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Prunier

[11] **3,916,574**

[45] **Nov. 4, 1975**

[54] **LENS SURFACING APPARATUS**

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[73] Assignee: **American Optical Corporation,** Southbridge, Mass.

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[21] Appl. No.: **528,298**

[52] **U.S. Cl.** ..... **51/124 L**

[51] **Int. Cl.²** **B24B 7/00;** B24B 9/00

[58] **Field of Search** ..... 51/105 LG, 124 L, 134.5

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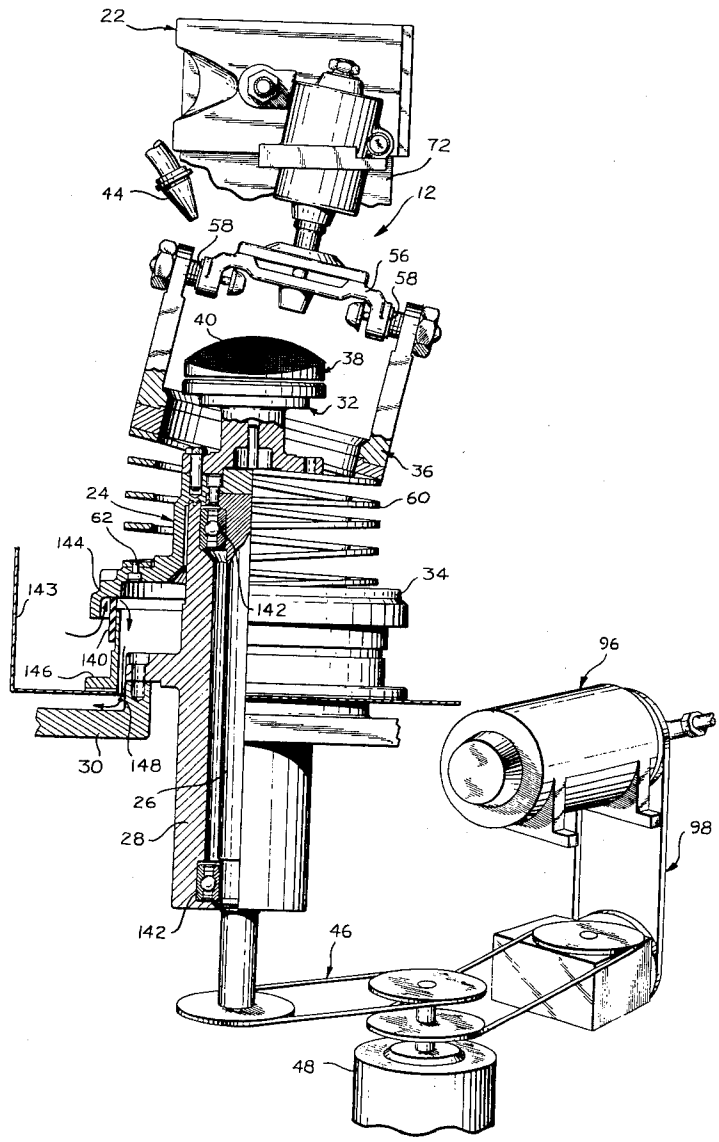
Primary Examiner—Othell M. Simpson

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[57] **ABSTRACT**

A lens surfacing machine having a rotatable lower tool supporting spindle and an oscillational work actuating head of minimal mass and weight. Vibration dampeners reducing noise, wear and lens breakage are incorporated in the tool and work actuating components of the machine. A motor driven compound motion imparting system, protected from abrasive contamination, produces oscillation of the work actuating head with a continuous break up of the oscillatory motion and simultaneous rotation of the tool supporting spindle.

10 Claims, 7 Drawing Figures



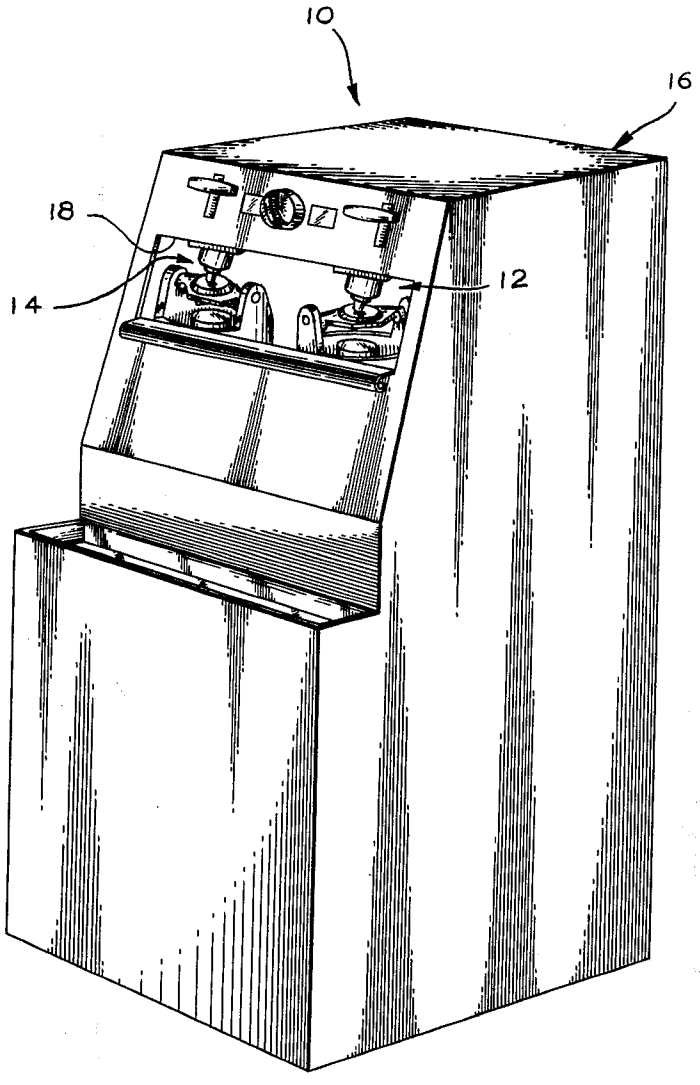


FIG. 1

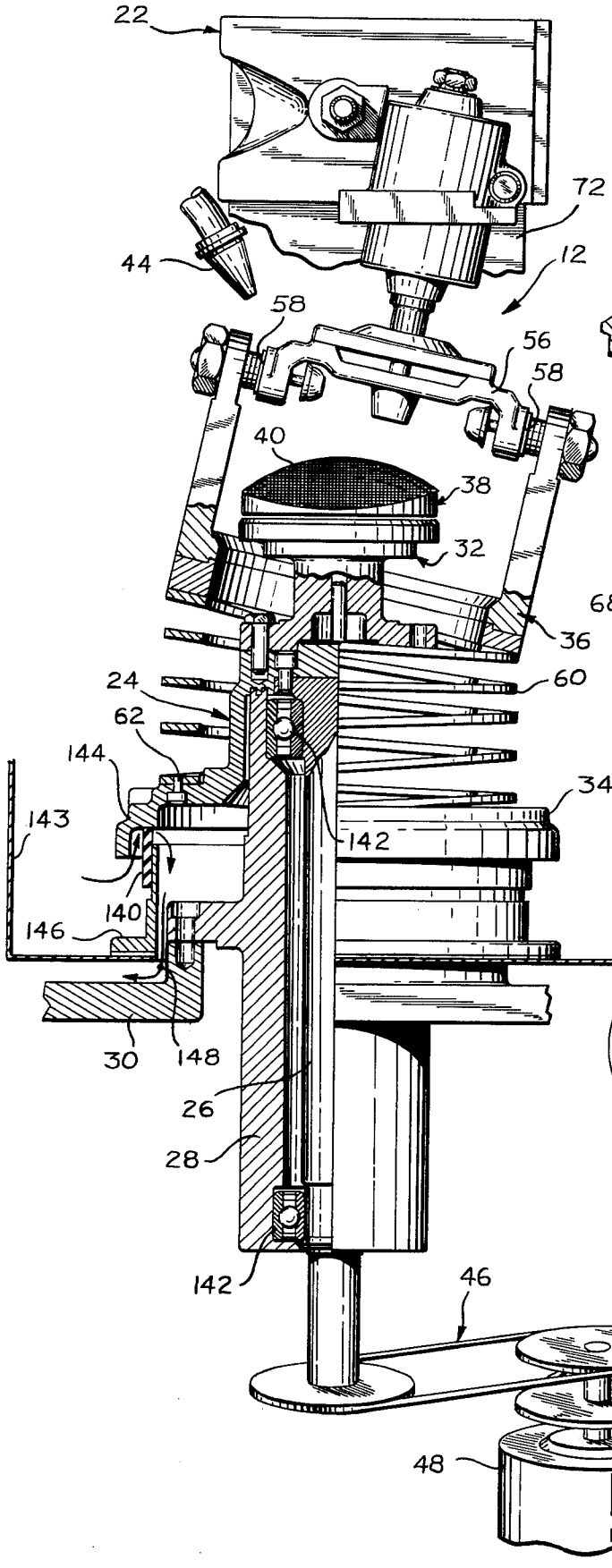

22
72
44
12
58
56
58
40
38
32
36
24
60
62
144
34
143
142
140
146
30
148
26
28
142
46
48
96
98

FIG. 2

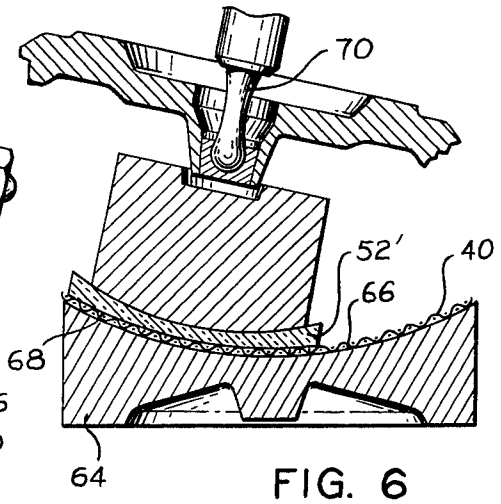

70
52'
40
66
68
64

FIG. 6

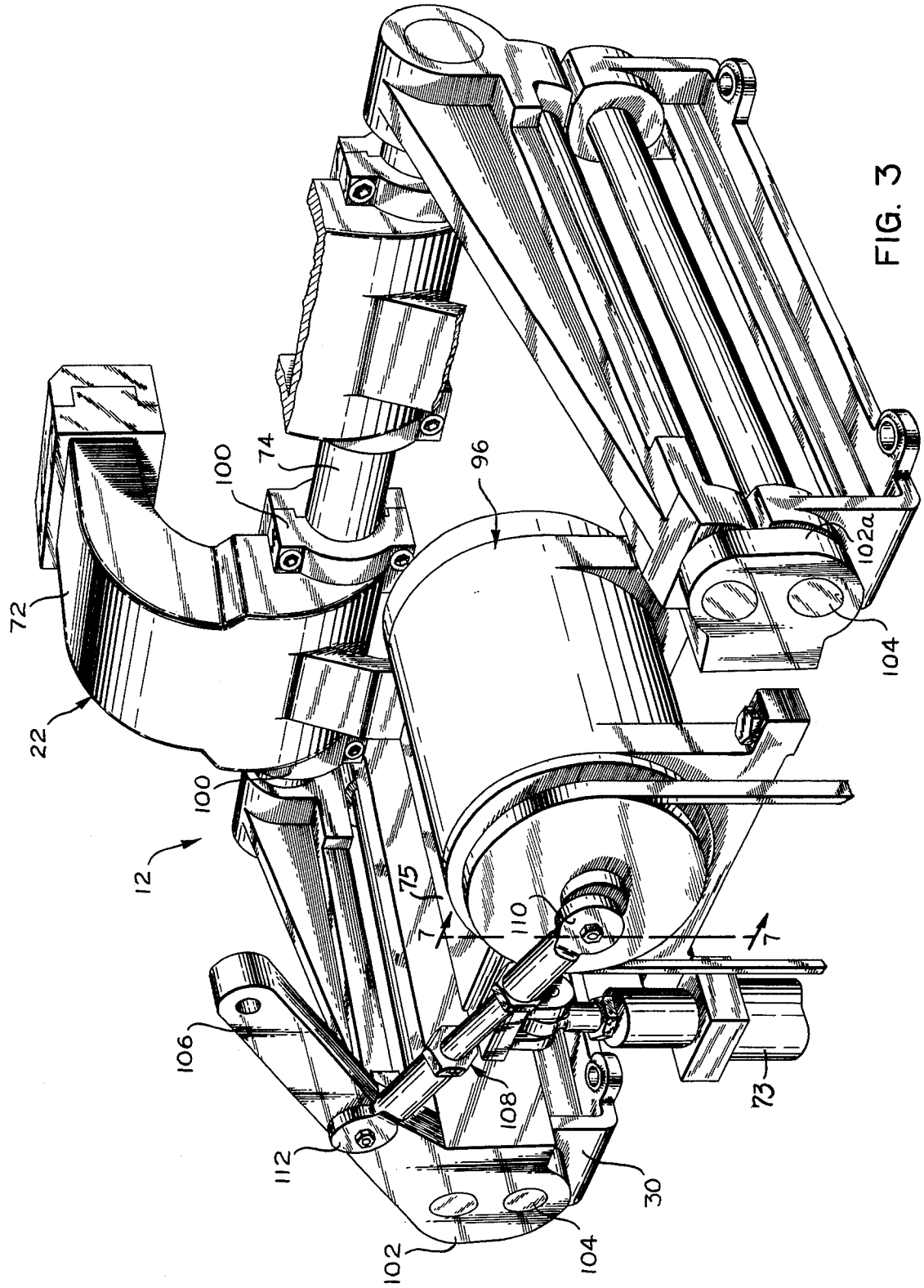


FIG. 3

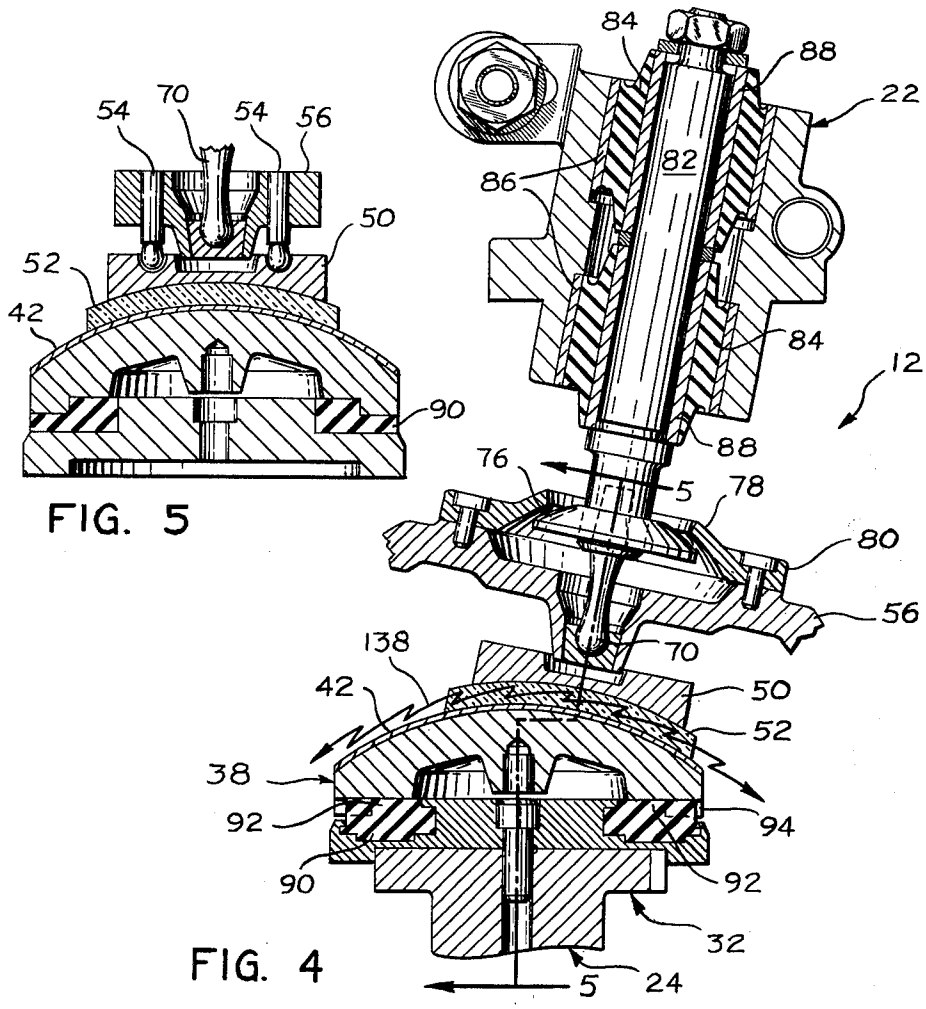


FIG. 5

FIG. 4

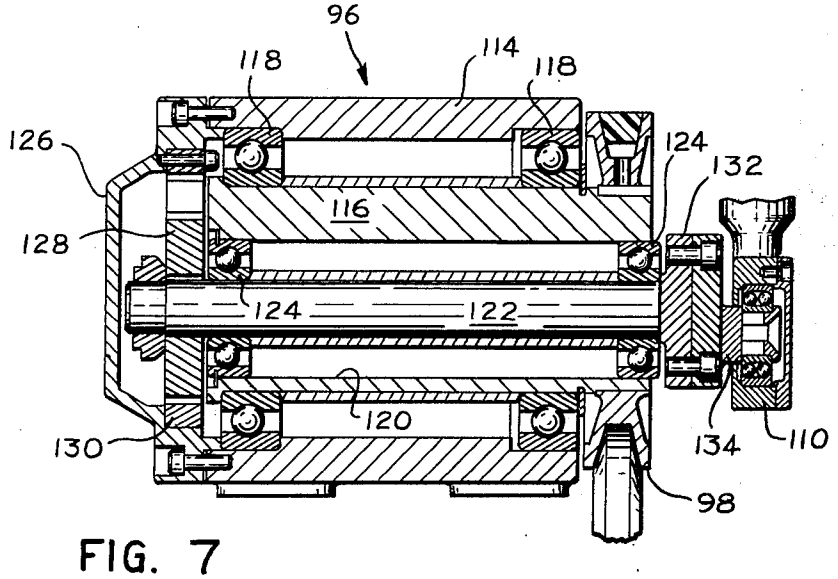


FIG. 7

LENS SURFACING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for surfacing articles such as lenses and has particular reference to improvements in high speed lens grinding and polishing machinery.

2. Discussion of the Prior Art

In the manufacture of ophthalmic lenses, preliminary operations of milling or generating the lenses to their desired surface configurations are usually followed by fine grinding, commonly referred to as "fining", and polishing.

Fining operations are conducted to true the curvatures of milled or generated surfaces and prepare such surfaces for polishing by removing excessive roughness, surface cracks and other such irregularities.

Polishing is then undertaken and continued for a period of time sufficient to produce a surface of optical quality. Those interested in a detailed technical description of the requirements for "optical quality" may refer to "Optical Glass Working" by F. Twyman published by Hilger & Watts Ltd. of London, 1955, pages 154 et seq.

In general, the time required to fine and/or polish a lens is dependent upon the amount and kind of relative motion which can be produced between the lens and tool and the rate at which the motion is imparted. That is, with factors such as texture of the initially milled or generated surface, the smoothness desired of the fined surface, pressure applied to the workpiece in fining and/or polishing and characteristics of the polishing medium all being equal, greater amounts of relative motion and faster operating speeds will reduce fining and/or polishing time.

Heretofore, however, attempts to reduce fining and polishing times with increased motion and operating speeds have been met with such adverse effects as machinery breakdown and/or excessive wear resulting from vibration, lens breakage or inferior surface finishes and undue noise pollution.

The present invention accomplishes a substantial reduction of prior art fining and polishing times and a lessening of product scrap yield by overcoming previous vibration problems and limitations of the extent and directions of relative tool and workpiece motion.

Accordingly, a principal object of the invention is to provide for improved and more efficient operation of lens surfacing apparatuses, lower product scrap yield and higher quality output with longer than usual machinery lifetime and a substantial reduction in occurrences of breakdown, a shortening of repair and maintenance times and large reduction of machinery noise pollution.

SUMMARY OF THE INVENTION

The invention relates to improvements in a type of lens surfacing machine having a rotatable lower tool supporting spindle and an oscillational work actuating head.

The present work actuating head is free of the usual individually power driven spindle apparatuses and, accordingly, is of minimal mass and weight thereby greatly reducing machine vibration and its adverse affects. Vibration dampeners further reducing noise, wear and lens breakage are incorporated in both the tool and work actuating components of the present machine.

A motor driven motion imparting system protected from contamination by abrasive slurry is constructed and arranged to produce a compound oscillatory motion of the work actuating head. This compound motion uniquely obviates the need for conventional ungainly and heavy spindle rotating devices heretofor used in surfacing machine heads.

With the foregoing improvements minimizing vibration problems, noise pollution, lens breakage and machinery wear, maintenance problems are still further lessened and machine lifetime is extended by a unique sealing of critical machinery bearing components and other such moving parts from abrasive slurry contamination. Additionally, an abrasive slurry overflow system is provided as a safeguard against possible malfunction of the sealing means to assure against contamination of the machine bearings.

Details of the invention will become more readily apparent from the following description when taken in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustration, in perspective, of a preferred embodiment of the invention;

FIG. **2** is a fragmentary partially cross-sectioned elevational view of a lens surfacing unit of the embodiment of the invention shown in FIG. **1**;

FIG. **3** is a fragmentary rear view, in perspective, of the upper portion of the unit shown in FIG. **2**;

FIG. **4** is a vertical cross section of the uppermost portion of the surfacing unit shown in FIG. **2**;

FIG. **5** is a cross sectional view taken generally along line **5—5** of FIG. **4**;

FIG. **6** is a view similar to that of FIG. **5** but illustrating a modification of the apparatus shown in FIG. **5**; and

FIG. **7** is a cross-sectional view of a portion of the apparatus shown in FIG. **3**, the cross-section being taken from line **7—7** looking in the direction of its arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more particularly to the drawings, the lens surfacing machine **10** (FIG. **1**) of the invention preferably comprises a pair of identical lens surfacing units **12** and **14** within a single shroud **16.** Shroud **16** has an opening **18** through which lenses may be positioned in and unloaded from surfacing units **12** and **14.** Cover **20** is adapted to be selectively placed over opening **18** to prevent excessive outward splashing of abrasive slurry during lens grinding or polishing operations performed with units **12** and **14.**

Only one of units **12** and **14,** namely unit **12,** is illustrated in FIGS. **2–7** of the drawings and will be described in detail hereinafter; it being understood that unit **14** is substantially identical. It is further pointed out that machine shroud **16** may be readily adapted, within the scope of the present invention, to incorporate more than the illustrated two surfacing units or, alternatively, only a single unit such as will be described in detail hereinafter.

Surfacing unit **12** (FIGS. **2, 3** and **4**) comprises oscillational work actuating head **22** and rotatable tool supporting spindle structure **24.** Spindle structure **24** comprises rotatable, vertically disposed spindle **26** journaled in housing **28** which is fixedly supported upon

machine base **30** within shroud **16.** Spindle **26** is topped with tool holder **32** and a depending generally hollow umbrella-shaped support **34** for lens supporting and axis aligning harness mechanism **36.**

Tool holder **32,** support **34** and harness mechanism **36** rotate in unison with spindle **26** to impart rotation to surfacing tool **38.**

Surfacing tool **38,** which may be of any one of various types commonly used in the industry, is preferably provided with a wire mesh pad **40,** e.g. of the type shown and described in U.S. Pat. No. 2,886,923, when a lens surface grinding operation is to be performed with machine **10.** Alternatively, the tool **38,** or a similar tool, is provided with a polishing pad of plastic, felt or other material conventionally used, as shown in FIGS. **4** and **5,** for example.

It is to be understood that this showing of both wire mesh grinding pads **40** and polishing pads **42** in different views of the same embodiment of the invention (unit **12**), has been used to minimize drawing detail and to emphasize the adaptability of unit **12** to either a surface grinding or a surface polishing operation. It is to be further understood that surface grinding and surface polishing operations are usually performed in separate but identical machines to prevent contamination of polishing slurries with grinding abrasives and vice versa. In a grinding operation, a slurry of emery particles supplied through a nozzle **44** would ordinarily be used while the same or a similar nozzle would supply a slurry of a polishing medium such as zirconium oxide or cerium oxide in water during the course of a polishing operation.

Those interested in greater details of lens surface grinding and surface polishing operations in general, may refer to U.S. Pat. Nos. 3,093,939 and 2,916,857.

Rotation of spindle **26** and tool **38** is produced by belt drive mechanism **46** (FIG. **2**) powered by motor **48.** Workpiece holder (e.g. lens block **50,** FIGS. **4** and **5**), carrying a lens **52** in conventional fashion for surfacing, is secured in harness **36** by locating pins **54** (FIG. **5**) in yoke **56.** Yoke **56** having its two opposite ends **58** pivotally mounted to harness **36** (FIG. **2**) prevents independent rotation of lens block **50** and lens **52** relative to tool **38.**

Flat spring coil **60** (FIG. **2**) of axis aligning harness **36** is secured to support **34,** e.g. by stud **62** so as to prevent the aforesaid relative rotational movement between lens **52** and tool **38** while freely permitting oscillational movement of harness **36** and lens **52** continuously during simultaneous rotation of the entire unit of spindle **26,** tool holder **32,** tool **38,** harness **36,** lens block **50** and lens **52.**

With such as the aforesaid rotational and oscillational action, lens **52** is adapted to be surfaced whether surfacing is desired to produce a toric negative (concave) curvature thereon or a simple spherical negative curvature. The term "surfacing" as used herein is intended to include both surface grinding and surface polishing operations.

More specific details of the function of axis aligning harnesses such as **36** and modifications thereof may be had by reference to U.S. Pat. No. 3,093,939. Another useful form of axis aligning harness is shown and described in U.S. Pat. No. 2,916,857.

While the aforesaid description of lens surfacing operations has thus far made reference only to the production of negative toric or spherical surfaces as illustrated in FIGS. **4** and **5,** simple substitution of a tool **64** having a concave working surface **66** (FIG. **6**) covered either with a wire mesh pad **40,** as shown, or with a polishing pad **42,** will provide the means necessary for surfacing positive (convex) surfaces **68** upon a lens **52',** for example. This convex surface **68** and working surface **66** may selectively be either spherically or torically curved as determined by the selection of tool **64,** i.e. whether tool **64** has a toric or spherical working surface **66.**

In order to produce the aforesaid oscillational movement of lens **52** or **52'** over tool **38** or tool **64,** head **22** of surfacing unit **12** (FIGS. **2** and **4**) is provided with drive pin **70** (FIGS. **4, 5** and **6**) which is stationary in head **22** and normally relatively permanently but removably seated in yoke **56.**

A rearward extension **72** of head **22** pivotally mounted on horizontal shaft **74** provides means for selectively moving head **22** downwardly toward and upwardly away from tool **38** for selective placement and removal of blocked lenses **52,** with their blocks **50,** from surfacing unit **12.** An air cylinder **73** or other suitable actuating means connected to lever **75** may be used to raise and lower head **22.** The lifting of yoke **56** upwardly to release pins **54** from block **50** is effected by washer **76** which is fastened to head **22.** Washer **76** is adapted to engage lip **78** of retainer **80** when head **22** is raised. Head **22** may be disconnected from harness **56** by removal of retainer **80.**

It can be seen from the drawings that the head **22** of surfacing unit **12** is entirely free of the usual separately motor driven eccentric pin rotating mechanism. Reasons for the present invention making it possible to eliminate such prior art complex ungainly and weighty mechanisms will become more readily apparent from a description of the oscillation producing mechanism of the present apparatus which will follow shortly.

In the meantime, with continued reference to details of head **22,** it will be seen by reference to FIG. **4** that prior art problems of machine vibration which are at least partly overcome by the aforementioned simplification of head **22** design, are still further reduced, if not eliminated, by resiliently mounting the drive pin **70** and supporting rod **82** in head **22.** This is accomplished by the incorporation of relatively hard but resilient rubber bushings **84** vulcanized to supporting sleeves **86** and **88** of metal. Rubber bushings **84,** acting as vibration dampening means, absorb both high and low frequency vibrations whether produced by movement of lens **52** over the abrading surface of tool **38** and/or from other movable parts of unit **12.**

In conjunction with the dampening means **84,** a hard rubber or plastic ring **90** in tool holder **32** (FIG. **4**) upon which tool **38** is seated further functions to absorb machine induced vibration and/or minimize parts chatter. Resilient ring **90** (FIGS. **4** and **5**) is formed with diametrically opposed enlarged key-shaped portions **92** (FIG. **4**) over which slot **94** in tool **38** is adapted to fit and thus key the tool **38** against independent rotation on holder **32.** Tool **38** may be readily, simply lifted from tool **32** for removal and similarly readily replaced by being dropped onto ring **90.**

A compound oscillational movement of head **22** which, as mentioned hereinabove, obviates the hitherto need for complex, heavy and ungainly head mechanisms, is produced by drive unit **96.** Unit **96** is powered by motor **48** through belt and pulley mechanism **98** (FIGS. **2** and **3**).

Referring more particularly to FIGS. 3 and 7, the aforementioned rearward extension 72 of head 22 which is permitted to pivot on shaft 74 is fixed against lateral movement therealong by anchor sleeves 100. Opposite ends of shaft 74 are secured in rockers 102 and 102*a* which, in turn, are pivoted upon rods 104 bracketed to base 30 of machine 10.

Rocker 102 is provided with arm 106 which is actuated by drive unit 96 through connecting rod 108. End 110 of connecting rod 108 is driven with a compound eccentric motion which is duplicated at end 112 and transmitted to rocker arm 106. This compound eccentric motion being imparted to rocker 102 and shaft 74 produces the compound oscillational motion (oscillation with break up) of head 22.

Referring more particularly to FIG. 7, details of the mechanism (drive unit 96) involved in producing the aforesaid compound motion are as follows:

Drive unit 96 comprises cylindrical housing 114 within which hollow drive shaft 116 is concentrically journaled by bearings 118. Belt and pulley drive mechanism 98 is affixed to shaft 116. Hollow shaft 116 has channel 120 extending therethrough within which second drive shaft 122 is journaled by bearings 124. Opposite ends of the second drive shaft 122 extend outwardly of channel 120.

Adjacent one end 126 of drive unit 96, spur gear 128 is affixed to drive shaft 122 in mesh with teeth of internal gear 130. Gear 130 is bolted or otherwise fastened to housing 114 of unit 96.

Fixed to the opposite end of shaft 122, e.g. end 132, is eccentric 134 to which end 110 of connecting rod 108 is journaled by bearings 136. Bearings 136 are preferably of a well-known commercially available variety which, with secureness and intimacy of fit upon eccentric 134, provide connecting rod 108 with freedom of limited lateral movement without chatter or looseness of fit. By the use of such bearing means, reasonable machining tolerances may be permitted in the manufacture of parts of drive unit 96 and/or rocker 102 without fear of binding or undue frictional problems occurring in the operation of the unit. End 112 of connecting rod 108 is similarly journaled to rocker arm 106.

The operation of drive unit 96 is as follows:

Belt and pulley drive 98, when set into motion by motor 48, rotates main drive shaft 116 causing shaft 122 to revolve with it, but eccentrically. While so revolving eccentrically, second drive shaft 122 is simultaneously rotated by gear 128. Gear 128 having fewer teeth than gear 130 transverses the inner periphery of gear 130. This rotation of shaft 122, while itself being eccentrically revolved, produces a second off-center motion of eccentric 134. The first revolving motion of hollow main drive shaft 116 thus produces a back and forth relatively slow cranking action upon connecting rod 108 which continually, during this cranking action, is reciprocated back and forth over a short distance several times per each larger cranking operation. The resulting compound cranking motion of connecting rod 108 is, accordingly, transmitted to rocker arm 106, rocker 102, shaft 74 and head 22 which convert the cranking motion to a compound oscillational movement causing drive pin 70 to move a lens 52 being abraded accordingly. This compound oscillatory (break up) movement is generally of the type schematically illustrated by line 138 (FIG. 4). It takes place in both directions of oscillation of lens 52 across tool 38 continuously during simultaneous rotation of the whole unit within and including harness 36 and yoke 56.

Referring now more particularly to the arrangement of the hollow umbrella shaped support 34 for harness 36 which rotates harness 36, the present invention features the provision of a novel resilient seal 140 (FIG. 2) preventing contamination of bearings 142 and/or other internal components of the tool drive mechanism of unit 12.

Grinding or polishing slurry emitted from nozzle 44 and flowing downwardly over a lens being surfaced and thence over the umbrella-shaped support 34 into splash pan 143 for return to its pumping station is deflected away from seal 140 by flange 144 of support 34. A typical slurry pumping and delivery system is shown in U.S. Pat. No. 3,093,939 and, accordingly, needs no further description herein.

While flange 144 deflects most of the grinding or polishing slurry away from seal 140, that not being so deflected is prevented from reaching internal parts of the spindle rotating mechanism by seal 140. Seal 140 is frictionally fitted to annular support 146 which is stationary upon machine base 30.

As a safeguard against failure of seal 140 to prevent abrasive slurry from passing thereover, e.g. due to flooding in pan 143, opening 148 provides an emergency drain into lower portions of machine 10 where no harm can come therefrom.

I claim:

1. In lens surfacing apparatus including a rotatable tool supporting structure, means for rotating said structure, work harnessing means rotatable with said tool supporting structure and a workpiece actuating head having a drive pin, the improvement comprising:
- means for fixedly mounting said drive pin in said head;
- a tool holder in said tool supporting structure;
- a drive unit remote from said head for producing a compound cranking motion and means for actuating said unit;
- rocker means interconnecting said drive unit and head for effecting conversion of said compound cranking motion into a compound oscillational motion and for oscillating said head accordingly when said drive unit is actuated; whereby
- rotation of said tool supporting structure and work harness with simultaneous actuation of said drive unit produces a surfacing motion between a workpiece in said harnessing means and a tool on said tool supporting structure which surfacing motion includes oscillation of said workpiece over said tool with a continuous breakup of its oscillational movement.

2. Apparatus according to claim 1 wherein said means for fixedly mounting said drive pin in said head includes a rod to one end of which said drive pin is immovably attached, said rod extending through and depending from a forward portion of said head; and
- an immovable but vibration dampening bushing surrounding at least a substantial portion of said rod in said head.

3. The lens surfacing apparatus according to claim 2 wherein said bushing is externally and internally surrounded by metallic sleeves and the material of said bushing is attached to said sleeves.

4. The apparatus according to claim 3 wherein said bushing is formed of hard rubber and is vulcanized to said sleeves.

5. The apparatus according to claim 1 wherein said tool holder includes an annular tool receiving seat formed of resilient material.

6. Lens surfacing apparatus according to claim 1 wherein said drive unit comprises a main housing, a hollow shaft journaled to rotate concentrically within said housing, means for rotating said hollow shaft, said shaft having an eccentrically disposed opening extending longitudinally therethrough, a second shaft journaled in said eccentric opening of said hollow shaft, opposite ends of said second shaft extending outwardly of said hollow shaft, one of said ends of said second shaft having an eccentric crank and one end of a connecting rod journaled thereon, the opposite end of said second shaft having a drive gear fixed thereto and an internal gear in mesh with said drive gear and said internal gear being fixed to said housing.

7. Lens surfacing apparatus according to claim 6 wherein said rocker means of claim 1 includes an actuating arm to which the opposite terminal end of said connecting rod is journaled and a shaft carrying said workpiece actuating head wherewith operation of said drive unit effects said conversion of said compound cranking motion into said compound oscillational motion.

8. Lens surfacing apparatus according to claim 1 wherein said means for rotating said tool supporting structure and for actuating said drive unit comprises a single motor.

9. Lens surfacing apparatus according to claim 1 wherein said rotatable tool supporting structure includes internal journaling and said apparatus further includes a stationary annular seal for protecting said journaling from external contaminants, said seal normally abutting said rotatable structure with minimal frictional force thereagainst.

10. Lens surfacing apparatus according to claim 9 further including a stationary annular support for said seal, said seal being adjustable longitudinally along said support and frictionally self-held in preselected positions of adjustment therealong.

* * * * *