June 30, 1953 K. C. BURROUGHS 2,643,492

GRINDING MACHINE AND METHOD

Filed Dec. 5, 1950 4 Sheets-Sheet 1

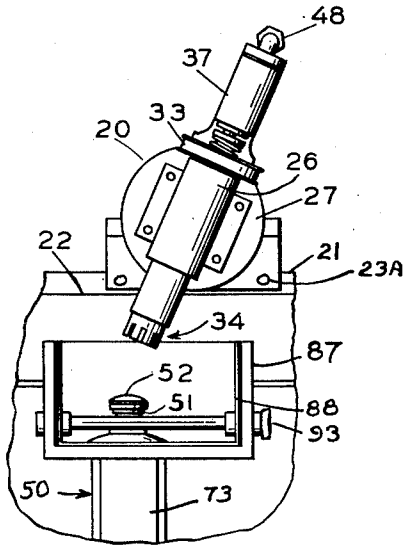


Fig.1

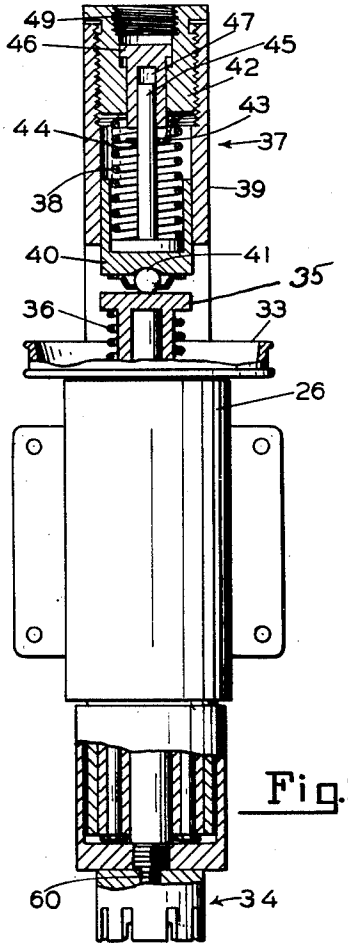


Fig.2

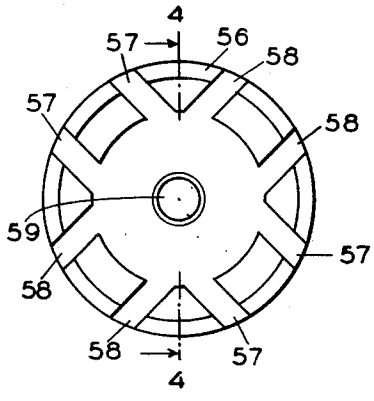


Fig.3

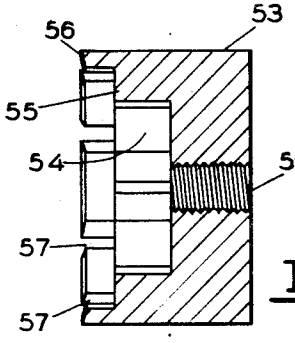


Fig.4

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Fig.5



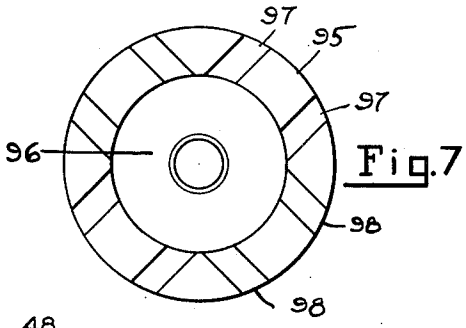


Fig.7

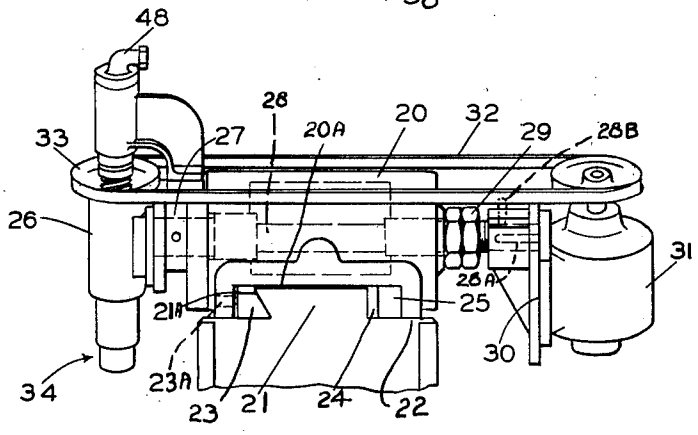


Fig.6

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GRINDING MACHINE AND METHOD

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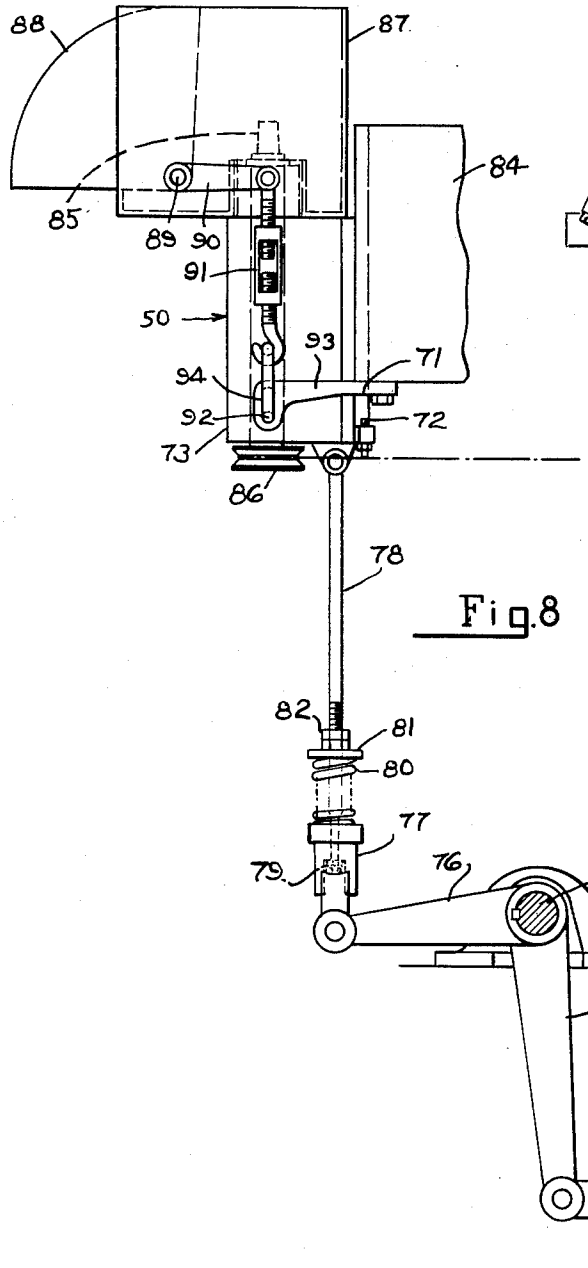


Fig. 8

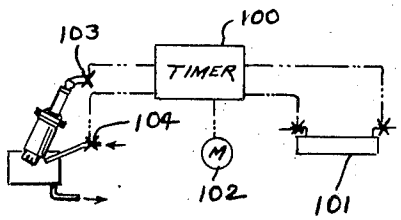


Fig. 9

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GRINDING MACHINE AND METHOD

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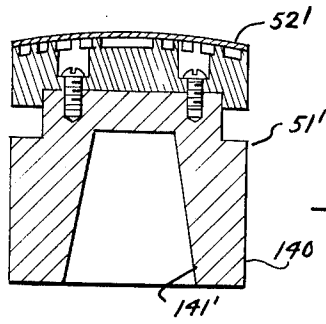


Fig. 10

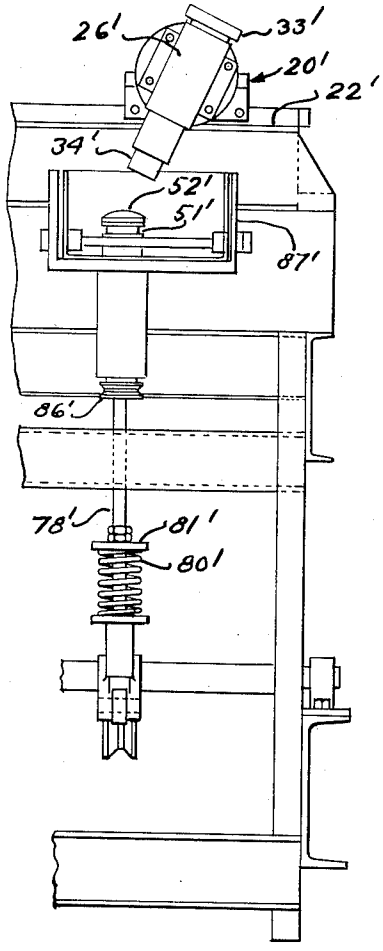


Fig. 11

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UNITED STATES PATENT OFFICE

2,643,492

GRINDING MACHINE AND METHOD

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Application December 5, 1950, Serial No. 199,336

15 Claims. (Cl. 51—131)

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This invention relates to the finishing and polishing of lenses or the like, particularly to the fine grinding generating step and especially in its relation to the rough grinding step.

In the generation of lens surfaces of spectacles or the like, it is necessary that the surfaces be accurately dimensioned. The machines employed must be arranged so that they can be adjusted with ease and so that they can be changed to produce the desired lens curvatures.

One of the objects of this invention is to provide a new and improved grinding arrangement, particularly useful for a fine grinding step in the production of lenses.

Another object of the invention is to provide an improved tool for the fine grinding step.

Still a further object of the invention is to provide an improved control arrangement for the fine generating step.

These and other objects, advantages, and features of the invention will become apparent from the following description and drawings which are merely exemplary.

In the drawings:

Figure 1 is a fragmentary front view of one of the tool heads.

Figure 2 is an enlarged view, partially in section, of a tool spindle.

Figure 3 is a bottom view of one form of tool.

Figure 4 is a sectional view taken along the line 4—4 of Figure 3.

Figure 5 is a schematic flow diagram of one manner in which the process can be performed.

Figure 6 is a fragmentary side view of the tool head mechanism of Figure 1.

Figure 7 is a bottom view of a modified form of tool.

Figure 8 is an enlarged side view of a spindle operator.

Figure 9 is a schematic view of one form of control arrangement.

Figure 10 is an enlarged sectional view of a blank holder.

Figure 11 is a fragmentary front view of a rough grinding station.

In the generation of lens surfaces, a lens blank can be provided and can be mounted on a rotatable spindle. The tool may be of the ring type rotatable about an axis angularly disposed relative to the axis of rotation of the lens blank and in the same plane. As the tool and work are moved relatively toward each other and into contact while both are being rotated, a spherical surface will be formed on the lens blank. The radius of curvature of the surface generated will

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depend upon the angle between the axes and the dimensional relationship of the parts as is known in the art of generating lenses and spherical surfaces.

The invention described herein may be known as the "fine grinding" operation, such being one of the steps in the complete forming of a lens to a desired shape. The rough grinding operation is illustrated and described particularly in copending application, Serial Number 199,335, filed December 5, 1950.

As an example, the rough grinding machine may have a plurality of tool heads, said tool heads having diamond type ring tools positively rotated and fixed axially, the work being moved upwardly and into contact therewith until a fixed position is reached. The lens blanks are mounted on blank holders, the holders having tapered apertures therein which can be made and finished so as to fit tapered spindle ends on the work spindles located at the various stations of the grinding and polishing machines. The taper is chosen so as to fix the vertical position of the holder and blank thereon, to fix concentricity, and yet to permit easy removal of the holder from a spindle. The parts are arranged so that successive and different blank holders can be used with blanks mounted thereon in successive operations.

In the rough grinding operation, the tool spindle is fixed axially and the tool spindle can be rotated by an electric motor. The work carrying spindle in the rough grinding and in the fine grinding operation is movable axially by a motor operating through a yieldable connecting means. In a preferred form, an air or fluid motor is employed. As the work spindle is moved upwardly toward the rotating tool, an adjustable fixed stop is provided for each work spindle of the machines so that each spindle can be adjusted to move the correct amount relative to its tool spindle.

All of this is described in detail in said copending application, Serial Number 199,335, the work spindle arrangement thereof being applicable to the present invention.

In the rough grinding operation, the tool spindle is not movable axially; whereas in the fine grinding operation, it is movable axially as will be described hereafter.

Upon completion of the fine grinding operation, the blank holders with ground lenses thereon can be transferred to tapered spindles on the polishing machine units where the final polishing operation is performed on a lens surface.

One of the tool heads now will be described as used for the fine grinding operation. The machine frame arrangement can be similar to that described in copending application, Serial Number 199,335. The frame may have slideways 22 along the longitudinal axis of the frame, the slideway having a projection or tongue 21 with a sloping front surface 21A.

The tool head includes a tool head frame 20 having a recess 20A straddling the longitudinally extending projection 21 of the slideway 22. Wedges 24 and 25 are provided between the rear surface of the projection 21 and the adjacent vertical surface of recess 20A. One of the wedges may have a loose connecting pin preventing longitudinal movement relative to its tool head as the other wedge is being adjusted. After the tool head has been properly positioned transversely relative to the slideway, spacer 23 is tightened against surface 21A by means of set screws 23A along the face of the tool head frame 20. Thus, the tool head frame can be adjusted longitudinally along the machine frame and transversely thereof. The latter adjustment permits the axes of the spindles to be brought into the same plane.

Tool spindle holder 26 is mounted on a plate 27, said plate being fastened to a suitable shaft 28 passing through the tool head frame 20. At the opposite end of the shaft 28 there is located a threaded portion having nuts 29 thereon which can be tightened so as to hold the shaft in any adjusted position. Motor bracket 30 also is attached to said shaft 28 so that when shaft 28 is turned, spindle 26 and motor bracket 30 will be turned integrally therewith. A key 28A is located between shaft 28 and bracket 30. Set screw 28B permits adjustment of the bracket 30 on shaft 28 so as to adjust tension on belt 32. Motor 31 can be fastened to motor bracket 30, belt 32 being employed to drive pulley 33 (Figure 2 and Figure 6) for the purpose of rotating tool 34.

Tool spindle 35 is reciprocably carried in tool spindle holder 26, spring 36 being located between the upper surface of the pulley 33 and the plate 35 of the spindle.

Spring arrangement 37 is provided for applying spring pressure when desired to urge the spindle downwardly and therefore to furnish pressure on the tool relative to the lens surface when in contact therewith during finishing. Spring 38 is located in holder body 39, said spring urging member 40 outwardly, member 40 having a ball element 41 through which force is transmitted to spindle 35. Spindle 35 is rotated relative to member 40 and spring holder 39, the ball thrust element 41 permitting such movement.

Plug 42 is screw-threadedly engaged in holder 39, said plug providing an upper abutment for spring 38. The plug 42 also has attached thereto a leaf latch spring 43, said latch spring having an aperture 44 therein through which the stem 45 connected with member 40 passes.

Air operated release latch 46 is located in a suitable aperture in plug 42, the latch having a central aperture 47 therein reciprocably receiving the upper end of plunger 45. Air pressure may be introduced at appropriate times through piping 48 (Figure 2) and into aperture 49. As the latch release 46 is moved downwardly, it will contact leaf latch spring 43 and straighten it out relative to stem 45, thus releasing its grip upon the stem so as to permit spring 38 to act against member 40 and thus urge the tool toward the work.

The work spindle 50 (Figures 1 and 8) carries a blank holder 51 thereon, there being a lens blank 52 mounted on said blank holder 51 by means of the usual pitch or other similar adhesive material. The blank or work holders are described in detail in copending application, Serial Number 199,335.

After the blank holders have been put in position on the various work spindles 50 of the machine, an air cylinder 70 is activated so as to urge all of the work spindles upwardly to a fixed stop surface 71, said stop surface being contactable by adjustable stop screw 72 located on the work spindle slide 73. At this time, the latch release member 46 has air or fluid supplied thereto so as to release the latch leaf spring 43 and permit spring 38 to urge the tool spindle downwardly and to provide the proper contact pressure of the tool on the lens blank.

Air cylinder 70 is connected to arm 74 which oscillates shaft 75, shaft 75 extending the length of the machine. Opposite each of the work spindle stations, an arm 76 is located on shaft 75, each arm being connected to a fitting 77 having an aperture therein for receiving rod 78. Rod 78 may have nuts 79 limiting upward movement thereof by spring 80. Spring 80 abuts plate 81 which is adjustably positioned by nuts 82. Work spindle slide 73 is carried in dovetail slot 83 located in the frame 84 of the machine. The work spindle has a tapered end 85 for receiving a work holder and has a pulley 86 for rotatably driving the work spindle shaft.

As the air motor 70 is operated, each of the work spindles will be moved upwardly until its stop 71 reaches surface 72, the yieldable connection then permitting complete travel of motor 70 so as to properly actuate all of the work spindles to their adjusted heights.

A splash pan 87 can be attached to each of the work spindles, a front shield 88 being pivotally mounted at 89 thereon. Arm 90 extends rearwardly from 89 and is connected through turnbuckle 91 and link 92 with fixed bracket 93. The fixed bracket 93 has a slot 94 arranged so that as link 92 moves upwardly, it will cause the front shield to rotate to a closed position after the link reaches the top of the slot 94, the work slide continuing in its upward movement.

Upon lowering of the work spindle slide, the front shield will not begin to open until the link 92 has reached the lower end of slot 94.

Suitable connections to supply abradant (not shown) and drains from the splash pan 87 (not shown) can be provided.

The tool is of particular importance in the fine grinding operation described herein. It may be made of cast iron or similar material. One form of tool has a body 53 (Figures 3 and 4) with a central portion 54 and 55 cut away so as to leave a relatively thin annulus 56. Slots 57, 58 are cut across the face of the tool. An aperture 59 is provided for the purpose of fixedly mounting the tool on member 60 (Figure 2) of the tool spindle so as to cause rotation of the tool therewith.

Another form of tool is seen in Figure 7, wherein there is a body 95 having a single central cutaway portion 96 with slots 97, 98 therein.

In the fine grinding operation, a liquid containing an abrasive is fed to the tool and lens surface as the fine grinding takes place. The tool spindle and the work spindle are operated at different speeds.

Following the rough grinding operation, the work holder with the rough ground blank thereon is transferred to a work spindle on the fine grinding machine described herein. Inasmuch as the tapered aperture in the work blank holder and the tapered ends of the work spindles have been accurately made, the work spindle stop can be adjusted so that it will reach a predetermined height which will be uniform for all successive work blocks transferred thereto from the rough grinding machine. Previously thereto, the angle between the axes of the tool spindle and the work spindle has been determined to produce the desired curvature on the rough ground blank, the tool head having been moved longitudinally on the machine slideway so that the tool spindle axis will intersect the work spindle axis when the work spindle is in its upper stopped position at the desired center of curvature. In the fine grinding operation, the tool spindle is floating or axially movable, it being pressed into contact with the rough ground blank by means of spring pressure or air pressure as desired.

The tool is made of cast iron as previously described and has an abrasive fed thereto when it is in contact with the rough ground lens blank. After having ground a blank to a finished radius, the tool will have a stronger curvature or smaller radius than the curvature of the next rough ground blank placed on the spindle. Thus, when the tool first comes into contact with the rough ground work blank, the curvatures will not be the same. As the grinding progresses, the tool will wear until it has the same curvature as the glass of the blank being ground, this occurring before the final desired curvature is reached. The grinding continues until the final curvature is reached, the lap or tool changing curvature during the entire grinding operation, finally attaining the desired curvature. It can be shown mathematically that the foregoing wearing characteristics occur. The restricted area of the grinding annulus facilitates proper wear of the tool to produce a correct lens surface.

At the start of the operation, the work spindle is brought up to a fixed stop. The tool spindle is moved down by pressure against the rough ground blank, the pressure thereon being maintained constant. The specific gravity of the abrasive compound is maintained and the time of the grinding cycle is automatically controlled and thus the amount of glass removed will be a constant.

As an example of one method of automatic control, reference may be made to Figure 9 wherein timer 100 is started after a work blank has been transferred to the work spindle. The timer is connected through relays with the air motor 101 which will serve to operate the work spindles and raise the amount permitted respectively by their stops. The timer also can be arranged to start motor 102 rotating the various work spindles on the machine. The timer further is connected to valve 103 applying air to the release latch of the tool spindle. Valve 104, controlled by the timer, is arranged to admit abradant to the tool and work at an appropriate time.

Figure 11 shows a rough grinding station as described in copending application Serial No. 199,335. The parts in Figure 11 corresponding to other similar parts of this application have been given the same numeral with a prime thereafter. The rough grinding station is generally similar to the fine grinding station previously described with the exception that tool spindle holder 26' is arranged so that the tool 34' does not move axially therein.

Figure 10 shows the details of a lens blank having lens 52' mounted thereon, the block having a tapered aperture 141' in the base member thereof.

It is apparent that details of the invention may be changed without departing from the spirit thereof except as defined in the appended claims.

What is claimed is:

1. In a grinding machine for lenses or the like, the combination including a tool spindle and a work spindle rotatable on fixed axes, tool carrying means on said tool spindle and rotatable therewith on its axis, work carrying means on said work spindle rotating work on a fixed axis, the axes of said spindles being angularly disposed in the same plane so that the tool and work carried by said spindles will rotate about axes in the same plane, means moving said work spindle to a predetermined position with the work in contact with said tool, floating means urging said tool into contact with the work, and means moving said spindles toward each other for a predetermined time interval and maintaining said contact for said predetermined time only.

2. In a grinding machine, the combination including a work supporting spindle carrying work on a fixed axis, a metallic tool rotatably mounted on a tool spindle on a fixed axis, the axes of said spindle being angularly disposed in the same plane so that the tool and work carried by said spindles will rotate about axes in the same plane, said tool having a central relieved surface defining an annulus, said annulus having slots cut therein, so that as said tool and work are brought into contact, said tool wears from a curve differing from the work surface when first contacted, to a mid curve, and then to the desired curve, means moving said work spindle to a predetermined position with the work in contact with said tool, floating means urging said tool into contact with the work, means moving said spindles toward each other for a predetermined interval and maintaining said contact for said predetermined time only, and means feeding abrasive to said tool when it is in contact with the work.

3. In the forming of lenses, the combination including a plurality of successive tool spindles rotatable about fixed axes, a plurality of successive work spindles rotatable about fixed axes and having tapered ends, said spindles being movable to predetermined positions relative to the tool spindles cooperating therewith, and a plurality of lens blank holders having apertures interchangeably mountable on said tapered ends on each of said work spindles, said lens blank holders having means positioning a lens mounted on each in a predetermined position on each different and successive spindle.

4. In a lens grinding apparatus, the combination including a rough grinding work spindle and tool spindle, the work and tool rotating about fixed axes of said spindles, a fine grinding work spindle and tool spindle, the work and tool rotating about fixed axes of said spindles, means adjusting the angular relationship of said work and tool spindles relative to each other to produce a desired curvature of lens, means bringing each of said work spindles to a predetermined active relationship with its tool spindle, each of

said spindles having tapered ends, a lens blank holder having a tapered aperture successively mountable on the tapered ends of said work spindles and having means bringing it into a predetermined height relationship with each of the work spindles.

5. In a lens grinding apparatus, the combination including a plurality of rough grinding work spindles and tool spindles, the work and tool rotating about fixed axes of said spindles, a plurality of fine grinding work spindles and tool spindles, the work and tool rotating about fixed axes of said spindles, means adjusting the angular relationship of said work and tool spindles in a plane relative to each other to produce a desired curvature of lens, means bringing each of said work spindles to a predetermined active relationship with its tool spindle, each of said spindles having tapered ends, and a plurality of lens blank holders having tapered apertures successively mountable on said work spindles and having means bringing them into a predetermined height relationship with each of the work spindles so that the lens blank holders can be mounted on successive and different work spindles.

6. In a grinding machine, the combination including a work spindle and tool spindle rotatable on fixed axes, said axes being angularly disposed relative to each other, spring means axially aligned relative to and urging said tool spindle relatively toward said work spindle, latch means contactable with means actuated by said spring and restraining said spring means from urging said spindles toward each other, and latch releasing mechanism movable into contact with said latch means releasing said spring means so as to activate the same.

7. In a grinding machine, the combination including a work spindle and tool spindle rotatable on fixed axes, said axes being angularly displaced relative to each other, spring means urging said tool spindle relative to said work spindle, latch means contactable with means actuated by said spring, and air pressure means movable into contact with said latch means for releasing said spring and activating the same.

8. In a grinding machine, the combination including a work spindle and tool spindle rotatable on fixed axes, said axes being angularly displaced relative to each other, spring means urging said tool spindle relative to said work spindle, latch means contactable with means actuated by said spring, air pressure means movable into contact with said latch means for releasing said spring and activating the same, and means raising said work spindle to a predetermined stop position relative to said tool spindle.

9. In a grinding machine, the combination including a rotatable spindle, spring means urging a thrust member into engagement with said spindle to axially move said spindle, said thrust means including a rod, a leaf spring having an aperture larger than said rod and through which said rod passes, said spring being movable so that said rod is gripped and restrained from movement thereby, a plunger movable to contact said leaf spring and straighten it so that said rod is released, and motor means for moving said plunger.

10. In a lens grinding machine, the combination comprising an axially movable work spindle, an axially movable tool spindle, means exerting force on said tool spindle, releasable means restraining said means exerting axial force, means moving said work spindle to a fixed position and into contact with a tool on said tool spindle, timer mechanism connected to said work spindle means moving it to said fixed position, connections between said timer and said releasable means releasing said axial force means so that said work and tool will be in active contact for a predetermined time, and timer connections moving said work spindle away from said fixed position at the end of a predetermined time.

11. In a lens grinding machine, the combination comprising an axially movable work spindle, an axially movable tool spindle, motor means rotating said work spindle, means exerting axial force on said tool spindle, releaseable means restraining said means exerting axial force, means moving said work spindle to a fixed position and into contact with a tool on said tool spindle, timer mechanism connected to said work spindle means moving it to said fixed position, connections between said timer and said releasable means releasing said axial force means so that said work and tool will be in active contact for a predetermined time, timer connections moving said work spindle away from said fixed position at the end of a predetermined time after a lens has been ground, and timer connections starting and stopping said work spindle when it is moved toward and away from said fixed position.

12. In a lens grinding machine, the combination comprising an axially movable work spindle, an axially movable tool spindle, motor means rotating said work spindle, means exerting axial force on said tool spindle, releasable means restraining said means exerting axial force, means moving said work spindle to a fixed position and into contact with a tool on said tool spindle, timer mechanism connected to said work spindle means moving it to said fixed position, connections between said timer and said releasable means releasing said axial force means so that said work and tool will be in active contact for a predetermined time, timer connections moving said work spindle away from said fixed position at the end of a predetermined time after a lens has been ground, timer connections starting and stopping said work spindle when it is moved toward and away from said fixed position, and timer connections between an abradant supply activating the same during the period said work and tool are in contact.

13. The method of grinding lenses by fixed axis rotatable tool means, comprising the steps of generating a curve on a lens blank at a first station, transferring the lens blank to a second station, starting the second generation at a fixed distance from the intersection of a tool spindle and work spindle axis, and moving said work and tool a predetermined distance relative to each other so as to generate a lens surface having the desired curvature.

14. The method of grinding lenses by fixed axis rotatable tool means, comprising the steps of generating a curve on a lens blank at a first station, transferring the lens blank to a second station, starting the second generation at a fixed distance from the intersection of a tool spindle and work spindle axis, moving said work and tool a predetermined distance relative to each other so as to generate a lens surface having the desired curvature, and holding said lens and tool in contact for a predetermined time during said second generation.

15. The method of grinding lenses utilizing a plurality of successive work spindles and cooper-

able tool spindles, the axis of rotation of said cooperable spindles and tool being angularly fixed for a desired curvature of lenses, comprising the steps of generating a predetermined curve on a lens at a first station, transferring said lens to a successive work spindle having a cooperable tool spindle and placing the lens at a predetermined fixed distance relative thereto, further generating a curve on said lens by moving said tool and work spindle relative to each other from said beginning fixed contact point until the desired radius of curvature of the work is obtained.

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