the lens in coincident alignment with the rotating axes of the spindles.

Third, a movable guidably supported cutting tool for reducing the diameter and the thickness of the lens at the periphery thereof. The cutting tool is guidingly moved laterally along two axes, i. e., one axis parallel with the longitudinal or rotating axes of the spindles and the other axis extends toward and away from the rotating spindles. A unique feature of the cutting tool is that movement along the latter of the above mentioned axes is along an arcuate path having a radius the center of which is located along the rotating axes of the spindles. Movement of the cutting tool along the former of the above-mentioned axes positions the cutting tool to an infinite number of settings, each having a different length radius at different points along the rotating axes of the spindles. The cutting tool, when moved along this former axis thins the peripheral edge of the lens to a desired thickness.

Fourth, a movable guidably supported rotating polishing wheel for blending the newly cut surfaces with the previously ground optic surfaces and polishing the periphery of the lens. A unique feature of the present invention is a mechanical oscillator which cyclically shifts the rotating axis of the polishing wheel assuring that the convex and concave surfaces of the lens are finished as desired.

Fifth, a workpiece enlarger scope which presents a visual blow-up to the operator of: the rotating lens, the cutting tool, and the portion of the polishing wheel that engages the lens. This feature greatly enhances the ability of the operator to precision finish a contact lens consistently and quickly.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of the machine of the present invention.

FIG. 2 is a front elevational view of the machine of the present invention.

FIG. 3 is a sectional view taken as on the line III—III of FIG. 1.

FIG. 4 is a sectional view taken as on the line IV—IV of FIG. 1, with much of the structure being deleted for clarity.

FIG. 5 is a sectional view taken as on the line V—V of FIG. 2, with much of the structure being deleted for clarity.

FIG. 6 is an enlarged view of the rotating spindles, showing the centering device in broken lines as it engages and centers the lens between the spindles.

FIG. 7 is an enlarged view of the spindles as might be seen in the scope, wherein the contact lens is clearly seen between the resilient tipped spindles, and the cutting tool as well as the polishing wheel are also shown on the scope.

FIG. 8 is a plan view of the guiding support structure for the cutting tool.

FIG. 9 is an enlarged sectional view taken as on the line IX—IX of FIG. 4 having much of the structure removed for clarity.

FIG. 10 is an enlarged sectional view taken as on the line X—X of FIG. 9.

FIG. 11 is an enlarged sectional view taken as on the line XI—XI of FIG. 8.

FIG. 12 is a schematic of the electrical system of the machine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The machine **11** of the present invention is used to accomplish the final operations in the sequence of fabricating a contact lens **13**. The final operations are subsequent to the lens blank having had the proper optic qualities ground therein, being now ready to be shaped to the contour of the wearer's eyeball, and to be reduced to the proper diameter, to have the edge thinned to the desired thickness and to be polished to a smooth surface wherein the multiple radii smoothly blend uninterruptingly from one to the other. The above description of the technique of contact lens edge finishing will suffice for present purposes, particularly since considerably prior art has been referenced and from a theoretical viewpoint in regard to the contact lens **13**, the preferred or desired shape substantially remains unchanged. In this regard, an important feature of the machine **11** of the present invention is that it turns out a contact lens **13** having a more perfect shape, i. e., more closely conforming to the theoretical requirements or desired specifications. Equally important is that the machine **11** of the present invention consistently turns out a contact lens **13** having the desired shape and the likelihood of human error in accomplishing the heretofore manual tasks is virtually eliminated.

The machine **11** is housed in a console-like cabinet **15** formed from sheet metal or the like and having a shape substantially as depicted in FIGS. **1**, **2** and **3**. The cabinet **15** has the usual left end **17** and right end **19**, each having a planar shape resembling the letter L, as best viewed in FIG. **1**, wherein the left end **17** is shown.

The cabinet **15** includes a front side **21** and a back side **23**, the latter comprising one contiguous surface spanning the distance between the respective left and right ends **17**, **19**. The front side **21** extends vertically upward from a first horizontal surface constituting the floor **25** of the cabinet **15** to a second horizontal surface constituting a work surface or table **27**. A second substantially vertically slanted surface **21'** extends upwardly from the table **27** to a third horizontal surface **29** constituting the top of the cabinet **15**. It should be understood that the front side **21**, the slanted front **21'**, the floor **25**, the table **27** and the top **29** of the cabinet **15** cover the span between the respective left and right ends **17**, **19**.

The slanted front **21** has numerous actuating devices attached thereto and generally constitutes the control panel for the machine **11**, details of which are yet to be disclosed.

The machine **11** of the present invention generally comprises a pair of opposed axially aligned inwardly directed rotating spindles **31**, **33** each including a resilient contact lens holding device **35**, **37** fixedly attached at the innermost ends thereof (the spindle **33** includes a lens centering device **39** circumjacent thereto for accurately concentrically positioning the lens **13** between the spindles **31**, **33**), a movable guidably supported cutting tool **41**, and a movable guidably supported rotating polishing wheel **43**.

Referring now to FIG. **5** of the drawings, wherein it may be seen that a spindle drive motor **45**, having a rotating output shaft **47** keyed to a pulley **49**, rotatably drives an elongated shaft **51** through an endless belt **53** and a second pulley **55**. The elongated shaft **51** is journaled to the floor **25** of the cabinet **15** by a pair of bearing and support assemblies **57**, **59**. Fixedly attached to the shaft **51** adjacent each end thereof are a pair of pulleys **61**, **63**. It should be pointed out that the pulley **55** preferably is located along the shaft **51** intermediate the two bearing and support assemblies **57**, **59** and that the bearing and support assemblies **57**, **59** preferably are positioned adjacent the outermost ends of the shaft **51**. Further, the shaft **51** is actually a greater distance removed from the motor **45** than is shown in FIG. **5**, i. e., the shaft **51** preferably is located adjacent the front side **21** of the cabinet **15** having its rotating axis parallel to and directly beneath the rotating axes of the spindles **31**, **33**, as best viewed in FIG. **3**. In order to more clearly illustrate the complete structure of the machine **11**, the shaft **51** is shown in FIG. **5** having a spaced apart relationship laterally from separate but adjacent structure yet to be disclosed, when actually the preferred positioning of the shaft **51** is subjacent to the just-mentioned undisclosed structure.

Referring now to FIG. **3** of the drawings, it may be seen that the spindles **31**, **33** are rotatably attached to the table **27** of the cabinet **15**, in a manner yet to be disclosed. In this regard, a bearing and support assembly **65** rotatably supports, at the one end, the spindle **31** and the opposite end rotatably supports a shaft **67**. Adjacent the outer end of the shaft **67** is fixedly attached thereto a pulley **69**. An endless belt **71** extends through a suitably aligned aperture (not shown) in the table surface **27** and engages the pulleys **61**, **69**.

Additionally, a bearing and support assembly **73** rotatably supports, at the inner end, the spindle **33** and the opposite end rotatably supports a shaft **75**. Adjacent the outermost end of the shaft **75** is fixedly attached thereto a pulley **77**. An endless belt **79** engages the pulleys **63**, **77**, extending through the table **27** in a suitably disposed aperture (not shown).

It should be pointed out that the respective belts **71**, **79** are of the well known positive drive type with the

obvious purpose being to preclude the possibility of one spindle, e. g., spindle 31, having a relative motion with respect to the other spindle 33. A relative motion between the spindles 31, 33 would possibly damage or mar the optic surfaces of the contact lens 13 sandwiched between the spindles 31, 33 in a manner yet to be disclosed.

Additionally, the structure of the bearing and support assemblies 65, 73 includes driving means between the respective shafts and spindles 67, 31; 75, 33, e. g., a positive engaging spline shaft or the like. Also, the spindles 31, 33 are rotatably supported in the respective support assemblies 65, 73 in any well known manner which will minimize the likelihood of the spindles 31, 33 having end play, e. g., thrust bearings (not shown) press fitted to the spindles 31, 33 providing lateral support thereto and obviating end play. It should be appreciated by those skilled in the art that the minute thickness of the lens 13 and its inherent susceptibility to becoming marred necessitates supporting the lens 13 between the spindles 31, 33 firmly. Thus, this precludes the possibility of the lens shifting once it has been positioned between the spindles 31, 33, a likely possibility if end play existed.

The contact lens holding devices 35, 37, having a resilient structure, e. g., like that of the well known rubber O-rings, frictionally engage the contact lens 13 when the spindle 33 is moved to the left as viewed in FIGS. 3, 6 and 7. The spindles 31, 33, being formed from machine steel or the like, have a round cross section and terminate inwardly with a concentrically aligned frusto-conical portion substantially as viewed in FIGS. 6 and 7. The innermost end of the spindles 31, 33 are further reduced in diameter concentrically so as to form a minute annular boss or nib portion (not shown) for receiving and frictionally supporting the annular O-rings 35, 37, i. e., the inner diameter of the O-rings 35, 37 circumjacently engaging the respective protruding nib.

The spindle 33 is moved along its longitudinal or rotating axis from a first position wherein the contact lens 13 may be freely inserted between the O-rings 35, 37 to a second position wherein the contact lens 13 is firmly held rigid with respect to the two spindles 31, 33. This movement of the spindle 33 is accomplished by the bearing and support assembly 73 being slidably moved along the shaft 75. The end of the shaft 75, being rotatably received by the bearing and support assembly 73, preferably is provided with a suitable splined portion, not shown, so that longitudinal movement along the shaft 75 of the bearing and support assembly 73 does not interfere with the synchronous drive of the two spindles 31, 33.

A locking handle 81 actuates a typical double link assembly 83, as shown in FIGS. 2 and 3. The double link assembly 83 includes a stationary member 85 having one end thereof fixedly attached to the table 27 in any well known manner, e. g., a bolt 87 extending through suitable apertures (not shown) in the member 85 and the table 27. The handle 81 extends upwardly from a first link 89 (FIG. 2) having the one end thereof pivotally attached to the stationary member 85 (FIG. 3) by a pivot pin 91. The other end of the link 89 is pivotally attached to the one end of a second link 93 by a pivot pin 95 (FIG. 2). The other end of the second link 93 is pivotally attached to the bearing and support assembly 73 in any well known manner, e. g., a bolt 97 inserted through a suitably sized aperture in the link 93 and received in a threaded aperture (not shown) in the bearing and support assembly 73.

It should be apparent that clockwise rotation of the handle 81 (FIG. 2) causes the bearing and support assembly 73 to move toward the right end 19 which in turn causes the spindle 33 to assume the aforementioned first position. In this regard, the respective first and second links 89, 93 are displaced so that the longitudinal axes thereof assume a substantial vertical position. Conversely, rotation of the handle 81 counterclockwise causes the spindle 33 to assume the aforementioned second position, additionally, the respective first and second links 89, 93 assume a position substantially as depicted in FIG. 2 wherein the longitudinal axes thereof are substantially horizontal.

The machine 11 preferably is intended for operation by connecting to any convenient outlet, e. g., 115 volts AC. The spindles 31, 33 are caused to rotate by first closing the main switch 97 located on the control panel 21' (FIG. 2). A spindle "on" and "off" switch 99, located on the control panel 21' adjacent the right end 19 actuates the motor 45, causing the spindles 31, 33 to rotate through the aforementioned drive train. The spindles 31, 33 may be rotated in either direction depending upon the position of an additional switch 101, i. e., switch 101 has a "forward" position, a "reverse" position, and a third or middle position, "break", wherein the spindles 31, 33 become rigid in regard to rotation. Additionally, a rheostat 103, having infinite positions, controls the speed of the spindles 31, 33 in either the "forward", or "reverse" position. The switch 101 and the rheostat 103 are also located on the control panel 21' toward the right end 19 of the cabinet 15, as viewed in FIG. 2.

The lens centering device 39, being formed from machine steel or the like, has a sleeve or tubular configuration, the inner diameter having a dimension which provides a close slip fit over the circumference of the spindle 33, as best viewed in FIGS. 3 and 6. The one end of the centering device 39 is provided with a plurality of inwardly directed tapered prongs 105 (preferably four) symmetrically arranged radially about the circumference of the centering device 39 and directed towards the opposite spindle 31, as best viewed in FIG. 6. The prongs 105, being directed toward the opposite spindle 31 have an inclined surface with an angular displacement between the circumference and the center of the device 39, e. g., 30°. Stated another way, the prongs 105 have a surface 106 with an inwardly directed taper whereby an extension inwardly of the innermost surface of each of the prongs 105 would converge precisely at a common point along the rotating axis of the spindle 33.

The lens centering device 39 has two positions: a stowed position, as best illustrated in FIG. 3, wherein the device 39 is slidably moved along the spindle 33 so as to come to rest adjacent the bearing and support assembly 73. A second position, wherein the device 39 is slidably moved manually toward the opposite spindle 31 so that the prongs 105 assume a position depicted in broken lines in FIG. 6, wherein the prongs are character referenced by the numeral 105'. It should be

pointed out that the centering device **39** preferably is locked in the stowed position in any suitable manner. Thus, I prefer to provide an annular recess about the outer circumference of the device adjacent the end opposite the prongs and to drill a transversal hole in the bottom of the recess which receives a steel ball, the steel ball is forced into a second recess provided about the circumference of the spindle **33** by an O-ring circumjacently received within the first mentioned recess within the centering device **39**. It should be understood that the above structure for locking the device **39** in the stowed position, being optional and mundane, is not shown on the drawings.

The important feature of the lens centering device **39** is that when the contact lens is placed between the spindles **31, 33** (FIG. **6**), with the handle **81** being rotated clockwise as above described, the device **39** is manually slid over the lens **13** so that the prongs **105'** accurately position the geometrical center of the lens in coincident alignment with the rotating axes of the spindles **31, 33**. While the centering device **39** remains in the above position, the locking handle **81** is rotated counterclockwise which moves the spindle **33** to the left as viewed in FIG. **6** and the resilient O-rings **35, 37** contiguously engage the respective convex and concave surfaces of the lens **13** so that it is bindingly held stationary with respect to the spindles **31, 33** as they rotate. The centering device **39** is then slidably moved manually to the stowed position, as above described.

One of the many steps in finishing the edge of a contact lens involves reducing the diameter of the lens to a specified dimension. Another important step in finishing the edge of a contact lens involves reducing the thickness of the lens at the outer periphery, i. e., cutting away material from the concave surface of the lens adjacent the peripheral edge and cutting away material from the convex surface adjacent the peripheral edge, so as to produce a lens having the desired shape. The machine **11** of the present invention accomplishes the above steps by use of the cutting tool **41**.

The cutting tool **41** is movable and guidably supported by a cutting tool feed assembly **107**, best viewed in FIGS. **2, 3, 8** and **11**. The cutting tool feed assembly **107** includes an upper dovetail member **109**, formed from machine steel or the like, having at the one end thereof a segment of a worm wheel or a sector gear **111** and supporting at the other end thereof a cutting tool support pedestal **113**. The pedestal **113**, being formed from machine steel or the like, is provided with an aperture **115** extending the length thereof for receiving an attachment bolt **117**. The attachment bolt **117**, being inserted through the aperture **115**, is threadedly received into an aperture (not shown) suitably positioned adjacent the innermost end of the upper dovetail member **109**. The upper end of the pedestal **113** is provided with a second aperture (not shown) extending parallel with the aperture **115** and threaded to receive a cutting tool set screw **119**.

The cutting tool **41**, being formed from tool steel and having a suitable knife-like wraparound cutting end, extends through a suitably sized and shaped transverse aperture **121**. Further, the threaded aperture receiving the set screw **119** extends perpendicular to the aperture **121** so that the set screw **119** may be threadedly run into the transverse aperture **121** so as to adjustably fixedly attach the cutting tool **41** to the pedestal **113** at infinite settings along the length thereof. Protruding downwardly from the lower surface of the dovetail member **109** is an elongated arcuate dovetailed male portion **123** having a center of curvature concentric with the center of curvature of the sector gear **111**, as best viewed in FIG. **8**.

The feed assembly **107** also includes an intermediate dovetail member **125**, formed from machine steel or the like, which has an inner end shaped substantially identical to the upper dovetail member **109**, when viewed from above as in FIG. **8**. The upper surface of the inner end of the intermediate dovetail member **125** is provided with an elongated arcuate dovetailed female portion **127** having a center of curvature concentric with the center of curvature of the male dovetail portion **123**. The female portion **127** is suitably positioned and has dimensions for mating with or slidably receiving the male dovetail portion **123** of the upper member **109**.

The outer end of the intermediate member **125** includes an upwardly directed rectangular portion **129** the height of which extends above the upper surface of the upper dovetail member **109**, substantially as viewed in FIG. **11**. The face of the inner side of the portion **129** is provided with an arcuate recess **131** having a center of curvature concentric with the center of curvature of the dovetailed portion **127** and having a dimension suitable for freely receiving the sector gear **111**.

The portion **129** is also provided with an elongated aperture **133** extending parallel with the longitudinal axis thereof. The aperture **133** receives a worm gear **135** meshing with the sector gear **111**. Fixedly attached at the one end of the worm gear **135** is a shaft **137** protruding outwardly from the portion **129** through the aperture **133** and through an aperture (not shown) in an annular boss portion **139**, an integral portion of the member **125**. The shaft **137** is free to rotate within the boss **139** and the opposite end of the shaft **137** carries a knurled knob **141** for manually rotating the worm gear **135**.

Rotation of the worm gear **135** displaces the upper dovetail member **109** from the midposition depicted in FIG. **8** to its outer limits depicted by the numeral **109'** for the one limit and **109''** for the opposite limit. In this regard, and referring to FIG. **7**, the cutting tool **41** is depicted in a midposition as it would appear when the member **109** is in the midposition and is character referenced by the numeral **41'** when the member **109** is displaced to one limit and character referenced by the numeral **41''** when the member **109** is displaced to its opposite limits. It should be pointed out that when the cutting tool **41** is at its extreme position as depicted in FIG. **7** by the numeral **41''**, it preferably would wrap around the edge of the contact lens **13**, the cutting tool set screw **119** and the pedestal attachment bolt **117** adjusts the cutting tool **41** so that it may engage the edge of the contact lens **13** in any desirable position.

The feed assembly **107** also includes a third or lower dovetail member **143**, formed from machine steel or the like. The member **143**, having a substantially square platelike structure, has a machine-cut female dovetailed portion **145** extending between opposite edges and recessed into the top surface thereof. The intermediate dovetail member **125** also includes a male

dovetail portion 147 protruding downwardly from the lower surface and extending transversely adjacent the outer end thereof, as best viewed in FIG. 11. The member 143 is provided with a pair of apertures 161 (FIG. 8) adjacent the outer edge thereof for receiving a pair of attachment bolts 163 which removably attach the member 143 to the table 27. It should be apparent that the dimensions of the dovetail portions 145, 147 are such that the male portion 147 may be mated with and may freely slide to and fro within the female portion 145. Additionally, the edges of the dovetail portions 145, 147 form a substantial straight line and opposite edges are parallel, one with the other, to insure the dovetail portions 143, 145 have a constant width, i. e., the dimensions between the opposite edges of the respective dovetail portions 145, 147 are substantially equal at all points along the length thereof.

The feed assembly 107 also includes an elongated shaft 149, as best viewed in FIG. 3. The inner end of the shaft 149 is provided with a threaded portion which is threadedly received into a suitably aligned and threaded aperture 151 in the intermediate dovetail member 155, as best viewed in FIG. 11. The opposite end of the shaft 149 carries a knurled knob 153 for manually rotating the shaft 149. The shaft 149 is journaled outwardly thereof to the table 27 (FIG. 3) by a bearing support assembly 155 and is journaled inwardly thereof to the lower dovetail member 143 by a second bearing support assembly 157. The bearing support assembly 157 may be an integral part of the member 143 or it may be separate structure fixedly attached thereto in any well known manner, e. g., bolts (not shown). The shaft 149, being free to rotate within the respective outer and inner support assemblies 155, 157 is prevented from movement along its longitudinal axis in any well known manner, e. g., annular recesses (not shown) adjacent each side of the support assembly 155 machined into the circumference of the shaft 149 to receive a pair of snaprings 159 (FIG. 3).

Manual rotation of the knob 153 runs the threaded end of the shaft 149 relatively in and/or out of the aperture 151, thus causing the intermediate dovetail member 125 to be slidably moved along the dovetail portion 145 of the lower member 143. The intermediate member 125 carries the upper member 109, the pedestal 113, and the cutting tool 41, thus guiding the cutting tool 41 parallel with the rotating axes of the spindle 31, 33, i. e., as viewed in FIG. 3. The cutting tool 41 is thusly moved to perform the operation of removing the desired amount of plastic material from both the concave and convex surfaces of the lens 13.

It will be appreciated by those skilled in the art that the assembly 107 coacting with the desired shaped cutting tool 41 used to guidingly remove plastic material from the accurately centered rotating lens 13 is capable of consistently turning out a contact lens 13 which precisely conforms to the desired specifications.

The art of finishing the edge portions of a contact lens includes polishing the surfaces of the concave and convex side adjacent the peripheral edge and also polishing the terminal edge. This polishing procedure preferably is of sufficient abrasion to blend surfaces having different radii into one smooth uninterrupted contour, i. e., both the concave and convex surfaces. Here again, particular care must be taken to guard against the possibility of marring the optical surfaces of the contact lens. Accordingly, this operation also has heretofore been accomplished by and large manually or at best semi-manually. The machine 11 of the present invention accomplishes the above operation substantially automatically with extreme precision and more importantly, consistently turns out a finished lens having the desired specifications. From FIG. 7 of the drawing, it may be seen that the polishing wheel 43 has an annular groove 165 recessed into the outer circumferential surface for burnishing both the concave and convex surfaces of the lens 13.

Referring now to FIG. 4 of the drawings wherein it may be seen that the polishing wheel 43 is fixedly attached to a rotatable shaft 167, in any well known manner, e. g., a locknut (not shown). The shaft 167 is journaled to the upper end of a support pedestal 169 by a bearing support assembly 171. The assembly 171, being formed from steel or the like, is fixedly attached to the pedestal 169 in any well known manner, e. g., welding or the like. The opposite end of the shaft 167 carries a pulley 173 which is rotatably driven by an endless belt or preferably an O-ring belt 175 having a circular cross section. The lower end of the support pedestal 169 is fixedly attached to a polishing wheel platform 177 in any well known manner, e. g., welding or the like.

The polishing wheel platform 177 is pivotally attached to the table 27 by a pivot pin 179 (FIG. 4). The lower end of the pivot pin 179 is fixedly attached, as by welding or the like, to the upper surface of the table 27 and the upper end of the pivot pin 179 is received into a suitably sized aperture (not shown) in the lower surface of the platform 177, the aperture preferably being provided with a suitable and typical friction-reducing means, e. g., roller bearing assembly or bronze bushing (not shown). The O-ring 175 extends downwardly through a suitably aligned elongated aperture (not shown) in both the platform 177 and the table 27 and frictionally engages a pulley 181, keyed to the output shaft 183 of a variable speed motor 185, as best viewed in FIG. 5.

The motor 185 is fixedly attached at the inner end of a movable motor mount 187 in any well known manner, e. g., bolts (not shown). The motor mount 187, formed from steel or the like, is pivotally attached intermediate thereof to a second movable mounting plate 189 by a pivot pin 191, as best viewed in FIGS. 4 and 5. The lower end of the pivot pin 191 is fixedly attached, as by welding or the like, to the mounting plate 189, which is formed from steel or the like. The upper end of the pivot pin 191 is received in a suitably aligned aperture (not shown) in the lower surface of the motor mount 187 preferably being provided with a suitable friction-reducing means, e. g., a roller bearing assembly or bronze bushing (not shown).

It should be observed (FIG. 4) that an extension downwardly of the vertical axis of the pivot pin 179 supporting the platform 177 passes precisely through the vertical axis of the pivot pin 191 pivotally supporting the mounting plate 189, for purposes yet to be disclosed. The outer end of the motor mount 187 carries a vertically disposed shaft 193, being fixedly attached thereto, as by welding or the like. The shaft 193 extends upwardly through an enlarged aperture (not

shown) within the table surface **27** being fixedly attached, as by welding or the like, to the lower surface of the platform **177**, as best viewed in FIG. **4**. It should be obvious that the platform **177** and the motor mount **187**, being rigid one with the other as above-described, may be pivoted about their respective pivot pins **179**, **191** by lateral movement of the vertical shaft **193**. Accordingly, reciprocal lateral movement of the shaft **193** is accomplished by a pittman arm **195** having the inner end thereof pivotally attached about the shaft **193**, in any well known minimum friction manner, e. g., a roller bearing assembly concentrically engaging the outer circumference of the shaft (not shown). It should be appreciated by those skilled in the art that while the shaft **193** is depicted in FIG. **4** as being one continuous member, engineering expediency may dictate that the shaft **193** preferably be formed of a plurality of shafts connected one to the other, in any well known manner, such as couplings or the like. In this regard, it is to be understood that the shaft **193** may be a plurality of connected shafts without departing from the spirit and scope of the present invention.

The lower surface of the mounting plate **189** (FIG. **4**) adjacent the outer end thereof removably supports an oscillating motor **197**, having its output shaft **199** extending upwardly through a suitable aperture (not shown) in the mounting plate **189**. The upper end of the shaft **199** carries a rotating disk **201** having an eccentrically positioned drive shaft **203** fixedly attached to the upper surface thereof, as by welding or the like. The outer end of the pittman arm **195** is pivotally attached to the eccentric shaft **203** in any well known minimum friction manner, e. g., a roller bearing assembly (not shown) concentrically engaging the outer circumference of the shaft **203**.

The polishing wheel drive motor **185** is energized by closing a switch **205** located adjacent the upper lefthand corner of the control panel **21'** (FIG. **2**). The variable speed of the motor **185** is controlled by a rheostat **207** located adjacent the switch **205** on the control panel **21'**. The oscillating motor **197** is energized by closing a switch **209** adjacent the rheostat **207** on the control panel **21'**.

Accordingly, the polishing wheel **43** may be rotated by first closing the main switch **97**, then closing the polisher switch **205**. The rpm of the polishing wheel **43** is controlled by manually changing the setting of the rheostat **207** to the desired setting. The oscillating motor **197** may be actuated independently of the motor **185** by closing the oscillator switch **209**. In this regard, the oscillating motor **197** rotates the disk **201**, having the eccentric shaft **203**, which causes the pittman arm **195** to reciprocate to and fro, which causes the platform **177** and the motor mount **189** to simultaneously pivot about their respective pivot pins **179**, **191** in unison, as above described. Since the polishing wheel **43** and its bearing support assembly **171** are fixedly attached to the support pedestal **169** which is fixedly attached to the platform **177**, the rotating axes of the shafts **183**, and **167** are likewise shifted in unison. The shaft **167** rotatably drives the polishing wheel **43** as it is being shifted. An important feature of the present invention is that a continuation upwardly of the vertical axis of the pivot pins **179**, **191** intersects the plane of the polishing wheel **43** adjacent the outer circumferential annular groove **165** thereof (FIG. **7**), as best viewed in FIG. **4**. Accordingly, the oscillator motor **197** shifts the rotating axis of the polisher motor **185** to a position character referenced in FIG. **5** by the numeral **185'** and it should be understood that the rotating axis of the shaft **167** is always directly above and parallel thereto.

In other words, the oscillating feature causes the plane of the polishing wheel **43** to be shifted from a midposition conveniently depicted in FIG. **7** by the numeral **43** to its extreme movement character referenced by the numerals **43'** and **43''**. However, the structure character referenced by the numerals **43'** and **43''** in FIG. **7** should, if accurately depicting the displacement of the polishing wheel **43** (by the oscillating motor **197** only), be substantially superimposed upon the structure depicted by the numeral **43**. Obviously, the polishing wheel **43** in FIG. **7** is conveniently so illustrated and character referenced as to more clearly show the displacement of the plane of the polishing wheel **43**. In other words, the polishing wheel **43** does not move toward and away from the contact lens **13** by energizing the oscillating motor **197**. It should be pointed out, however, that the polishing wheel **43** may be moved towards and away from the contact lens by structure yet to be disclosed.

The oscillating motor **197** preferably includes gear reduction structure (not shown) which will drive the disk **201** with considerable force and at a relatively low speed, e.g., 7 rpm. The important feature of the oscillating structure is that the polishing wheel **43** is canted inwardly as shown in FIG. **7** by the numeral **43''** to polish the posterior radius or concave surface adjacent the peripheral edge of the contact lens **13** and is canted outwardly so as to polish the anterior radii or convex surface adjacent the peripheral edge of the contact lens at a constant rate resulting in substantially uniform burnishment. It should be understood that the polishing wheel **43** is rotating at a relatively high rpm as determined by the setting of the rheostat **207**. Further, the contact lens **13** is rotating at a speed determined by the setting of the rheostat **103** and the spindles **31**, **33** are rotating in a desired direction, i.e., preferably opposite the direction of rotation of the polishing wheel **43** depending upon the position of the switch **101**, which was previously described.

Referring now to FIGS. **4**, **5**, **9** and **10**, it may be seen that the mounting plate **189**, supporting the entire polishing and oscillating structure, may be moved from left to right and right to left as viewed in FIGS. **4** and **5** by manually rotating a knurled knob **211**. Additionally, the mounting plate **189** may be moved from top to bottom and from bottom to top, as viewed in FIG. **5**, by manually rotating a knurled knob **213**.

The structure which makes possible the above movement of the mounting plate **189** is designated as a polishing wheel feed assembly and is character referenced by the numeral **215**, details of which are shown in FIGS. **9** and **10**. The polishing wheel feed assembly **215**, comprising several members formed from machine steel or the like, includes an upper dovetail member **217** which carries the mounting plate **189**, the mounting plate **189** being fixedly attached thereto as with bolts (not shown).

The lower surface of the dovetail member 217 is provided with a female dovetail portion 219 extending the length thereof. The member 217 additionally is provided with a threaded aperture 221, the longitudinal axis of which extends substantially parallel with the longitudinal axis of which extends substantially parallel with the longitudinal axis of the dovetail portion 219.

The feed assembly 215 also includes an intermediate dovetail member 223, the upper surface of which includes an upwardly protruding male dovetail portion 225 having a dimension so as to be slidably received in the dovetail portion 219. The lower surface of the dovetail member 223 is provided with a female dovetail portion 227, the longitudinal axis of which extends substantially 90° from the longitudinal axis of the dovetail portion 225.

The intermediate member 223 is also provided with a threaded aperture 229, the longitudinal axis of which extends substantially parallel with the longitudinal axis of the dovetail portion 227. Both the male and female dovetail portions 225, 227 respectively, extend between opposite ends of the member 223.

The intermediate member 223 also includes a shaft supporting bracket 231 for supporting and retaining the inner end of an elongated shaft 233. The supporting bracket 231, having a cross sectional shape resembling the capital L, extends from the end of the member 223, and the upright portion thereof is provided with a suitably aligned aperture 235 for receiving the shaft 233. The inner end of the shaft 233 carries a threaded portion which is received into the threaded aperture 221 and the outer end thereof carries the knurled knob 213. The shaft 233 is retained from lateral movement by a pair of snaprings 237 being received one on either side of the aperture 235 into suitably aligned annular recesses (not shown) in the shaft 233.

Manual rotation of the knob 213 threadedly drives the shaft 233 relatively into or out of the threaded aperture 221, thus causing the upper member 217 to slide to and fro within the mated dovetail portions 219, 225. In this regard, FIG. 9 depicts the displacement accomplished by rotation of the knob 213 wherein the mounting plate 189 and the upper member 217 are shown in a displaced relationship by the respective numerals 189', 217'.

The feed assembly 215 also includes a lower dovetail member 239 having an upwardly directed protruding male dovetail portion 241 extending between opposite ends along the upper surface thereof. The member 239 also includes a shaft supporting bracket 243, having the cross sectional shape of the capital L and a length preferably equal to the overall dimension of the member 239. It should be apparent that the dovetail portion 241 has a dimension which will enable it to be slidably received within the female dovetail portion 227 of the intermediate member 223.

The upright portion of the bracket 243 is provided with a suitably aligned aperture 245 for receiving and supporting the inner end of an elongated shaft 247, the aperture 245 being in alignment with the threaded aperture 229. The inner end of the shaft 247 carries a threaded portion which is threadedly received by the threaded aperture 229 and the outer end thereof carries the knurled knob 211. The shaft 247 is prevented from lateral movement by a pair of snaprings 249 being received, one on either side of the aperture 245, into a pair of suitably positioned annular recesses (not shown).

Manual rotation of the knob 211 threadedly drives the shaft 247 relatively into and out of the aperture 229, thus displacing the intermediate member 223 by sliding engagement between the respective dovetail portion 227, 241. In this regard, FIG. 10 depicts the displacement accomplished by rotation of the knob 211 wherein the mounting plate 189 and the intermediate member 223 are shown in a displaced relationship by the respective numerals 189', 223'.

The horizontal portion of the bracket 243 is provided with a pair of apertures 251 for receiving a pair of attachment bolts 253 which fixedly attach the lower member 239 to the floor 25 of the cabinet 15.

It will be appreciated by those skilled in the art that the feed assembly 215, as above described, provides structure for precision positioning of the polishing wheel 43, a feature which further insures that the contact lens 13 may be consistently finished in accordance with the desired specifications.

From FIGS. 1 and 2 of the drawings, it may be seen that the machine 11 of the present invention also includes a magnification projector or work enlarger device 255. The enlarger 255 further aids the operator of the machine by enabling him to substantially finish the contact lens 13 under a microscope. Thus, the lens 13 is free of irregularities and the shape thereof consistently conforms to the desired specifications.

The enlarger device 255 includes a lens assembly 257, being positioned over the innermost ends of the spindles 31, 33, having typical focusing and magnification features. The magnified image transmitted by the lens assembly 257 is projected upwardly and visually displayed on a typical projector scope 259. The scope 259 includes the usual reflective means 261 and the usual image displace surface 263, presenting an enlarged image of the work, e.g., a magnification factor of 10, to the operator. The device 255 is suspended directly above the inner ends of the spindles 31, 33 and is herewith supported by a scope support pedestal 265, as best viewed in FIGS. 1 and 2.

The machine 11 also includes a reflective surface or mirror 267 coacting with the device 255, the plane of which is maintained substantially horizontal and is suspendedly supported subjacent the inner ends of the spindles 31, 33, as best viewed in FIG. 3. A stationary mirror support arm 269, being fixedly attached at the one end thereof to the table 27 in any well known manner, i.e., bolts 271, extends inwardly reaching over the movable platform 177 and supports the mirror 267 at the innermost end thereof, the mirror 267 having typical clamping and/or adjusting means (not shown) integrally attached to the back side thereof for clampingly engaging the arm 269.

The machine 11 of the present invention also includes a luminaire 273 coacting with the device 255 and the mirror 267, as best viewed in FIGS. 1 and 2. The luminaire 273, being supported in an elevated position above the table 27 by a luminaire support pedestal 275, preferably has the light radiating therefrom directed downwardly toward the inner ends of the spindles 31, 33 so that the subjacent mirror surface 267 reflects a large portion of these light rays up-

wardly through the lens assembly **257** so as to present a well contrasted image of the work, i.e., the contact lens **13**, the cutting tool **41**, and/or the polishing wheel **43**, to the operator. FIG. **7** of the drawings closely resembles the preferred picture in the display surface **263**, i.e., the extent of the structure presented to the operator by the scope **259**. The luminaire **273** is operated by a typical toggle switch **277** located adjacent the upper left corner of the control panel **21'**.

From FIG. **12** of the drawings, it may be seen that the machine **11** includes a typical voltage rectification means **278**, e.g., a selenium control rectifier, type ASH–500 or similar, manufactured by the Bodine Electric Co., of Collierville, Tennessee. A rectifier of this type generates considerable heat and in order to prolong the life thereof, this heat is preferably rapidly dissipated. Accordingly, the machine of the present invention includes a blower assembly **279** housed within the cabinet **15** so as to create a strong current of air for rapidly dissipating the heat referred to above. The blower assembly **279** (FIG. **1**) preferably is attached in any well known manner to the back side **23** of the cabinet **15**, e.g., bolts and nuts (not shown).

An important feature of the blower assembly **279** is that air is drawn in through a suitably provided aperture (not shown) in the back side **23**, the aperture being provided with a suitable filtering means and is directed initially over the rectifier; however, this creates a positive air pressure within the cavity of the cabinet **15** which is made use of in a rather unique fashion: The air, being warmed by the displacement or transfer of heat, is permitted to be discharged from the cavity of the cabinet **15** through the numerous apertures, previously described, in the table **27** adjacent the work piece, i.e., the contact lens **13**.

The heated air movement through the interior of the cabinet **15** obviates most problems which normally develop from moisture and/or corrosion and additionally the movement of air outwardly from the apertures adjacent the work piece prevents foreign particles, i.e., plastic material removed from the lens **13** and/or dust and the like, from entering the interior of the cabinet **15**.

Thus, maintenance problems which are usually associated with moisture and/or foreign particles are precluded. The blower assembly **279** and the rectifier **278** are energized when the main switch **97** is moved to the closed position.

Referring now to FIG. **12** of the drawings wherein it may be seen that the machine **11** is provided with the usual power cord, having the usual male connector or plug **281** and the usual pair of conductors **283**, **285**, providing power from any convenient outlet, e.g., 115 volts AC. It should be understood that the power cord may include the more recent usual third ground wire (not shown). The conductor **285** leading from the plug **281** is connected to a bus bar **287** or common connection point and the conductor **283** is connected to a terminal **289** of the single pole single throw main switch **97**.

A second conductor **291** leading from the switch **97**, being connected to the terminal **289** at the one end, leads to a terminal **293** of the single pole single throw switch **277** which energizes the luminaire **273**. Closing the switch **277** completes the circuit from the terminal **293** to a second terminal **295** which receives the one end of a conductor **297**. The other end of the conductor **297** is connected to one side of the luminaire **273**. A conductor **299** is connected at the one end to the other side of the luminaire **273** and at the other end thereof to the bus bar **287**.

A step-down transformer **301** reduces the **115** volts AC to a suitable voltage for rectification, e.g., 56 volts AC or the like. The input voltage of the primary winding of the transformer **301** is applied, i.e., connected to a terminal **303** of the main switch **97** by a conductor **305** and is connected to the bus bar **287** by a conductor **307**.

The blower assembly **279** is energized by the main switch **97** and is connected to the terminal **303** thereof by a conductor **309** and to the bus bar **287** by a conductor **311**. The output voltage or the secondary winding of the transformer **301** is connected to the selenium control rectifier **278** by a pair of conductors **313**, **315**, i.e., conductor **313** at the one end and conductor **315** at the other end.

A pair of conductors **317**, **319**, carry the output voltage, e.g., 28 volts direct current for energizing the DC components, by one end of the conductor **317** being connected to the rectifier **278**, as depicted in FIG. **12**, and the other end thereof connected to a negative DC bus bar **321**. The conductor **319** is connected at the one end thereof to the rectifier **278**, as depicted in FIG. **12**, and at the other end thereof to a positive DC bus bar **323**.

The reversible variable speed spindle drive motor **45** is energized by the DC voltage as follows: A conductor **325** is connected at the one end thereof to the bus bar **323** and at the other end thereof to a terminal **327** of the single pole single throw switch **99**. Closing the switch **99** completes the circuit to a second terminal **329**, having the one end of a conductor **331** connected thereto. The other end of the conductor **331** is connected to a terminal **333** of the rheostat **103**. A conductor **335** carries the variable voltage, e.g., 0 – 28 volts DC or the like, from the rheostat **103** to the motor **45** by having one end thereof connected to a terminal or wiper **337** and the other end thereof connected to one brush or common terminal **339** of the motor **45**, as depicted in FIG. **12**.

The other brush or armature of the motor **45** is connected to the negative bus bar **321** by a conductor **341** having the one end thereof connected to a terminal **343** of the motor **45** and the other end thereof connected to the bus bar **321**.

The forward winding of the motor **45**, having a terminal **345**, is energized through the rotary or selector switch **101**. The switch **101** has an arcuate terminal **347**, a second arcuate terminal **349**, and a broad wiper terminal **351** and is preferably a three-position switch, having a "forward", "break" and "reverse" position. A conductor **353** is connected at the one end to the forward winding terminal **345** and at the other end thereof to the terminal **347**. When the switch **101** is in the "forward" position, the wiper **351** is electrically engaging the terminal **347**, accordingly, the forward winding of the motor **45** is energized through a common conductor **355** having one end thereof connected to the wiper **351** and the other end thereof connected to the bus bar **321**.

The reverse winding of the motor **45** terminate at a reverse winding terminal **357** and is energized through a conductor **359** having one end thereof connected to the terminal **357** and the other end thereof connected to the terminal **349**. When the switch **101** is in the "reverse" position, the reverse winding of the motor **45** is energized, i.e., the wiper **351** electrically engages the terminal **349** which completes the circuit through the common conductor **355**, as above described.

The motor **45** is braked by placing the switch **101** in the midposition, i.e., the wiper **351** simultaneously electrically engaging the arcuate terminals **347**, **349**, thus simultaneously energizing the forward and reverse windings of the motor **45**.

The oscillator motor **197** is energized by closing the single pole single throw switch **209**. A conductor **361** carries the DC voltage from the bus bar **323** to a terminal **363** of the switch **209**. Closing the switch **209** completes the circuit to a second terminal **365**, which receives the one end of a conductor **367**. The other end of the conductor **367** is connected to the motor **197**. A conductor **369** completes the circuit from the motor **197** to the bus bar **321**.

It should be understood that the circuit for the machine **11** preferably is adapted with appropriate fuses, i.e., interposed between the voltage source and certain components. However, since the placement of fuses is operationally optional and technically mundane the schematic as depicted is void of fuses.

Although the invention has been described and illustrated with respect to a preferred embodiment thereof, it is not to be so limited since changes and modifications may be made therein which are within the full intended scope of this invention.

I claim:

1. A machine for finishing a contact lens and the like comprising a pair of opposed axially aligned inwardly directed rotating spindles each including a resilient contact lens holding means fixedly attached at the innermost ends thereof for sandwiching and firmly holding the lens therewith between said spindles, one of said spindles including lateral leverage means for moving said holding means from a first position whereby the sandwiched lens is bindingly held stationary with respect to said spindles, one of said spindles including lens centering means circumjacent thereto for accurately concentrically positioning the lens between said holding means of said spindles while said holding means are held in said first position by said leverage means, a motor rotatably driving said spindles including positive drive means for synchronically rotating said spindles, cutting means including knife-like edges for substantially wrapping around the peripheral edge of the contact lens; means movably supporting said cutting means for laterally adjusting said cutting means for selective engagement thereof with the circumferential terminal edge, the posterior surface, and the anterior surface of the lens for respectively reducing the diameter and the thickness of the lens adjacent the periphery thereof; polishing means, a motor rotatably driving said polishing means, means movably supporting said rotating polishing means having an inner and an outer end, oscillating means, a motor driving said oscillating means, said means supporting said polishing means adjacent the inner end thereof movably supporting said rotating polishing means; said polishing support means including lateral adjusting means adjacent the inner end thereof for laterally adjusting said polishing means to selectively engage said polishing means with the circumferential terminal edge, the posterior surface and the anterior surface of the lens for finishing the respective outermost circumferential edge and the peripheral surfaces thereof; and said polishing support means adjacent the outer end thereof movably engaging said oscillating means for lateral shifting of the rotating axis of said polishing means so as to cyclically engage a portion thereof with the respective posterior and anterior surfaces adjacent the periphery of the rotating contact lens.

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