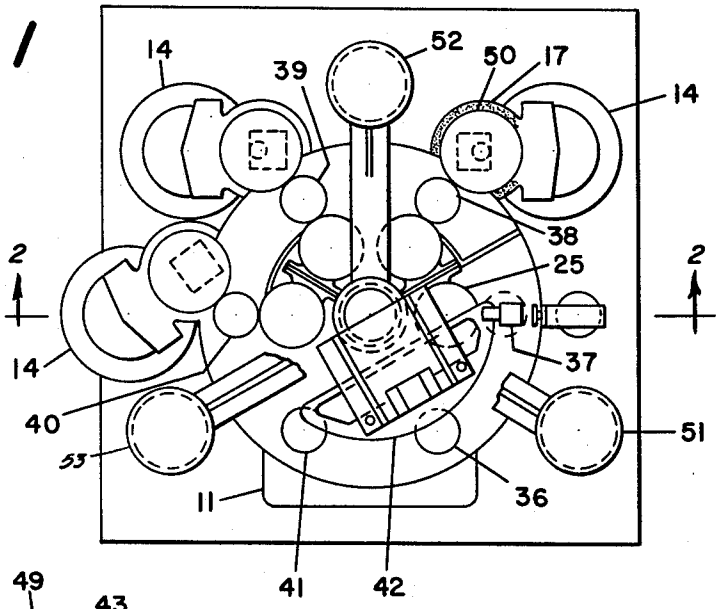
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LENS CENTERING AND BEVELING MACHINE

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Fig. 1



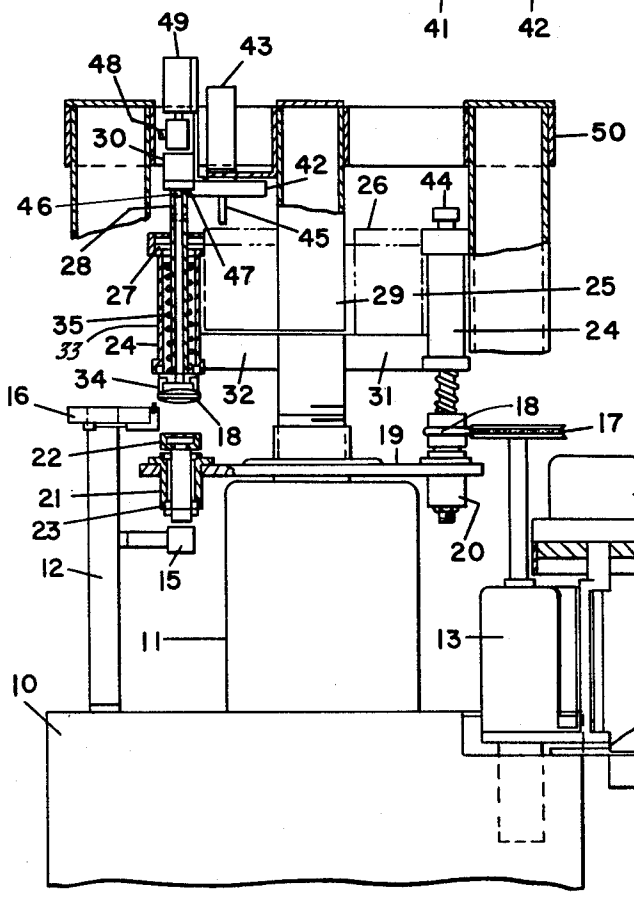


Fig. 2

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LENS CENTERING AND BEVELING MACHINE

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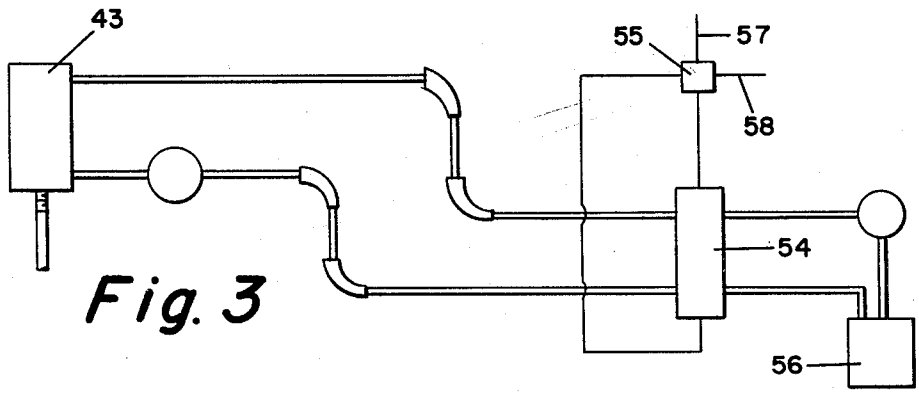
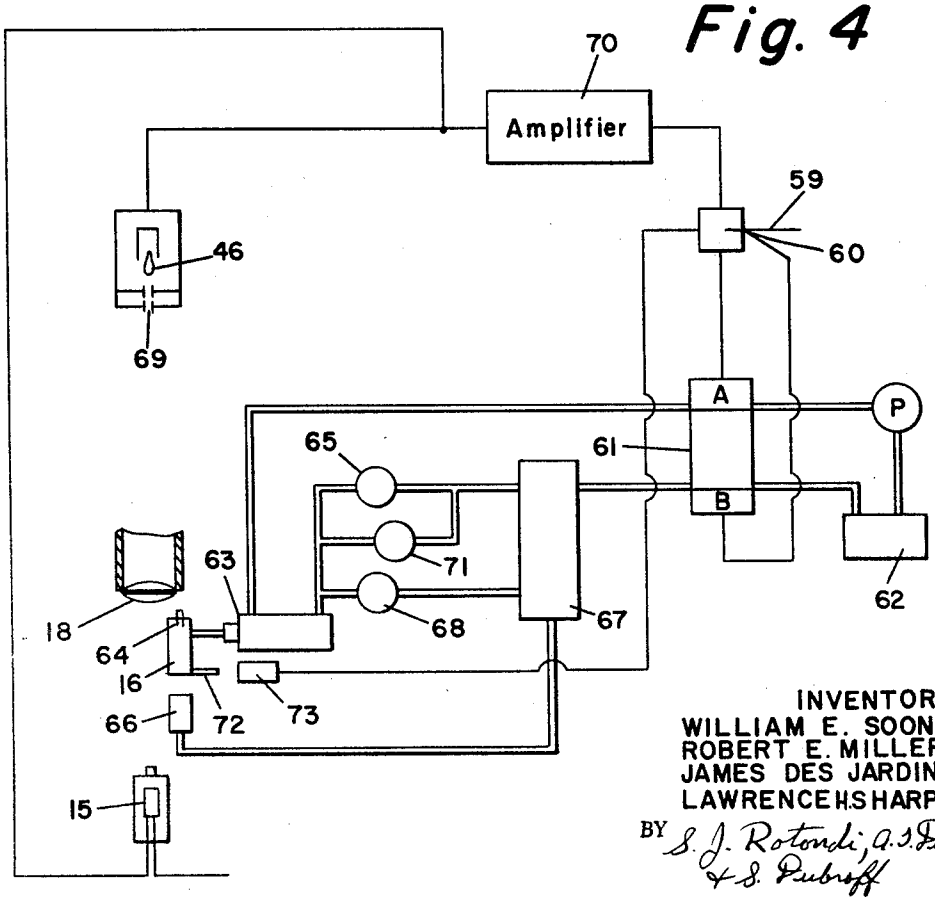


Fig. 3

Fig. 4



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LENS CENTERING AND BEVELING MACHINE

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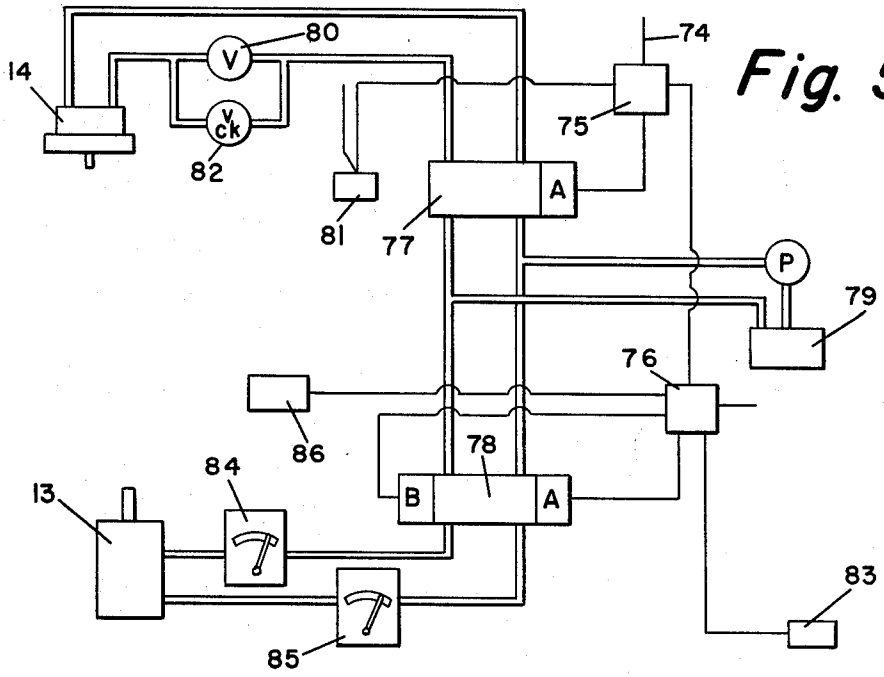
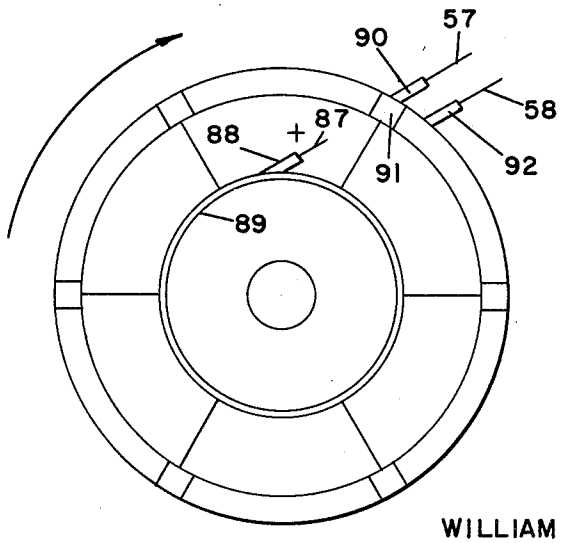


Fig. 5

Fig. 6



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LENS CENTERING AND BEVELING MACHINE

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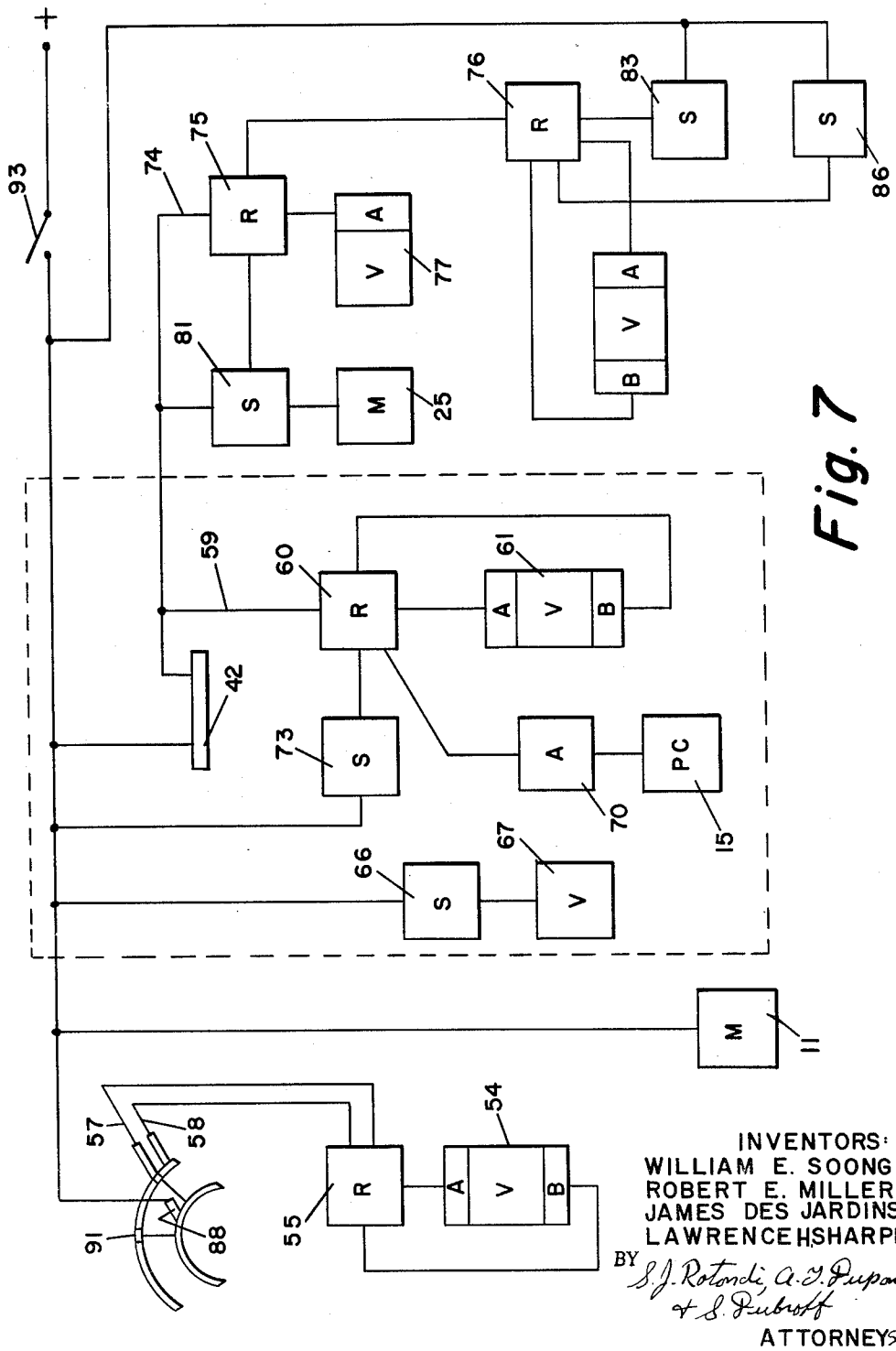


Fig. 7

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3,140,567

LENS CENTERING AND BEVELING MACHINE

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7 Claims. (Cl. 51—108)

This invention relates to the manufacture of lenses. It provides a machine which greatly expedites the centering and grinding of lenses.

Conventional methods of centering and grinding lenses generally involve manual operations which require the presence of an attendant and contribute materially to the cost of the lens. The present invention provides a machine which operates continuously to receive a series of blank lenses one after another and functions automatically to center each lens and to thereafter pass it through a series of grinding stations. As will appear, this machine includes a number of spindle pairs each including a lower spindle fixed to an index table and an upper spindle biased into engagement with the lower spindle, means for raising the upper spindles at certain of the stations to permit entry, centering and discharge of the lens, and various control elements for effecting these operations automatically.

The invention will be better understood from the following description when considered in connection with the accompanying drawings and its scope is indicated by the appended claims.

Referring to the drawings:

FIG. 1 is a top view of the automatic lens centering and beveling machine,

FIG. 2 is a partial section taken on the line 2—2 of FIG. 1,

FIG. 3 illustrates a circuit which is utilized to raise and lower the upper spindles at the loading, centering and unloading stations,

FIG. 4 illustrates the means for centering the lens blank, this means being set into operation upon the raising of the spindles at the loading, centering and unloading stations,

FIG. 5 illustrates the means for controlling the feed and traversing movements of a lens grinding wheel,

FIG. 6 illustrates a contact device through which the connections of the circuit of FIG. 3 is controlled, and

FIG. 7 is a wiring diagram of the various connections of the system, only the positive lead of the voltage source being shown.

As indicated by FIGS. 1 and 2, the lens centering and beveling machine of the present invention includes a base **10** to which are fixed a six stop spindle positioning unit **11**, an upright **12**, a grinding wheel drive unit **13** and a rotary oscillating torque actuator **14**. The upright **12** supports a photoelectric unit **15** and a centering wheel mechanism **16**. The drive unit **13** rotates a grinding wheel **17** and is mounted on a slide along which it is moved toward and from a lens blank **18**, this movement being effected by the rotary oscillating torque actuator **14**. The drive unit **13** and torque actuator **14** constitute a commercially available unit sold by Ex-Cell-O Corp., Greenville, Ohio and designated as "Rotac HN–34–U." The unit **11** drives an index table **19**, bears the commercial designation "Ferguson BT–121–G–270 Intermittor," and is manufactured by Ferguson Machine Co. of St. Louis, Mo. The unit **11** is provided with a "Variable Dwell" setting for predetermining the duration of time the index table **19** will remain at each of the various stations to be described hereinafter.

The "Variable Dwell" setting will only permit equal

durations of time for each of the various stations and not predetermined durations of varying times.

Fixed to and rotatable with the index table **19** are six spindle pairs each including a lower spindle **20** which has a housing **21**, a quick change spindle adapter **22** and a precision bearing **23**. Also rotatable with and movable axially of the index table **19** are six upper spindles **24** which are supported by members **31** and **32**. Each of these upper spindles includes a housing **33**, a quick change adapter **34** and a spring **35** which functions to force the upper and lower spindles together during the grinding and indexing operations. Each of the upper spindles is alined with a corresponding lower spindle and together they are indexed by the drive unit from a loading station **36** (FIG. 1) successively to a lens centering station **37**, a first grinding station **38**, a second grinding station **39**, a grinding and beveling station **40** and an unloading station **41**.

Each of the upper spindles **24** is driven by a motor **25** to which it is coupled through a gear reducer **26** and a spindle drive gear **27** which is splined on the upper spindle shaft **28**. A stationary center tube **29** supports the spindle drive motors **25**, a vacuum adapter **30** and the spindle raising mechanism which includes a cast plate **42** and a hydraulic cylinder **43**. As will appear, the cast plate **42** functions to raise the upper spindles **24** only at the loading station **36**, the centering station **37** and the unloading station **41**. This is accomplished by a flange which is located on the outer periphery of the cast plate and slides under the knobs **44** at the upper end of the spindle housing. A rod **45** functions to guide the cast plate **42** as it raises the spindles. The shafts of the various spindles are hollow and mounted near the upper end of the upper spindle shafts is a light source **46** which is energized through a slip ring **47**. A vacuum pump connection **48** is pressed against the adapter **30** by a hydraulic cylinder **49** (Hydraulic Development Co. Model HB) which is of the one stroke type.

Located above each of the grinding stations **38**, **39** and **40** is a hood **50** for evacuating the dust incident to the grinding of the lenses. A plurality of support stands **51**, **52** and **53** are supported by the stationary center tube **29** as indicated by FIG. 1.

The hydraulic cylinder **43** for raising the upper spindles at loading station **36**, centering station **37** and unloading station **41** has a 1½ inch bore, has a 1 inch stroke and is commercially designated as Miller Model H–65. It is controlled by the circuit of FIG. 3. This control circuit includes a solenoid operated 4-way valve **54** (Double-A Products, No. KF 170–C) which is spring centered to close all its ports and includes solenoids A and B.

Operation of this control circuit is initiated by an electric signal applied upon the indexing of the table **19** through an angle of 60° by the spindle positioning drive **11**. This signal is transmitted from a terminal **87** (FIG. 6) through a brush **88**, a slip ring **89**, a brush **90**, and a lead **57** and partially operates a relay **55** (FIG. 3) through which the solenoid A is actuated. Thereupon the valve **54** functions to admit operating fluid under pressure from a reservoir **56** to the cylinder **43** which raises the upper spindles at the loading, centering and unloading stations as previously indicated.

When the work at the loading, centering and unloading stations is completed, the table **19** is indexed to the next position by the spindle positioning unit **11**. As the table starts its movement, a signal is applied to the partially operated relay **55** through lead **87** (FIG. 6), brush **88**, slip ring **89**, conductive segment **91**, brush **92** and lead **58**. This signal completes operation of the relay **55** thereby deenergizing solenoid A of the valve **54**, energizing solenoid B, and returning the three upper spindles to their

lower position. It is to be understood that the circuit contactor of FIG. 6 rotates with the index table **19** and that its brushes **90** and **92** are so disposed that solenoids A and B (FIG. 3) are deenergized and all parts of the valve **54** are closed while the table is indexed and while the machine is idle. This prevents any undesired axial movement of the spindles.

FIG. 4 illustrates the lens blank centering control system. Operation of this system is initiated by a signal applied through a lead **59** when the spindles at stations **36**, **37** and **41** are raised to their upper positions. This signal functions through a relay **60** to energize the B solenoid of a 4-way valve **61** which is spring centered to close all ports. Energization of the B solenoid allows operating fluid under pressure to flow from a reservoir **62** into the hydraulic cylinder **63** of the centering wheel operating mechanism **16** (FIG. 2). Thereupon a nylon centering wheel **64** is advanced toward the lens blank **18** which is held to the upper rotating spindle **24** by evacuating the spindle through the vacuum pump connection **48** (FIG. 2). The flow of the operating fluid is controlled by a needle valve flow regulator **65** at the exhaust port of the cylinder **63**.

Immediately before the wheel **64** begins to bear against the lens **18**, the final approach limit switch **66** is actuated to operate a solenoid operated 3-way valve **67** which is spring centered. Upon operation of the valve **67**, the advance of the wheel **64** is slowed down under the control of the needle valve **68** and the wheel centers the lens until the beam from the light source apertures **69** passes through the lens **18** to the photocell **15** without bending.

At this point, the current through the photocell produces at the output of an amplifier **70** a voltage whereby the relay **60** is operated to (1) deenergize the B solenoid of the valve **61**, (2) deenergize the solenoid of the valve **67**, and (3) terminate advancement of the wheel **64**. At the same time, the A solenoid of the valve **61** is energized and the wheel is moved back to its original standby position, this backward movement being relatively rapid due to the fact that the valves **65** and **68** are bypassed by a check valve **71** which permits a free flow of the operating fluid in the reverse direction.

In the standby position of the centering wheel mechanism **16**, a rod **72** (FIG. 4) operates an adjustable limit switch **73** which deenergizes the relay **60** which in turn deenergizes the A solenoid of the valve **61**. This permits the valve **61** to close so that all flow of operating fluid to the cylinder **63** is interrupted. The centered lens is thereupon indexed to the first grinding station **38** (FIG. 1).

Grinding of the lens is effected with the lens clamped between an upper and lower spindle by the spring **35** (FIG. 2). The grinding wheel **17** is fed against the lens **18** by the hydraulic oscillating torque actuator **14** (Rotac HN–IV–34) and is traversed across the edge of the lens by the drive unit.

Operation of the lens grinding feed and traversing system of FIG. 5 is initiated by an electric signal applied to the lead **74** when the upper spindles at stations **36**, **37** and **41** (FIG. 1) are raised to their working positions. This signal actuates a rotary actuator circuit relay **75**, and through the relay **75**, a hydraulic cylinder circuit relay **76**. This actuates the A solenoids of (1) a solenoid operated, spring returned, 4-way valve **77** (Double A Products No. QJP 2–155–C) and (2) a solenoid operated spring centered 4-way valve **78** (Double A Products No. QFP 2–155–C).

Energization of the A solenoid of valve **77** admits operating fluid under pressure from the reservoir **79** to the rotary oscillating actuator **14** which advances the grinding wheel against the edge of the lens. Flow of the operating fluid is controlled by a needle valve flow regulator **80** at the actuator exhaust port. When grinding is completed, a micrometer-adjusted limit switch **81** is actuated to deenergize the relay **75** and stop the electric motor **25** (FIG. 2) and the spindle to the adapter of which the ground lens is attached. Deenergization of the relay **75** interrupts current in the A solenoid of the valve **77** which is spring returned to reverse the flow of operating fluid to the rotary oscillating actuator and retract the grinding wheel to its original position. Fast return of the wheel results from the fact that the needle valve **80** is shunted by a check valve **82**.

Eenergization of the A solenoid of the valve **78** permits flow of the operating fluid to the drive unit **13** by which the grinding wheel is driven across the edge of the lens. At the end of the cylinder stroke, a limit switch **83** operates through the relaly **76** to deenergize the A solenoid and energize the B solenoid of the valve **78** for returning the grinding wheel to its original position. At the end of its return, a limit switch **86** operates through the relay **76** to deenergize the B solenoid and energize the A solenoid of the switch **78** thus initiating a repetition of the traversing cycle. When grinding is completed and the limit switch **81** has been actuated as indicated above to operate the relay **75**, the solenoids of the valve **78** are deenergized and this valve is spring operated to close all its ports. During operation of the system, the traversing rate is controlled by the flow regulators **84** and **85**.

As indicated by the wiring diagram of FIG. 7, operation of the system is initiated by closure of a main switch **93**. This energizes the six stop drive unit **11** which indexes the table **19** to bring a set of upper and lower spindles to the lens centering stations. At this point a signal applied from the rotary contactor (FIG. 6) through the lead **57** functions as described in connection with FIG. 3 to raise the upper spindles at the loading, centering and unloading stations to their top positions. At this point, a connection is made through the cast plate **42** to the input lead **59** of the centering control circuit of FIG. 4 and the input lead **74** of the grinding feed and traversing control circuit **5**. Thereupon these two circuits are operated as indicated in connection with FIGS. 4 and 5, the cast plate being maintained in its upper position while work is completed at the loading, centering and unloading stations. Upon the completion of this work, the table **19** is indexed to the next position by the six stop drive unit **11**, a signal being applied through the lead **58** at the start of the indexing and the spindles being returned to their lower position by this signal.

We claim:

1. A lens grinding mechanism including
a support,
an index table rotatable on said support,
a plurality of spindle pairs spaced apart along a circumference of said table at loading, lens centering, lens grinding and unloading stations, each of said pairs including a lower spindle fixed to said table and an upper spindle rotatable with and movable axially of said table,
a multispeed device for rotating said table with a stop of equal predetermined durations at each of said stations,
means operable upon the rotation of said table to raise said upper spindles at said loading, centering and unloading stations at the beginning of said stop and to lower said upper spindles at said loading, centering and unloading stations at the end of said stop,
a lens centering wheel,
a lens grinding wheel, and
means operable upon the raising of said upper spindles at said loading, centering and unloading stations to initiate operation of said wheels and operable upon the lowering of said upper spindles at said loading, centering and unloading stations to terminate the operation of said wheels.

2. A lens grinding mechanism according to claim 1 wherein said upper spindles are hollow and connected to means for producing therein a vacuum for holding a lens against the lower end thereof during the operation of said centering wheel.

3. A lens grinding mechanism including
a support,
an index table rotatable on said support,
a plurality of spindle pairs spaced apart along a circumference of said table at loading, lens centering, lens grinding and unloading stations, each of said pairs including a lower spindle fixed to said table and an upper spindle rotatable with and movable axially of said table,
a multispeed device for rotating said table with a stop of equal predetermined durations at each of said stations,
means operable upon the rotation of said table to raise said upper spindles at said loading, centering and unloading stations at the beginning of said stop and to lower said upper spindles at said loading, centering and unloading stations at the end of said stop,
a lens centering wheel,
a lens grinding wheel, and
centering wheel control means,
grinding wheel control means, and
means operable upon the raising of said upper spindles at said loading, centering and unloading stations to energize said centering wheel control means and grinding wheel control means and operable upon the lowering of said upper spindles at said loading, centering and unloading stations to deenergize said centering wheel control means and grinding wheel control means.

4. A lens grinding mechanism according to claim 1 including means for rotating said upper spindles, and means operable to energize said spindle rotating means upon the raising of said upper spindles at said loading, centering and unloading stations and to deenergize said spindle rotating means upon the lowering of said upper spindles at said loading, center and unloading stations.

5. A mechanism according to claim 3 wherein said grinding wheel control means includes means for simultaneously advancing said grinding wheel toward and transversely of the edge of a lens held between the upper and lower spindles at said grinding station.

6. A lens grinding mechanism according to claim 2 wherein said lower spindles are hollow, said upper spindles contain a light source, and a photoelectric cell having a restricted aperture is alined with said spindles whereby said photoelectric cell conducts when a lens held by said upper spindle at said centering station is centered.

7. A lens grinding mechanism according to claim 6 including means operable by the output of said photoelectric cell to retract and deenergize said centering wheel.

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