United States Patent [19]

Hodges

[11] **3,838,542**

[45] **Oct. 1, 1974**

[54] **LENS POLISHING MACHINE**

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[73] Assignee: **Associated Development Corporation,** Pinellas Park, Fla.

[22] Filed: **Oct. 16, 1972**

[21] Appl. No.: **297,932**

[52] **U.S. Cl.** **51/119,** 51/160

[51] **Int. Cl.** **B24b 7/00,** B24b 9/00, B24b 13/00

[58] **Field of Search** ..... 51/119–121, 51/160, 124 L

[56] **References Cited**

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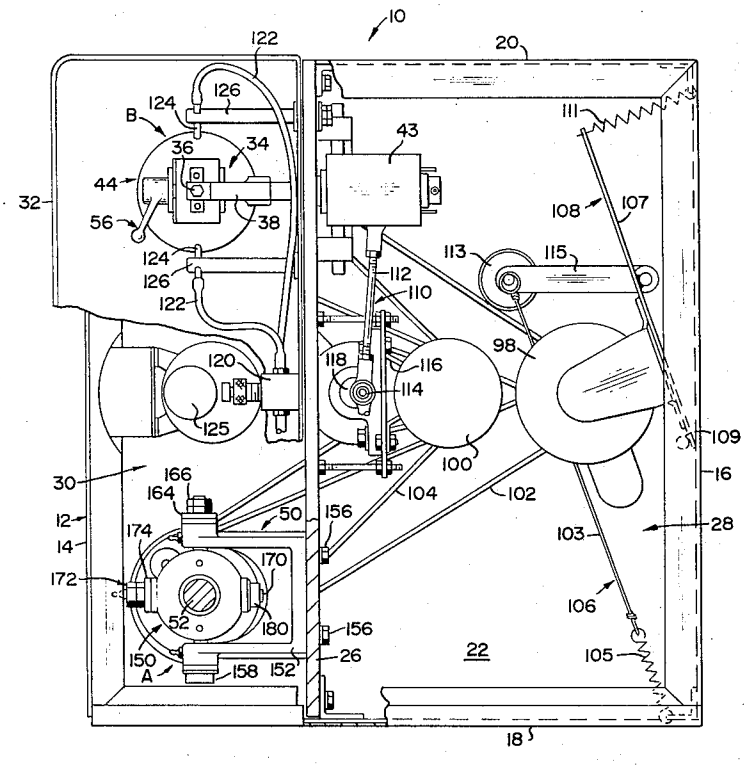
Primary Examiner—Othell M. Simpson

Attorney, Agent, or Firm—Stein and Orman

[57] **ABSTRACT**

A high speed lens grinding and polishing machine comprising a gimbal mounted polishing element mounted at its lower extreme in a spherical bearing permitting an upper lens clamping element to follow the contour of the lens during the polishing process. Eccentric movement of the polishing element is accomplished by the cooperative movement of a breakup and main drive means. In addition, the machine includes a labyrinth seal to prevent slurry compound from flowing into the gimbal and drive means during operation of the machine.

13 Claims, 6 Drawing Figures



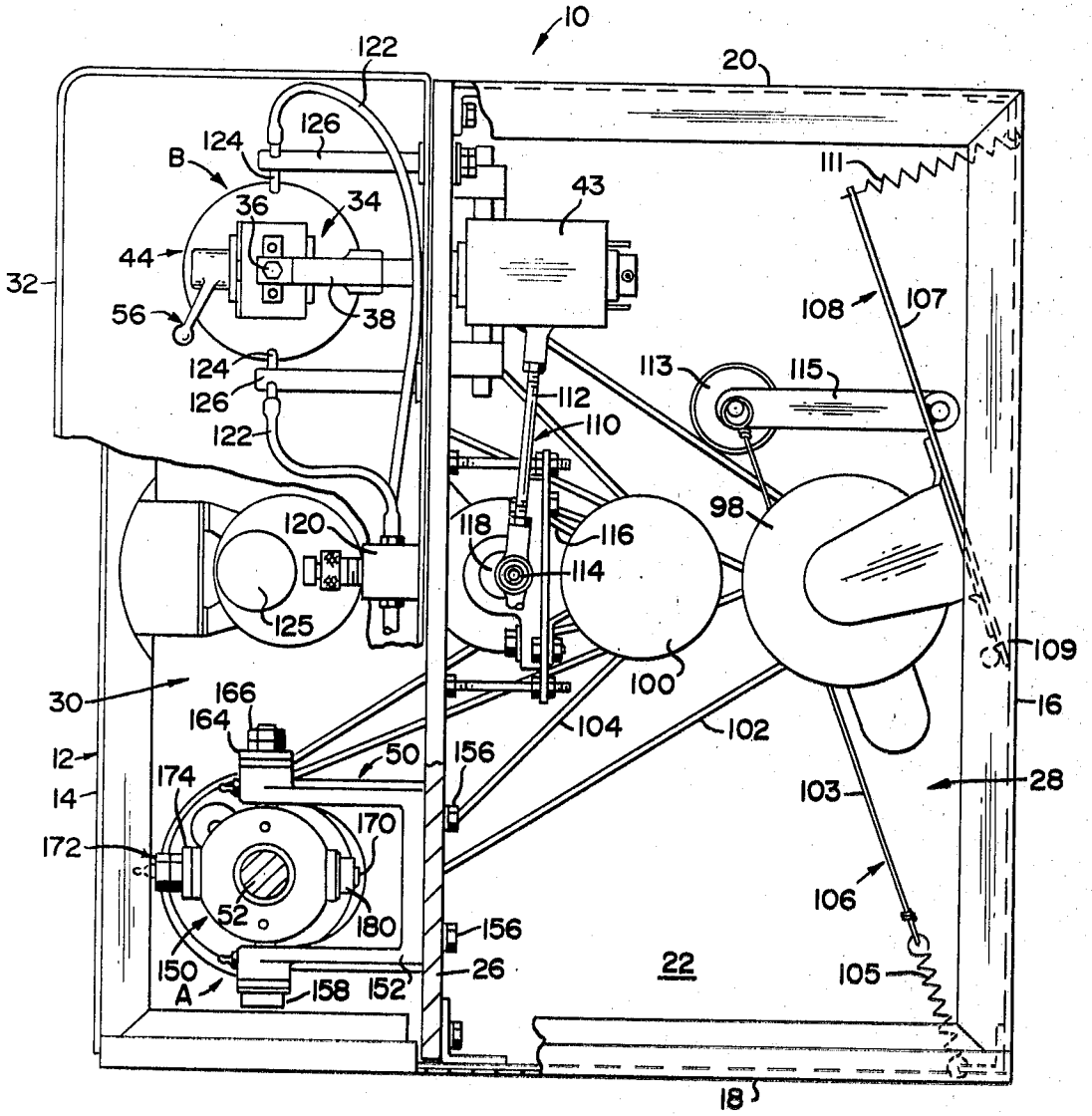

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FIG. 1

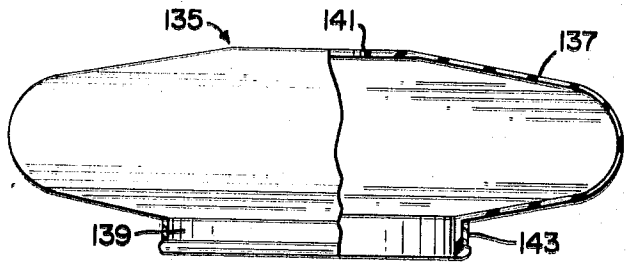

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FIG. 6

FIG. 2

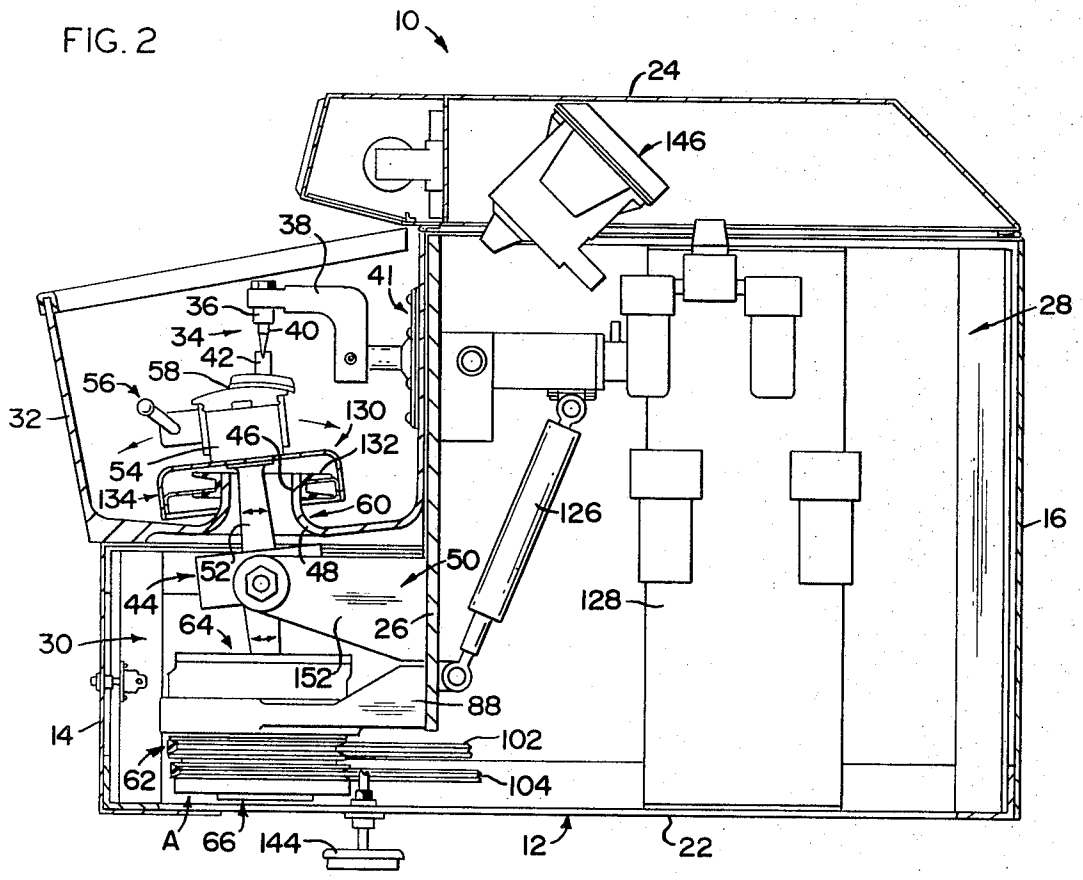

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FIG. 5

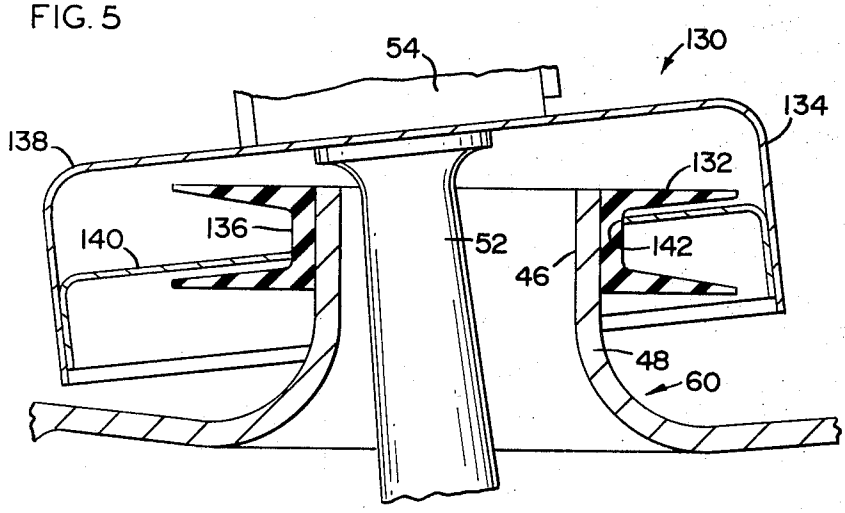

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FIG. 3

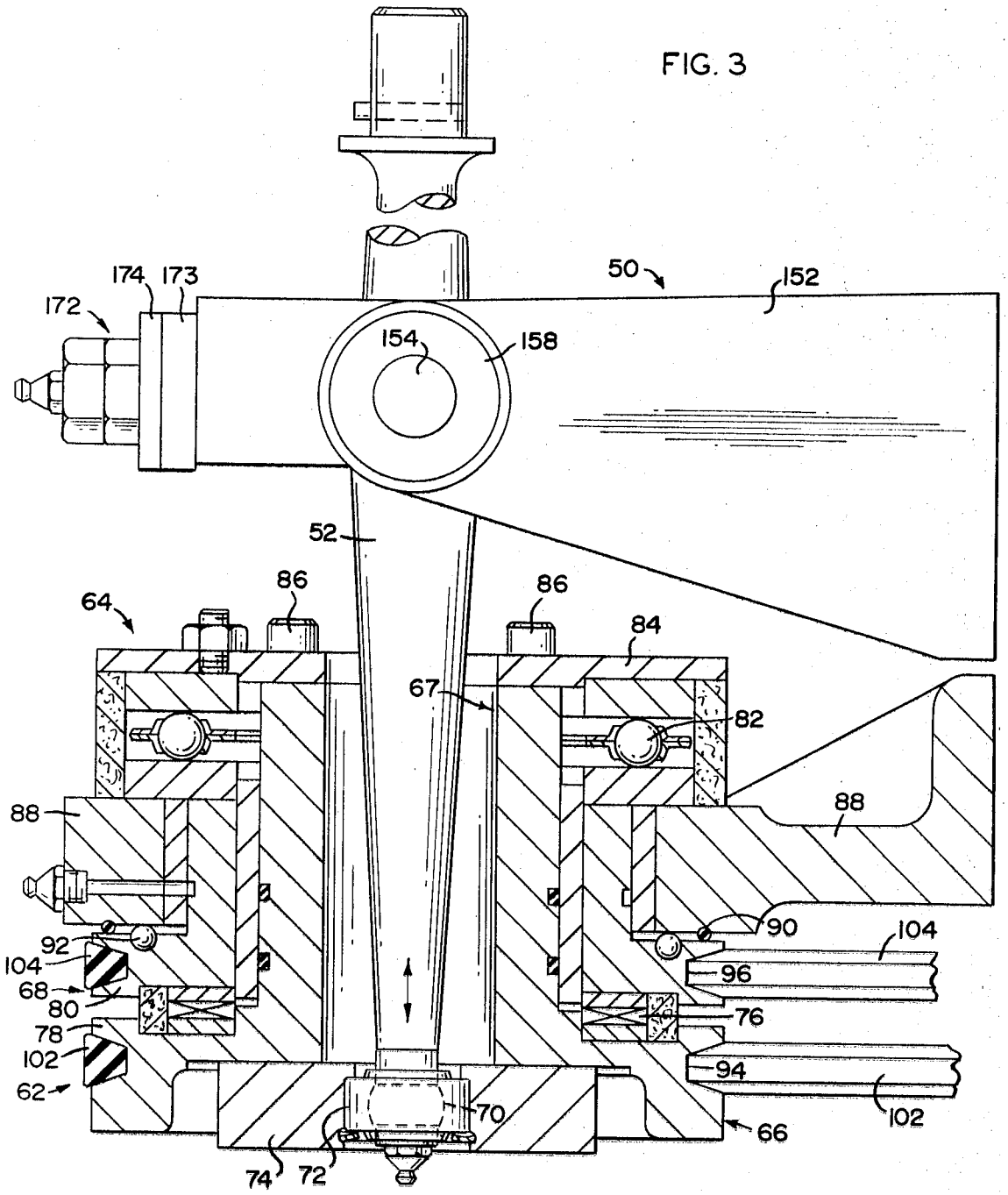
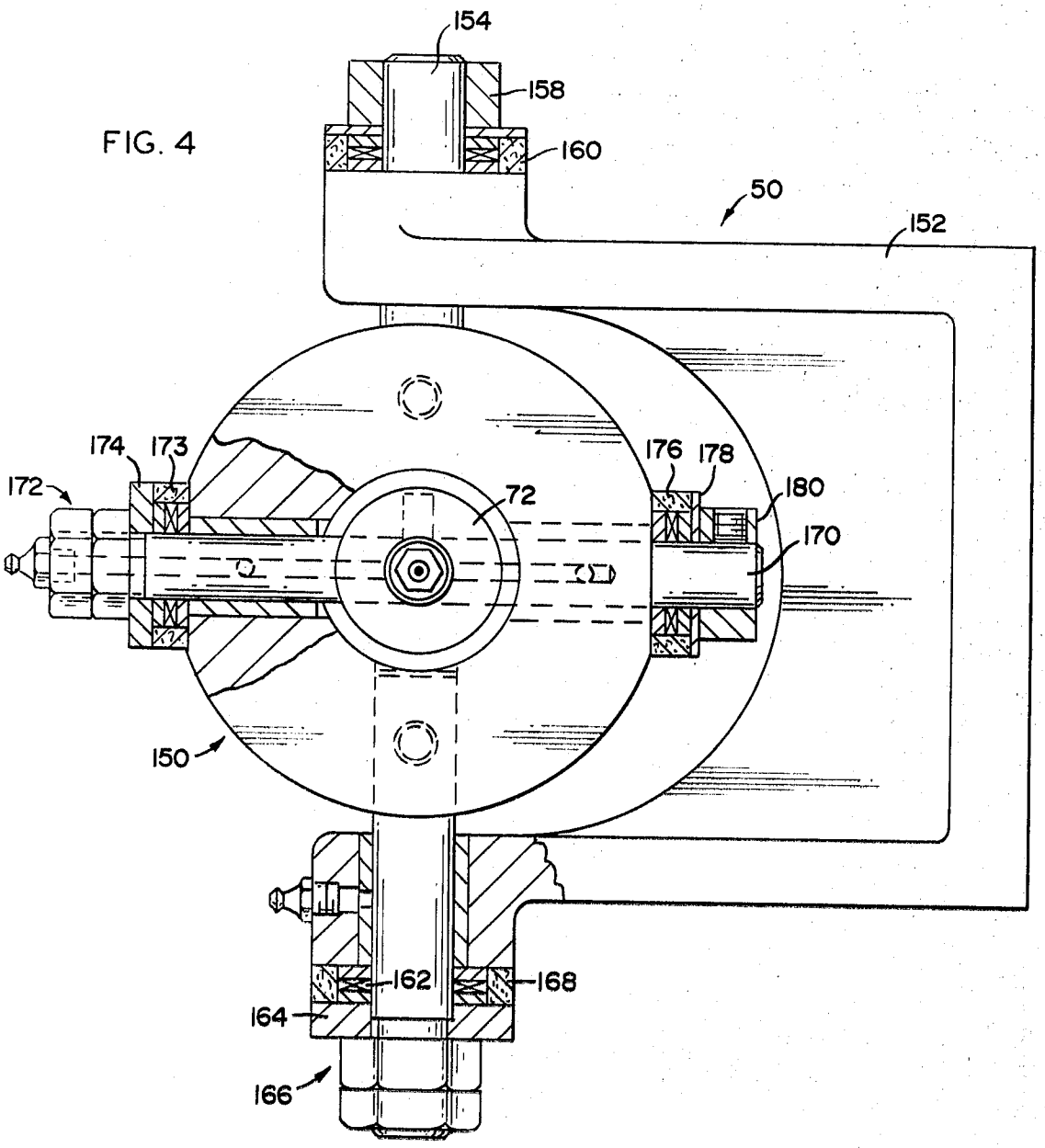

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FIG. 4


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LENS POLISHING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

A high speed lens grinding and polishing machine including a gimbal mounted polishing element mounted within a spherical bearing to permit an upper lens clamping element to follow the contour of the lens during the polishing process.

2. Description of the Prior Art

Numerous devices have been developed for grinding and polishing lens blanks for producing a compound curvature surface. Generally the lens blanks are ground to a predetermined toric shape and then polished with a lap tool having a curvature corresponding with that to be imparted to the finished lens.

In surfacing operations, alignment axes of the lens blank and lap tool is critical. To maintain proper alignment various complex and elaborate structures to support the lens blanks and lap tools have been developed. Unfortunately the complexity of such devices present poor lens quality when operating at relatively high speeds. Generally existing machines fall into one of two groups. The first group shows various spring biased operable support shafts in combination with various lens support working tools. These devices disclose grinding and polishing machines employing a biasing spring to urge the work piece and lens upward against the grinding/polishing tool itself. The second group shows a number of polishing machines including movable linkages or spring biasing means attached to the upper portions of the machines or mechanism which urge the cutting or grinding tool into operative engagement with the lens or mirror surface.

Since the time required to produce a polished surface is dependent upon the relative movement between the lens blank and lap tool existing devices designed for low speed operations are inadequate. Other factors affecting the effective operating speeds are the initial lens blank surface, the pressure applied between the lens blank and lap tool and the polishing medium.

Present devices and techniques have not been able to meet the increased requirements for more accurate and efficient production methods without sacrifice of lens quality. This is particularly true due to the problems of balance and variations in the interface between the lens blank and lap tool during high-speed operations.

SUMMARY OF THE INVENTION

This invention relates to a high-speed lens grinding and polishing machine. More specifically, this machine comprises a bench model cabinet housing a gimbal mounted polishing element supported within a bearing housing.

The gimbal mounted polishing element comprises a spindle operatively coupled to a first drive means including a main drive for rotational movement and a breakup drive of constantly changing the center point of rotation of the main drive. A lens blank holder is attached to the upper portion of the spindle to hold a lens blank in operative communication with a lap tool held in place by a tool holder. A second drive means is attached to the tool holder to provide lateral movement of the lap tool relative to the lens blank. The lower portion of the spindle comprises a spherical bearing housed within the bearing housing.

An air cylinder is coupled to the tool holder to maintain a constant pressure between the lap tool and lens blank during the polishing process.

The machine also includes a polishing slurry means to supply a polishing slurry for the lens blank surface during the polishing process. In addition, a sealing means is provided to isolate the slurry from the gimbal and drive assemblies.

In operation the spindle and lens blank are driven in eccentric movement through the gimbal assembly by the first drive means. As the lens blank moves relative to the lap tool, the distance between the bearing housing and lap tool changes due to the curvature of the lap and lens blank. Since the spindle includes the spherical bearing the effective length of spindle varies to compensate for the changing bearing housing to lap tool distance providing a smooth, constant pressure polishing interface between the lens blank and lap tool.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings which:

FIG. **1** shows a partial cross-sectional top view of the present invention.

FIG. **2** shows a cross-sectional side view of the present invention.

FIG. **3** shows a detailed cross-sectional side view of the drive means of the present invention.

FIG. **4** shows a detailed partial cross-sectional top view of the gimbal assembly of the present invention.

FIG. **5** shows a detailed cross-sectional side view of the sealing means of the present invention.

FIG. **6** shows a detailed view of an alternative seal means.

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

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. **1**, this invention comprises a bench model high speed lens grinding and polishing machine generally indicated as **10**. As seen in FIGS. **1** and **2**, the machine **10** includes cabinet **12** comprising front and rear panels **14**/16 respectively, side panels **18**/20 and bottom panel **22**. Pivotally attached to the upper portion of rear panel **16** is cover assembly **24**. Extending vertically upward between side panels **18**/20 is divider panel **26** separating cabinet **12** into enlarged rear enclosure **28** and open forward housing **30**. Sink **32** is attached to divider panel **26**.

Extending inwardly into the upper portion of sink **32** is tool holder means generally indicated as **34**. Tool holder means **34** includes pin holder **36** attached to pin holder support means **38** extending outward from divider panel **26**. Pin **40** is fixedly held within pin holder **36** to engage lap tool **42**. Extending rearwardly through divider panel **26** is interconnecting means **41** that attaches plates **43** to support means **38**.

A lens polishing element, generally indicated as **44**, extends upwardly from housing **30** through aperture **46** formed in neck portion **48** of sink **32** and into sink **32**. The lower portion of polishing element **44** comprises gimbal assembly **50** and spindle **52**. The upper portion of spindle **52** is attached to lens holder **54** including adjustment means **56** to hold lens **58** of various sizes within lens holder **54**. The upper portion of spindle **52** extends through neck **60** as more fully described hereinafter. The lower portion of spindle **52** is in operative communication with first drive means **62** as more fully described hereinafter.

As best shown in FIG. **4**, gimbal assembly **50** comprises gimbal block assembly **150** operatively connected to U-shaped gimbal braceket **152** by lateral gimbal shaft **154**. Bracket **152** is affixed to divider panel **26** by fastening means **156** (FIG. **1**). Lateral gimbal shaft **154** is attached to bracket **152** at one end by set screw collar **158** and spacer **160**, and at the opposite end by trust bearing **162**, spacer **164** and fastening means **166**. Trust bearing **162** is enclosed within felt washer **168**. A longitudinal gimbal shaft **170** extends through gimbal block assembly **150** substantially at right angles to lateral gimbal shaft **154**. Longitudinal gimbal shaft **170** is attached to block assembly **150** by fastening means **172**, washer **173** and spacer **174** at one end; and washer **176**, spacer **178** and set screw collar **180** at the opposite end.

First drive means **62**, as best shown in FIG. **3**, includes main drive housing assembly means **64** comprising main drive orbit sleeve assembly **66** and breakup sleeve assembly **68**. The lower portion of spindle **52** extends through aperture **67** and terminates in spherical bearing **70** housed within bearing means **72**. Bearing means **72** is secured within bearing housing **74** attached to the lower portion of sleeve assembly **66**. Thrust race **76** is operatively disposed between annular bases **78** and **80** of sleeve assemblies **66** and **68** respectively. Thrust bearing **82** is operatively disposed between sleeve assembly **68** and bearing plate **84** which is attached to sleeve assembly **66** by cap screws **86**. The entire main drive housing assembly **64** is affixed to divider panel **26** by bracket means **88**. An O-ring **90** and ring of bearings **92** are operatively disposed between base **80** and bracket **88**. Bases **78** and **80** include annular grooves **94** and **96** respectively. As best shown in FIG. **1** and **3**, sleeve assemblies **66** and **68** are interconnected to drive motors **98** and **100** respectively by V-belts **102** and **104** which are operatively coupled to grooves **94** and **96** respectively. Of course a single drive motor may be used in place of drive motors **98** and **100**. Drive motor **98** is mounted to housing **20** a mounting means comprising spring bias means **106** and **108**. Spring bias means **106** comprises flexible linkage **103** affixed to the motor **98** and spring **105** affixed to the frame. Spring bias means **108** comprises rigid member **107** affixed to motor **98** and pivotally attached to the frame at **109**, and spring **111** affixed to the frame. Idler wheel **113** is attached to member **107** by member **115**. Since main drive assembly **66** moves eccentrically relative to gimbal assembly **50** it is necessary that motor **98** coupled to main drive assembly **66** by V-belts **102** follow the changing between center point of the drive assembly **66**. When drive assembly **66** of unit A is at its rearward most point of travel spring **111** will bias motor **98** rearward toward panel **16**. As drive assembly **66** of unit A moves forward away from panel **16** V-belt **102** draws motor **98** forward. Simultaneously the distance between drive assembly **66** and motor **98** decreases V-belt **102** of unit B rides against idler wheel **113** to take up the slack. As drive assembly **66** of unit A returns to the rearward most position spring **111** draws motor **98** rearward to maintain the tension of V-belt **102** of unit A. This action continues throughout the operation of the device **10**.

As seen in FIG. **1**, second drive means generally indicates as **110** provides lateral movement of tool holder **34** relative to lens holder **44**. Second drive means **110** comprises linkages **112** fixedly attached to plates **43** and eccentric drive post **114**. The lower portion of eccentric drive post **114** is operatively coupled to drive motor **100** by V-belt **116**. Eccentric drive post **114** is disposed within bearing **118**.

As shown in FIG. **1** the machine also includes polish slurry means to supply a polishing fluid. The polish slurry means comprises a manifold means **120** interconnecting a slurry pump means (not shown) and feed tubing **122**. Feed tubing **122** is coupled to nozzle means **124** held in operative communications with tool holder means **34** and lens blank **58** by support means **126** attached to divider panel **26**. Return drain **125** is formed in the bottom of sink **32** whereby the slurry is recycled to the pump for continuous use.

As shown in FIG. **2**, the machine includes a constant pressure means to maintain the pressure between the lap tool **42** and lens blank **58** at an adjustable predetermined pressure during the polishing process. The constant pressure means comprises an air cylinder **126** pivotally connected at one end to plate **43** and at the opposite end to divider panel **26**. The air cylinder **126** is operatively connected to a pneumatic panel assembly **128** within housing **28**.

As shown in FIG. **5**, the machine further includes a sealing means generally indicated as **130** comprising baffle **132** and cup-shaped labyrinth **134**. Baffle **132** comprises an annular seal **136** including groove **136** affixed to neck **60**. Labyrinth **134** comprises a cup-shaped outer member **138** affixed to the upper end of spindle **52**. Affixed to inside of outer member **138** is a second cup-shaped inner member **140** including a central aperture **142** in sealing engagement with the inner portion of groove **136**.

FIG. **6** shows an alternate seal means **135** comprising elliptically shaped enclosure **137** including sleeve **139** and aperture **141**. Sleeve **139** is affixed to neck **60** by coupling means **143**. The upper end of spindle **52** is attached to tool holder **54** through aperture **141**.

A shown in FIG. **2**, the machine includes leveling means **144** rotatably attached at either end of button panel **22** and automatic timer **146** to turn off first and second drive means **62** and **110** respectively and pressure means after a predetermined time laps.

In operation, lens blank **52** is placed within the adjustable lens holder **54** and affixed thereto. Lap tool **42** is then operatively engaged therewith and held in operative position by pin **40** of tool holder **34**. The proper pressure between these surfaces is applied by adjusting the pressure of air cylinder **126**. The machine **10** may be used for either grinding or polishing. According to whether it is a rough or smooth finish, the pressure is adjusted and the timer **146** is set to automatically run for a predetermined time. Once actuated motors **98** and **100** drive spindle **52** in eccentric movement relative to pin **40** and lap tool **42** through gimbal assembly

44. This eccentric movement results from the circular movement of the main drive assembly **66** and breakup drive assembly **68** constantly moving the center point of the circular movement. It should be noted in FIG. **1**, two polishing assemblies may be placed in tandem and driven simultaneously by motors **98** and **100**.

Where desired, slurry polish may be applied against the lens blank surface to assist in the polishing process. This is accomplished by pumping the polish slurry through manifold **120**, tubing **122** and nozzle **124** onto the lens blank **42** itself. As the slurry is thrown from the moving surfaces it is returned to the slurry pump (not shown) through drain **125**. It should be particularly noted that sealing means **16** prevents the slurry polish from flowing through neck **62** and onto the gimbal assembly **44** and drive means **62**.

It should also be noted that the tool holder **34** and lap tool **42** may be moved laterally relative to the lens blank **52** and lens holder **54** by second drive means **110**.

During the polishing process as the lens blank **52** moves in relation to lap tool **42**, the distance between bearing housing **72** and lap tool **42** changes due to the curvature of lap tool **42** and lens blank **42**; eccentric movement of lens blank **42** and lateral movement of lap tool **42**. Since spindle **52** includes bearing **70**, spindle **52** rises within housing **72** to effectively change virtual length of spindle **52** to compensate for the changing housing **72** to lap tool **42** distance providing a smooth, constant pressure polishing interface lens blank **52** and lap tool **42**.

It will thus be seen that the object made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which as a matter of language, might be said to fall therebetween.

Now that the invention has been described.

What is claimed is:

1. A high-speed lens polishing machine comprising a cabinet and a polishing element mounted thereon, said polishing element including spindle means and lens holding means configured to retain a lens blank, first drive means attached to said cabinet operatively coupled to said polishing element, tool holding means attached to said cabinet, said tool holding means configured to retain a lap tool, said tool holding means in operative communication with said lens holding means, said first drive means moving said lens holding means relative to said tool holding means, said spindle means including a substantially circular bearing means and said first drive means including a substantially spherical bearing means, said substantially circular bearing means being movably disposed within said substantially spherical bearing means such that said spindle means moves within said drive means to change the virtual length of said spindle means relative to said tool holding means whereby tool holding means follows the contour of lens during the polishing process.

2. The high-speed lens polishing machine of claim **1** further including a second drive means operatively connected to said tool holding means to move said tool holding means laterally relative to said lens holding means during the polishing process.

3. A high-speed lens polishing machine of claim **1** further including a gimbal assembly means interconnected to said cabinet said spindle means being operatively coupled to said gimbal assembly means and wherein said drive means comprises a main drive assembly means and breakup drive assembly said lens holder in a substantially circular orbit and said breakup drive assembly means constantly changing the center point of the circular orbit relative to said lap tool holder whereby said lens holding means follows an eccentric orbit relative to said tool holding means during the polishing process.

4. The high-speed lens polishing machine of claim **3** further including a slurry polish supply means comprising manifold means, tube means and nozzle means, said nozzle means in operative communication with said lap tool holding means and said lens holding means to provide slurry polish during the polishing operation.

5. The high-speed lens polishing machine of claim **4** further including a seal means isolating said lens holding means, said tool holding means and said slurry polish supply means from said gimbal assembly means and said first drive means.

6. The high-speed lens polishing machine of claim **5** wherein said seal means comprises a cup-shaped labyrinth including outer cup-shaped member affixed to said spindle and inner cup-shaped member affixed to said outer cup-shaped member.

7. The high-speed lens polishing machine of claim **6** wherein said seal means further includes a baffle engaging said inner cupshaped member to seal said spindle means, said gimbal means and first drive means from said slurry polish.

8. The high-speed lens polishing machine of claim **7** wherein said baffle comprises a resilient substantially annular member including a groove formed about the circumference thereof and said inner cup-shaped member includes a substantially annular aperture from therein such that the inner periphery of said annular aperture sealingly engages the inner periphery of said groove to cooperatively form a seal therebetween.

9. The high-speed lens polishing machine of claim **1** further including a fluid pressure means attached to said tool holding means to maintain a substantially constant predetermined pressure between said lens blank and said lap tool during the polishing process.

10. The high-speed lens polishing machine of claim **5** wherein said seal means comprises an enclosure including a sleeve portion affixed to said spindle.

11. The high-speed lens polishing machine of claim **1** further including motor means operatively interconnected to said main drive assembly means to drive said main drive assembly means.

12. The high-speed lens polishing machine of claim **11** wherein said motor means coupled by flexible belt means to said main drive assembly means.

13. The high-speed lens polishing machine of claim **12** wherein said motor means is attached to said mahcine by mounting means, said mounting means comprising biasing means such that said mounting means follows the movement of said spindle assembly during the polishing process.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,838,542 Dated October 1, 1974

Inventor(s) Lee R. Hodges

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 62, delete "mah-".

Column 6, line 63, delete "cine" and insert therefor -- machine --.

Signed and sealed this 22nd day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

FORM PO-1050 (10-69)

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