March 24, 1953 A. I. DILLER 2,632,288

LENS GRINDING AND POLISHING MACHINE

Filed Feb. 2, 1951 2 SHEETS—SHEET 1

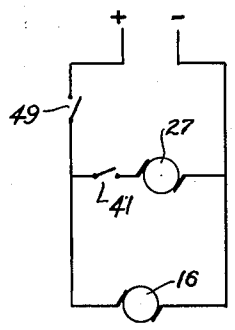

Fig. ~7~

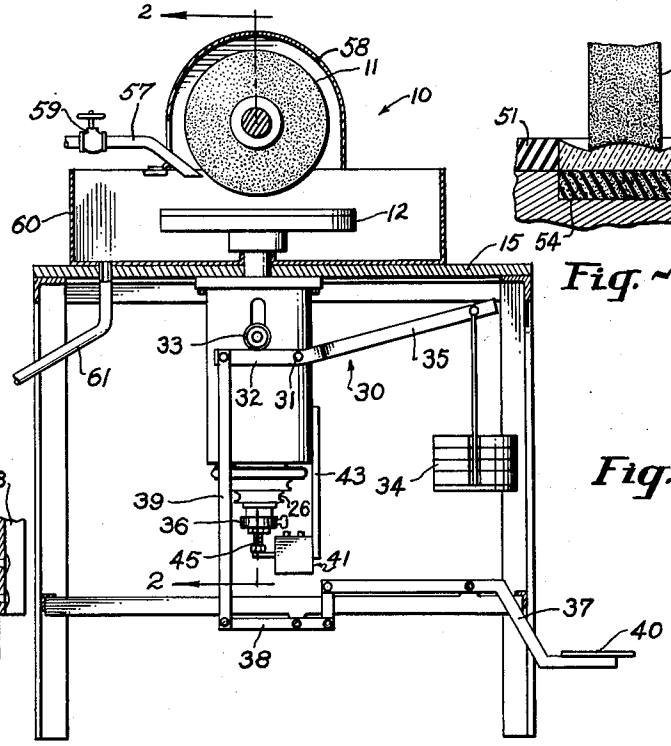

Fig. ~1~

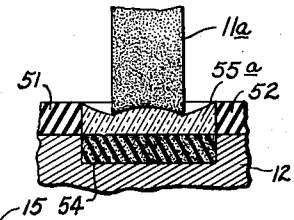

Fig. ~6~

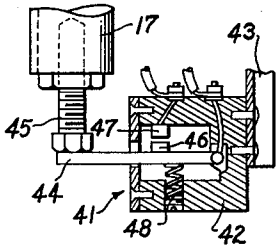

Fig. ~3~

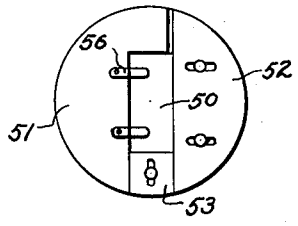

Fig. ~4~

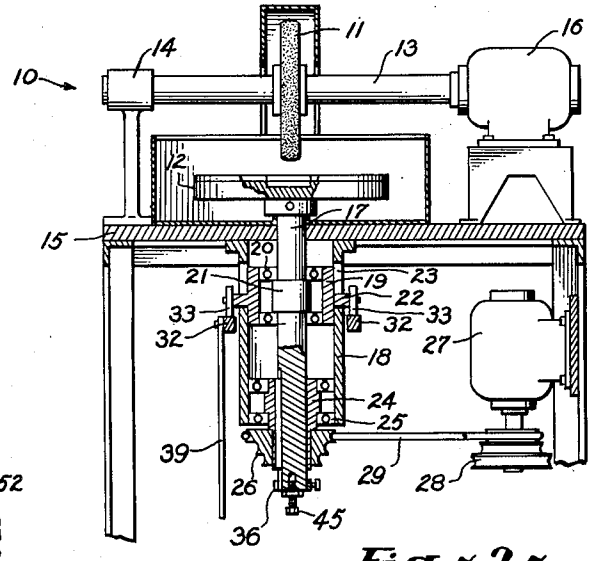

Fig. ~2~

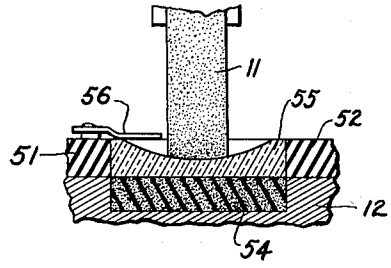

Fig. ~5~

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LENS GRINDING AND POLISHING MACHINE

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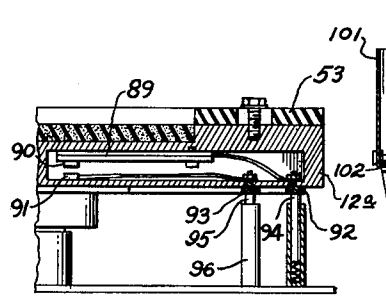

Fig. ~11~

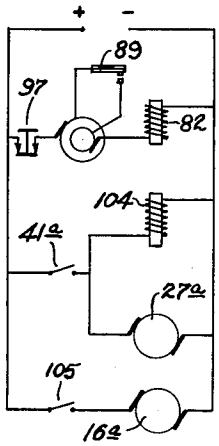

Fig. ~12~

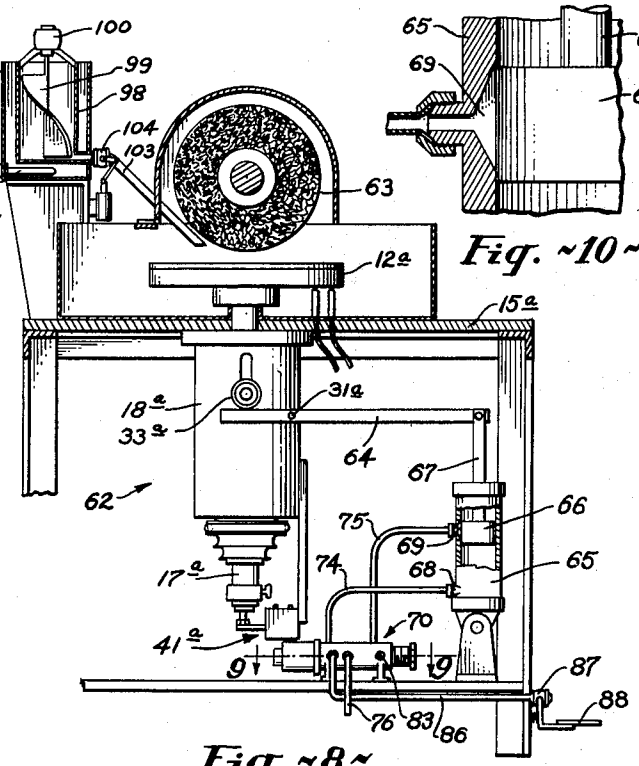

Fig. ~8~

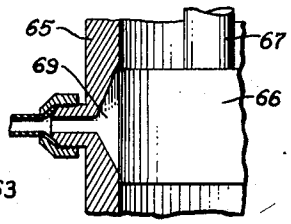

Fig. ~10~

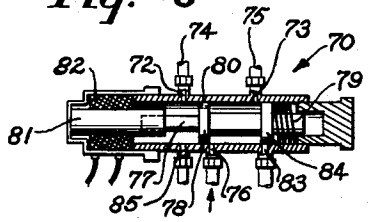

Fig. ~9~

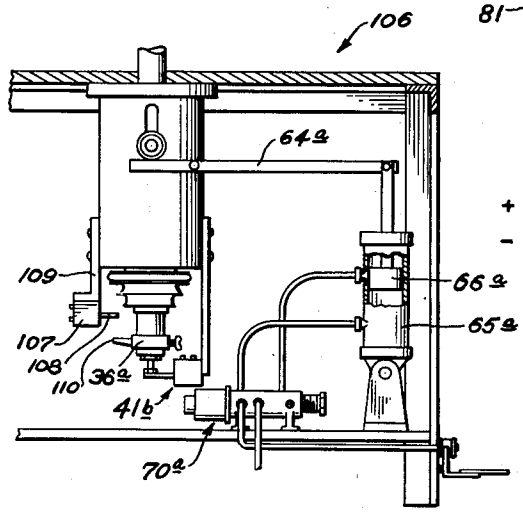

Fig. ~13~

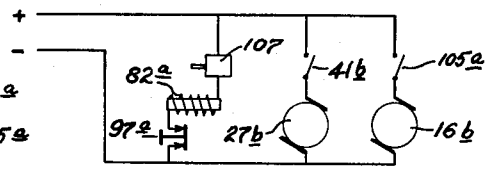

Fig. ~14~

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UNITED STATES PATENT OFFICE

2,632,288

LENS GRINDING AND POLISHING MACHINE

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Application February 2, 1951, Serial No. 208,995

12 Claims. (Cl. 51—105)

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The present invention relates to lens grinding and polishing machines, and is particularly directed to such machines wherein the lens is mounted on a rotatable table which is fed axially toward the periphery of an abrading wheel.

In lens grinding or polishing machines of the described character which have been previously proposed, no provision is made for varying the feeding force on the table so that the contact pressure of the lens against the periphery of the abrading wheel conforms continuously to the conditions necessary for accurate and efficient grinding or polishing. By way of explanation, in grinding it is desirable to increase the feeding force as the grinding continues so that the grinding pressure will remain constant even as the area of contact of the abrading wheel against the lens increases, and then to finish the grinding operation with only a very small grinding pressure. On the other hand, in polishing a ground surface already formed on the lens, it is desirable to initially gradually increase the polishing pressure between the ground surface and the wheel so that the polishing compound may be drawn by the latter onto the surface being polished, and then to gradually decrease the polishing pressure as the operation continues to obtain a smoothly finished surface.

It is therefore an object of the present invention to provide lens grinding and polishing machines of the described character constructed so that the contact pressure between the lens and the abrading wheel, at all times during the operation of the machine, conforms to the conditions necessary for accurate and efficient grinding or polishing.

Another object of the present invention resides in the provision of grinding and polishing machines of the described character wherein the rotation of the lens carrying table is controlled automatically in response to axially directed movement of the table toward and away from the periphery of the abrading wheel, so that rotation of the latter is commenced as the table is fed toward the wheel, and is interrupted when the table is removed from the wheel to permit replacement of the lens being ground or polished.

Another object is to provide in grinding and polishing machines of the described character an improved table construction for accurately locating and holding the lens being ground or polished.

Another object is to provide lens grinding and polishing machines of the described character wherein the table is fed axially toward the periphery of the abrading wheel by a force increasing progressively with movement of the table in that direction.

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Another object of the present invention is to provide a lens grinding machine of the described character having devices controlling axial movement of the table so that the table is fed toward the periphery of the abrading wheel by a force increasing progressively with such feeding movement to an adjustably determined position of maximum feed, at which position the grinding continues for a predetermined period with only negligible contact pressure between the abrading wheel and the lens, and then, at the conclusion of that predetermined period, the table is returned to its inoperative position remote from the periphery of the abrading wheel.

Still another object of the present invention is to provide a lens polishing machine of the described character having devices controlling the axial movement of the lens carrying table so that the table is fed toward the periphery of the abrading wheel by a force initially increasing progressively with such feeding movement, to permit the wheel to draw the abrading compound between the contacting surfaces of the lens and the wheel, and then decreasing progressively to gradually reduce the polishing pressure to obtain a smoothly finished surface.

A further object is to provide a lens polishing machine of the described character wherein the lens carrying table is automatically moved away from the abrading wheel in response to the temperature of the lens to thereby interrupt the polishing operation when the temperature of the lens becomes excessive and thus prevent "burning" of the lens.

A still further object resides in the provision of a lens polishing machine of the described character wherein the supply of abrading substance to the table and also rotation of the latter are automatically interrupted when the table is axially displaced to its inoperative position remote from the periphery of the abrading wheel.

The invention resides in the combinations, arrangements and details of construction pointed out in the following detailed description of specific embodiments thereof and then more particularly defined in the appended claims.

In the accompanying drawings forming a part hereof, wherein I have illustrated several preferred embodiments of the invention:

Fig. 1 is a side elevational view, partly broken away and in section, of a grinding machine embodying the present invention;

Fig. 2 is a fragmentary vertical sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary detail on an enlarged scale and partly in section illustrating the construction of the switch arrangement controlling the rotation of the lens carrying table included in the grinding machine of Figs. 1 and 2;

Fig. 4 is a top plan view of the lens carrying table included in the grinding machine of Figs. 1 and 2;

Fig. 5 is a fragmentary, vertical sectional view, on an enlarged scale, illustrating the contact of the abrading wheel with the lens during the grinding of a concave circular surface in the latter;

Fig. 6 is a view similar to Fig. 5, but illustrating the contact of the abrading wheel with the lens during the grinding of a substantially convex circular surface on the latter;

Fig. 7 is an electrical wiring diagram of the control circuits for the motors rotating the abrading wheel and table of the grinding machine of Figs. 1 and 2;

Fig. 8 is a side elevational view, partly broken away and in section, of a lens polishing machine embodying the present invention;

Fig. 9 is a horizontal sectional view, on an enlarged scale, illustrating the details of construction of a solenoid operated valve controlling the axial movements of the lens carrying table included in the lens polishing machine of Fig. 8, and taken along line 9—9 of Fig. 8;

Fig. 10 is an enlarged detail view in section showing the construction of a pressure fluid inlet of the cylinder provided to effect axial movement of the table in the lens polishing machine of Fig. 8;

Fig. 11 is a fragmentary, vertical section, on an enlarged scale, showing the thermostatic switch arrangement in the lens carrying table of the polishing machine of Fig. 8;

Fig. 12 is a wiring diagram showing the electrical control circuits of the polishing machine of Fig. 8;

Fig. 13 is a fragmentary side elevation partly broken away in section, illustrating the adaptation of the machine of Fig. 8 for grinding purposes, and

Fig. 14 is a wiring diagram showing the electrical control circuits of the grinding machine of Fig. 13.

Referring to the drawing in detail, and initially to Figs. 1 and 2 thereof, a lens grinding machine 10 embodying the present invention is there shown to include a grinding or abrasive wheel 11 and a lens carrying table 12 mounted for rotation about right angularly related and intersecting axes of rotation. In the illustrated machine, the grinding or abrasive wheel 11 is mounted for rotation about a horizontal axis on a horizontal shaft 13, which shaft is journalled in a bearing bracket 14 extending above a suitable supporting platform 15 and is driven by an electric motor 16. The platform 15 is provided with supporting legs of frame members to raise the platform to a convenient height so that space is provided below the platform to accommodate certain of the operating mechanisms hereinafter described in detail. The lens carrying table 12 is mounted below the wheel 11 for rotation about a vertical axis which intersects the axis of rotation of the abrasive wheel and for axial movement toward and away from the periphery of the wheel.

The mounting for table 12 includes a spindle 17 extending vertically through the platform 15

and having the lens carrying table fixed to its upper end. The spindle 17 extends coaxially through a support housing 18 of substantially cylindrical configuration which is secured to the bottom of the platform 15. A bearing sleeve 19 is axially slidable within the housing 18 and carries a pair of anti-friction bearings 20 which engage on the opposite sides of a diametrically enlarged portion 21 of the spindle so that the latter is rotatable within the bearing sleeve and axially movable with the sleeve. The bearing sleeve 19 is formed with a pair of diametrically opposed trunnions 22 extending radially through registering, elongated slots 23 cut in the wall of the housing 18 to prevent rotation of the bearing sleeve within the housing and to provide accessible portions of the bearing sleeve that may be manipulated vertically for conveniently effecting the axial movement of the spindle and the table.

In order to provide for the rotation of the spindle 17, and hence of the table 12, a driving sleeve 24 is mounted rotatably within the housing 18, by anti-friction bearings 25, and has the spindle extending slidably therethrough. A key and keyway arrangement locks the spindle to the driving sleeve for rotation with the latter, while permitting axial movement of the spindle, and a stepped pulley 26 is fixed on the end portion of the driving sleeve extending out of the bottom of the housing 18. An electric motor 27 is mounted on the frame members supporting the platform and has a driving stepped pulley 28 fixed on its shaft to receive a driving belt 29 which is also trained over the pulley 26. The stepped pulleys 26 and 28 and the belt 29 provide a variable speed transmission between the motor 27 and the driving sleeve 24 so that the rotational speed of the spindle and of the lens carrying table may be conveniently varied.

The table 12 and spindle 17 are displaced downwardly away from the abrading wheel by the force of gravity, and the movement of the table in that direction is limited by the engagement of trunnions 22 against the lower ends of the related slots 23. In order to move the table 12 in the feeding direction, that is, upwardly towards the periphery of the abrading wheel, a feeding lever 30, which is bifurcated at one end to extend across both sides of the housing 18, is pivoted intermediate its ends on the pivot pins 31 carried by the housing. The legs 32 at the bifurcated portion of lever 30 engage under rollers 33 carried by the related trunnions so that the rollers are lifted to move the table upwardly when the feeding lever is rocked in the clockwise direction as viewed in Fig. 1. Such rocking of the lever 30 is effected by weights 34 depending from the free outer end of the lever. As seen in Fig. 1, the arm 35 of the lever 30, to which the weights are connected, is longitudinally bent to incline upwardly from the horizontal when the lever is in the position corresponding to the lowered or inoperative position of the table 12. Thus, as the arm 35 swings downwardly toward the horizontal during feeding of the table toward the periphery of the abrading wheel, the effective length of the moment arm of the force of the weights 34 around the pivot pins 31 increases to progressively increase the forces exerted upwardly by the legs 32 against the rollers 33. By this arrangement, the grinding pressure between a lens carried by the table 12 and the wheel 11 remains substantially constant even though the area of contact of the lens and wheel increases in proportion to

the depth of the concave or convex surface being ground.

In order to limit the upward movement of the table 12, so that the depth of the ground surface may be controlled, an axially adjustable stop collar 36 is mounted on the lower end of the spindle 17 for engagement against the lower end of the driving sleeve 24. Counter-clockwise rocking of the lever 30, to permit the force of gravity to return the table 12 to its lowered, inoperative position, is preferably accomplished by a treadle 37 operatively connected to the free end of at least one of the legs 32 of the feeding lever by pivoted links 38 and 39 so that depressing the pedal 40 on the treadle effects the return of the table to its inoperative position.

With the table in its inoperative position (Fig. 1), the lens held thereon for grinding may be replaced, and it is desired for this purpose that rotation of the table be automatically interrupted when the table is in the inoperative position and then commenced as the table moves toward the wheel 11. In the illustrated embodiment of the invention, this function is conveniently accomplished by providing a switch, generally indicated by the numeral 41, which is connected in series with the table rotating motor 27. The switch 41, shown in detail in Fig. 3, includes a housing 42 mounted on a bracket 43 depending from the housing 18. A contact arm 44 is pivoted in the housing 42 and extends out of the latter into the path of travel of an axially adjustable, switch operating bolt 45 threaded into the lower end of the spindle 17. A movable contact 46 is carried by the arm 44 and confronts a fixed contact 47 arranged thereabove. A spring 48 in the housing 42 engages against the contact arm 44 to continuously urge the latter upwardly for effecting contact between the contacts 46 and 47. When the table is in its lowered inoperative position, bolt 45 engages the arm 44 to separate the contacts and thus open the circuit to the motor 27 (Fig. 7), and when the table moves upwardly the spindle releases the contact arm to permit the contacts to close and thereby energize the table rotating motor. As seen in Fig. 7, the motors 27 and 16, for rotating the table and wheel, rsepectively, are preferably connected in parallel across the power lines, and a manually controlled switch 49 may be interposed in the power line as an on-off control for the machine as a whole.

In order to retain the piece of glass being ground on the table 12, the latter is provided with three clamping sections (Fig. 4) formed preferably of hard rubber and defining a central rectangular space 50. One section 51 is fixed to the top surface of the table and is formed with a right angled edge defining two adjacent sides of the space 50, while the other two sides of the space 50 are formed by radially adjustable sections 52 and 53 so that the dimensions of the plate receiving space may be varied to accommodate and hold glass plates of different sizes. As seen in Fig. 5, an inlay 54 of soft rubber, or other similar resilient material, is provided in the top surface of the table 12, substantially coextensive with the space 50 enclosed by the sections 51, 52 and 53, to cushion and support a glass plate 55 in the process of being ground. The plate 55 is held down on the cushioning inlay 54 by suitable holding means which in the illustrated embodiment includes spring retainers 56 pivoted on the fixed section 51 to swing to positions overlying the end portions of a plate in the space 50 (Fig. 5).

When a concave surface is to be ground in the surface of the glass plate 55, the periphery of the abrading wheel 11 is dressed with a convexly rounded surface. It will be noted that in grinding a concave surface the diameter of the circular surface is not limited by the thickness of the abrading wheel but is rather determined by the radius of the wheel and the depth to which the plate is ground. When a convex surface is to be ground in a glass plate 55a (Fig. 6), the periphery of the wheel 11a is dressed with a concavely rounded surface of the desired curvature. In grinding a convex surface, the thickness of the wheel 11a does not limit the diameter of the circular area having the convex surface. In finishing a lens ground with a convex surface, the concave portions of the glass plate surrounding the convex area are cut away.

In order to provide a coolant, for example, water, at the area of contact of the abrading wheel 11 with the surface of the glass plate, a pipe 57 extends through the hinged safety hood 58 covering the wheel to direct a stream of the coolant at the glass plate on the rotated table 12. A valve 59 is provided in the coolant pipe to control the flow of the coolant and a suitable shaped receptacle 60 is supported on the platform 15 to catch the coolant for discharge through a drain pipe 61.

Referring now to Figs. 8 to 12, inclusive, another embodiment of my invention is there shown, which is adapted for the polishing of lenses. As in the grinding machine 10 previously described, the polishing machine 62 includes a lens carrying table 12a mounted above the supporting platform 15a for rotation about a vertical axis and for axial movement toward and away from the periphery of an abrading wheel 63, formed preferably of felt, which is mounted for rotation about a horizontal axis which the axis of the table intersects. So far as the structure supporting the table 12a is concerned, the construction thereof may be the same as that described in connection with the grinding machine of Figs. 1 to 7, and this construction includes, in part, a housing 18a, a spindle 17a rotatable and axially movable in the housing, and rollers 33a on trunnions extending from a bearing sleeve within the housing to provide accessible means that may be vertically displaced for moving the spindle and table toward and away from the felt abrading wheel 63.

The polishing machine 62 differs mainly from the grinding machine 10 in the devices provided for effecting axial movement of the table 12a. These devices include a feed lever 64 pivoted intermediate its length on the pivot pins 31a on the housing and engaging at one end, as in the case of the lever 30, under the rollers 33a. In place of the weights 34 connected to the lever 30 to effect rocking thereof, a fluid pressure actuated cylinder 65 is mounted on the supporting frame and provided with a piston 66 slidable therein and having a piston rod 67 extending axially therefrom and pivotally connected to the free outer end of the lever 64. Thus, as the piston 66 moves downwardly within the cylinder 65, the lever 64 is rocked in the clockwise direction, as viewed in Fig. 8, to move the spindle 17a and table 12a upwardly toward the periphery of the wheel 63, and, as the piston 66 moves upwardly, the lever 64 is rocked in the opposite direction to permit the table and spindle to be lowered to inoperative position by the force of gravity.

In order to move the piston 66 upwardly and

downwardly in the cylinder 65, the wall of the latter is formed with ports 68 and 69 through which pressure fluid may enter the cylinder below and above the piston, respectively. The upper port 69, seen in detail in Fig. 10, terminates at its inner end in the form of a vertically elongated slit which is disposed in the wall of the cylinder so that only a small portion of this slit projects above the piston 66, when the latter is in its raised position, with the remainder of the slit being covered by the piston body. Thus, when pressure fluid is supplied to the port 69 to move the piston 66 downwardly and thus feed the table 12a towards the wheel 63, downward movement of the piston progressively uncovers more and more of the inner end of the port 69 so that this port and the piston cooperate to provide a valve arrangement effecting an automatic and progressive increase in the upward force acting on the rollers 33a, and hence on the table, as the latter is fed upwardly. Thus, the initial contact pressure between a lens on the table 12a and the wheel 63 will be relatively small, to permit the polishing compound or abrading substance to be drawn by the wheel 63 into the area of contact of the latter with the lens being polished, and will then increase gradually to a maximum as the felt wheel is radially compressed by upward movement of the table.

A fluid pressure control valve, generally indicated by the numeral 70 and shown in detail in Fig. 9, is provided for controlling the flow of pressure fluid to and from the ports 68 and 69 of the cylinder 65. The valve 70 includes a hollow valve body 71 formed with spaced apart ports 72 and 73 connected to the ports 68 and 69 of the cylinder by suitable conduits 74 and 75, respectively. A pressure fluid inlet port 76 is formed in the valve body and opens into the latter intermediate the locations of the ports 72 and 73. A valve member is mounted in the body 71 for reciprocation in the latter and includes a valve stem 77 and a radially enlarged portion 78 which moves from one side to the other of the inlet port 76 as the stem is reciprocated to thereby direct the pressure fluid to either the port 72 or the port 73. A spring 79 in the valve body continuously urges the stem 77 to a position in which the valve portion 78 is to the left, as viewed in Fig. 9, of the inlet port 76 so that the pressure fluid is directed through the port 73, conduit 75 and cylinder port 69 to the upper part of the cylinder 65. Since in polishing lenses it is desirable to gradually increase the polishing pressure, as set forth above, and then to progressively decrease the polishing pressure so that the final polishing is carried on with only slight pressure to thereby obtain a highly polished surface, the portion 78 of the valve member is provided with a bleed orifice 80 opening at the opposite faces thereof to permit the controlled seepage of pressure fluid through the portion 78, to flow through the port 72, the conduit 74 and the cylinder port 68 into the lower portion of the cylinder 65. Thus, the pressure below the piston 66 gradually increases toward the pressure above the piston for gradually decreasing the feeding force acting on the table.

In order to return the table to its lowered or inoperative position, the core 81 of a solenoid 82 is connected to the valve stem 77 to move the latter, when energized, against the force of the spring 79 to a position in which the portion 78 of the valve member is disposed to the right of the inlet port 76, as viewed in Fig. 9, so that pressure fluid is directed to the lower portion of the cylinder 65. Since the pressure fluid above the piston 66 must be exhausted from the cylinder in order to permit upward movement of the piston under the influence of the pressure fluid therebelow, an exhaust port 83 is formed in the valve body 71 to communicate the upper portion of the cylinder 65 with the atmosphere or with a suitable pressure fluid storage tank (not shown) during return movement of the table to its inoperative position. A second radially enlarged portion 84 is formed on the valve stem to cover the exhaust port 83, when the valve member is displaced to the left by the spring 79, and to uncover the exhaust port, when the valve member is displaced to the right by energization of the solenoid 82.

Another exhaust port 85 is formed in the valve body 71 to the left of the valve member portion 78, as viewed in Fig. 9, and has an exhaust conduit 86 connected thereto. A valve 87 is normally spring urged to closed position and is provided with an actuator in the form of a pedal 88 which when depressed manipulates the valve 87 to open position. Thus, when the piston 66 has been raised to lower the table and it is desired to begin a new cycle of operation, the solenoid 82 is deenergized to move the valve member to the position of Fig. 9 and the valve 87 is momentarily opened so that pressure fluid flows into the upper portion of the cylinder 65 and the lower portion of the cylinder is cleared of pressure fluid.

In polishing lenses considerable heat is generated, and if the polishing operation continues at excessive temperatures, the lens may be "burned." In order to avoid "burning" of the lens being polished, energization of the solenoid 82 is controlled in response to the temperature in the vicinity of the lens being polished so that the solenoid is energized to effect return of the table to inoperative position whenever the temperature at the lens is excessive. For this purpose, a bimetallic, temperature responsive element 89 (Fig. 11) is installed in a recess 90 of the table 12a to underlie the lens carried by the latter. The element 89 carries a movable contact 90 which is spaced from a fixed contact 91 at normal temperatures and which moves against the fixed contact when the temperatures become excessive. As shown in Fig. 12, the thermostatic switch, provided by the contacts 90 and 91 and the element 89, is connected in series with the solenoid 82 across the power lines. This electrical circuit is provided in part (Fig. 11 by concentric slip rings 92 and 93 connected, respectively, to the contacts 90 and 91 by suitable electrical conductors and disposed on the bottom surface of the table for contact with vertically movable brushes 94 and 95. The brushes 94 and 95 are slidable in tubular holders 96 mounted on the platform 15a and are spring urged against the slip rings to follow the axial movements of the table. A normally closed push-button switch 97 is preferably included in the series circuit of the solenoid 82 to permit over-riding of the thermostatic control in the event it is desired to move the table against the abrading wheel even though the element 89 indicates an excessive temperature.

In polishing lenses, an abrading or polishing compound is usually employed to supply the desired abrasive action between the felt wheel 63 and the lens. This abrading or polishing compound usually consists of a mixture of water and iron oxide. In the machine 62 embodying this invention, the abrading compound is held in a

tank or receptacle 98 (Fig. 8) and is continuously agitated by a spiralled blade 99 driven by an electric motor 100 so that the mixture is kept homogeneous. The tank 98 is submerged in a second oil containing receptacle 101 provided with electrical heating elements 102 so that the abrading mixture is pre-heated and will not fracture the heated lens being polished upon contact with the latter. A discharge pipe 103 extends from the tank 98 to direct a stream of the abrading compound at the area of the lens being polished and has a solenoid controlled valve 104, of conventional construction, interposed therein to close the pipe 103 when the solenoid is deenergized and to open the pipe for discharge of the compound when the solenoid is energized. A switch 41*a*, constructed and operated in the manner of switch 41 heretofore described, is connected in series with a parallel circuit of the table rotating motor 27*a* and the solenoid valve 104, so that both the supply of polishing or abrading compound and the rotation of the table 12*a* are interrupted when the table is in its lowered, inoperative position, and are automatically commenced when the table is raised toward the periphery of the polishing wheel. The electrical circuits for the machine 62 may be completed by connecting a manually actuated switch 105 in series with the wheel rotating motor 16*a* (Fig. 12) so that rotation of the polishing wheel may be individually controlled.

Referring now to Figs. 13 and 14, I have illustrated a modification of the table manipulating mechanisms provided in the polishing machine 62 which adapts that machine for grinding lenses. The grinding machine 106 of Figs. 13 and 14 includes a lens carrying table and grinding wheel (not shown) which are mounted in the same relation to each other as the wheel 11 and table 12 of Figs. 1 and 2. As in the device illustrated in Figs. 1 and 2, the table is mounted on a rotated and axially movable spindle, the vertical movement of which is effected by a rocking lever 64*a*, actuated by a pressure fluid operated system similar to that of the polishing machine 62. The pressure fluid operated system of the grinding machine 106 includes a pressure fluid cylinder 65*a*, having a piston 66*a* working therein and connected to the lever 64*a*, and a control valve 70*a* for controlling the flow of pressure fluid to the cylinder 65*a*, all of such parts corresponding to the similarly numbered parts of the device 62. The pressure fluid operated system of the grinding machine 106 differs from that of the polishing machine 62 only in that the enlarged portion of the valve member of the valve 70*a*, controlling the flow of pressure fluid to either the top or bottom portion of the cylinder 65*a* is imperforate, that is, formed without a bleed orifice, such as the orifice 80. Thus, when the solenoid 82*a* is deenergized, the table carrying the lens is moved upwardly with increasing force as the grinding proceeds due to the shape and position of the upper cylinder port and no opportunity is provided for equalization of the pressures above and below the piston 66*a*. As in the embodiment of Figs. 1 and 2, the grinding machine has an adjustable stop 36*a* on the table carrying spindle to limit the upward movement of the latter. Since in grinding lenses it is desirable to conclude the grinding operation with a final grinding period at substantially little or no pressure, an arrangement is provided in the machine 106 for returning the table to inoperative position after the table has been in its fully raised position, with the stop 36*a* engaged, for a predetermined period. This arrangement includes a timer switch 107, of conventional construction, which is normally open, and closes a predetermined period after the actuating arm 108 thereof has been manipulated. The timer switch 107 is mounted on a suitable bracket 109 so that the actuating arm 108 of the switch projects into the path of travel of an abutment 110 on the stop 36*a* so that the arm 108 is manipulated when the stop reaches the limit of its upward movement. Thus, the switch 107 (Fig. 14) connected in series with the solenoid 82*a* of the control valve 70*a* operates to energize the solenoid for lowering the table a predetermined period after the table has reached its uppermost position. As in the grinding machine 10, the machine 106 includes a switch 41*b* controlling the operation of the table rotating motor 27*b*, so that rotation of the table is interrupted when the latter is in its inoperative position, and also includes a manually controlled switch 105*a* for individually controlling operation of the wheel rotating motor 16*b*. Finally, a normally closed push-button switch 97*a* may be connected in series with the solenoid 82*a* and timer switch 107 to provide a manually controlled over-ride of the latter.

Having thus described several specific embodiments of my invention, it is apparent that the invention provides machines for grinding and polishing lenses and the like wherein the conditions for carrying out such operations in the most accurate and efficient manner are automatically maintained.

While I have described certain embodiments of the invention in detail, it is to be understood that the invention is not limited to such precise embodiments, and that changes may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the appended claims.

What I claim is:

1. A lens grinding or polishing machine comprising a rotatably mounted abrading wheel, means for rotating said wheel, a lens carrying table, means supporting said table for rotation about an axis which intersects the axis of rotation of said wheel at right angles and for axial movement toward and away from the periphery of said wheel, means for rotating said table, and means for displacing said table axially toward the periphery of said wheel including a cylinder having a pressure fluid actuated piston working therein, means operatively connecting said piston to said table, and means for supplying pressure fluid to said cylinder to act against said piston in the direction for moving the table toward the periphery of the wheel, the last mentioned means including a pressure fluid inlet port formed in the wall of said cylinder to be progressively uncovered as said piston moves in said direction.

2. A lens grinding or polishing machine according to claim 1, further comprising means for supplying pressure fluid to said cylinder to act against said piston in the direction for returning the table to an inoperative position away from the periphery of said wheel, valve means controlling the flow of pressure fluid through the first and last mentioned pressure fluid supplying means, and valve controlling means including resilient means continuously tending to condition said valve means for flow of pressure fluid through said first mentioned pressure fluid supplying means and electrical means operative, when energized, to condition said valve means

for flow of pressure fluid through said last mentioned pressure fluid supplying means.

3. A lens grinding machine comprising a rotatably mounted abrading wheel, means for rotating said wheel, a lens carrying table, means supporting said table for rotation about an axis which intersects the axis of rotation of said wheel at right angles and for axial movement toward and away from the periphery of said wheel, means for rotating said table, stop means for adjustably limiting the axial movement of said table in the direction toward the periphery of said wheel, operating means for moving said table axially toward and away from the periphery of said wheel, and means actuated by said stop means to condition said operating means for moving said table axially away from the periphery of said wheel after said table has been in residence at the position determined by said stop means for a predetermined interval.

4. A lens grinding machine according to claim 3, wherein said operating means includes a cylinder having a pressure fluid operated piston working therein, a valve means for selectively directing pressure fluid to the opposite end portions of said cylinder, means resiliently actuating said valve means for directing pressure fluid to the end portion of the cylinder operative to effect movement of said piston in the direction displacing said table toward said periphery of the wheel, and electrical means actuating said valve means, when energized, for directing pressure fluid to the end portion of the cylinder operative to effect movement of said piston in the direction displacing said table away from said periphery of the wheel, and wherein said means actuated by the stop means includes timer switch means interposed in a circuit for energizing said electrical means to close said circuit a predetermined interval after said table has reached the limit of its movement toward said periphery of the wheel.

5. A lens polishing machine comprising a rotatably mounted abrading wheel, means for rotating said wheel, a lens carrying table, means supporting said table for rotation about an axis which intersects the axis of rotation of said wheel at right angles and for axial movement toward and away from the periphery of said wheel, means for rotating said table, operating means for axially displacing said table toward and away from the periphery of said wheel, means for supplying abrading material to the surface of a lens on said table, and control means operatively connected to said table rotating means and said abrading material supplying means to interrupt the rotation of said table and the supply of abrading material when said table is in an inoperative position away from the periphery of said wheel and to commence the rotation of said table and the supply of abrading material as said table moves axially toward said periphery of the wheel.

6. A lens polishing machine according to claim 5, wherein said means for supplying abrading material includes a container for the abrading material, a continuously operative agitating member working in said container, heating means for heating the contents of said container, a discharge conduit extending from said container and opening adjacent said table, and a solenoid operated valve interposed in said discharge conduit, said valve being normally closed and being manipulated to open position by energization of the solenoid thereof.

7. A lens polishing machine according to claim 6, wherein said table rotating means includes an electric motor, and wherein said control means includes an electrical circuit for energizing said motor and said solenoid, a normally closed switch interposed in said electrical circuit, and switch actuating means operative to open said switch when said table is positioned away from the periphery of said wheel.

8. A lens polishing machine according to claim 5, further comprising temperature responsive control means for said operating means operative to condition the latter for displacement of said table away from the periphery of said wheel when the heat generated by frictional contact of said wheel with a lens on said table exceeds a predetermined degree.

9. A lens grinding machine; comprising a rotatably mounted abrading wheel; means for rotating said wheel; a lens carrying table; means supporting said table for rotation about an axis which intersects the axis of rotation of said wheel at right angles and for axial movement toward and away from the periphery of said wheel; means for rotating said table; and means for displacing said table toward the periphery of said wheel including a lever pivotally mounted intermediate its ends for rocking movement in a vertical plane, means for connecting one end of said lever to said table, said lever being formed so that a line extending through the pivot of the lever and the other end of the latter inclines upwardly relative to the horizontal when the lever is positioned for locating said table away from the periphery of said wheel, and free hanging weights suspended from said other end of the latter and applying a linearly acting constant force to said other end of the lever thereby continuously urging said lever to rock in the direction causing said other end to move toward a horizontal line extending through said pivot of the lever so that the moment arm of said force increases as the lever rocks in said direction for increasing the turning moment imposed on said lever as said table is rocked toward the periphery of said wheel.

10. A lens polishing machine comprising a rotatably mounted abrading wheel; means for rotating said wheel; a lens carrying table; means supporting said table for rotation about an axis which intersects the axis of rotation of said wheel at right angles and for axial movement toward and away from the periphery of said wheel; means for rotating said table; and means for displacing said table toward the periphery of said wheel with a force increasing progressively as the table moves a predetermined distance in that direction and then gradually decreasing, the last mentioned means including a cylinder having a pressure fluid operated piston working therein, means connecting said piston to said table so that movement of said piston in one direction effects displacement of said table toward the periphery of said wheel and movement of said piston in the other direction effects displacement of said table away from said periphery, valve means for controlling the supply of pressure fluid to said cylinder, means continuously tending to condition said valve means for supplying pressure fluid to said cylinder to move said piston in said one direction, said valve means being formed with a metered bypass so that, with said valve means in said condition, pressure fluid is supplied to said cylinder to apply a progressively increasing force against said piston in opposition to the movement of the latter in said one direction.

11. A lens polishing machine according to claim 10, further comprising electrical means operative,

when energized, to condition said valve means for supplying pressure fluid to said cylinder to move said piston in said other direction, and an electrical circuit connected to said electrical means for energizing the latter including a normally open switch and a thermal responsive element located on said table to respond to the temperature of a lens on the latter and operative to close said circuit in response to the rise of the temperature of a lens on the table above a predetermined degree.

12. In a lens grinding or polishing machine of the described character; a rotated table for supporting a lens, a cushioning insert in said table to underlie a lens on the latter, a resilient lens retaining member fixed to said table at a side of said insert, radially adjustable, resilient lens retaining members carried by said table at other sides of said insert to enclose a lens receiving space with said fixed retaining member to accommodate lenses of different sizes, and means carried by

said table for holding a lens axially against said insert.

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