

Nov. 27, 1923.

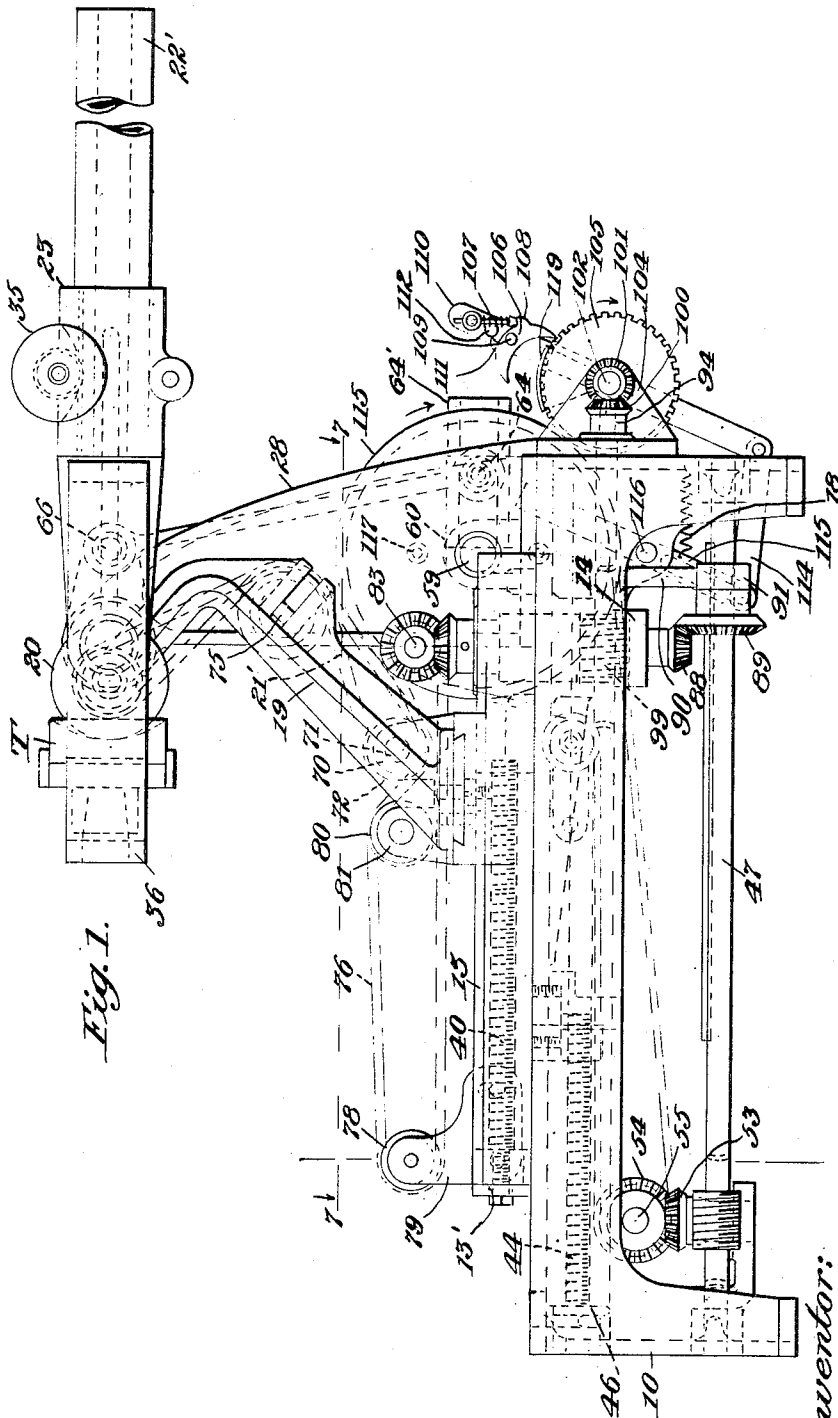
J. S. GALESKI

1,475,626

LENS TOOL GRINDING MACHINE

Filed Nov. 17, 1920

4 Sheets-Sheet 1



Inventor:
J. S. Galeski,
By *Charles Bryant Worley*
Att'y.

Nov. 27, 1923.

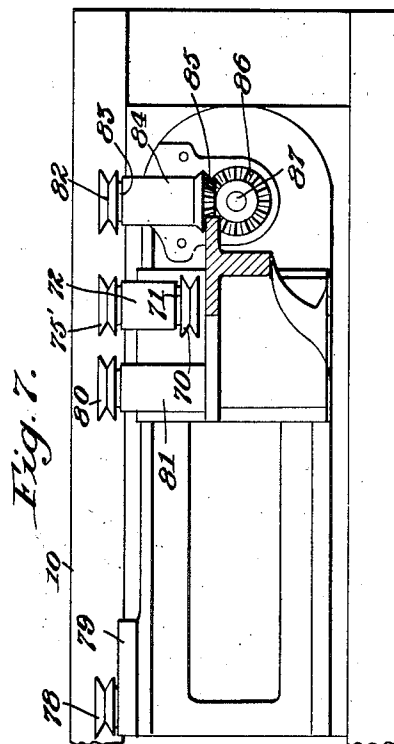
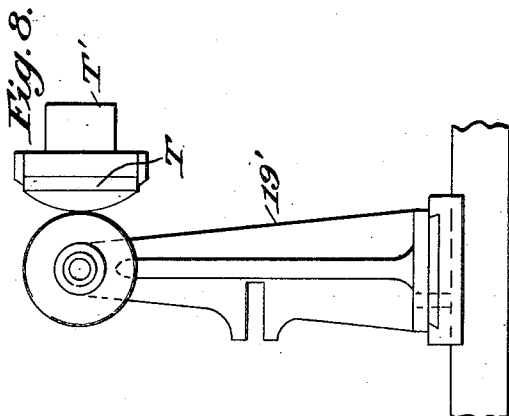
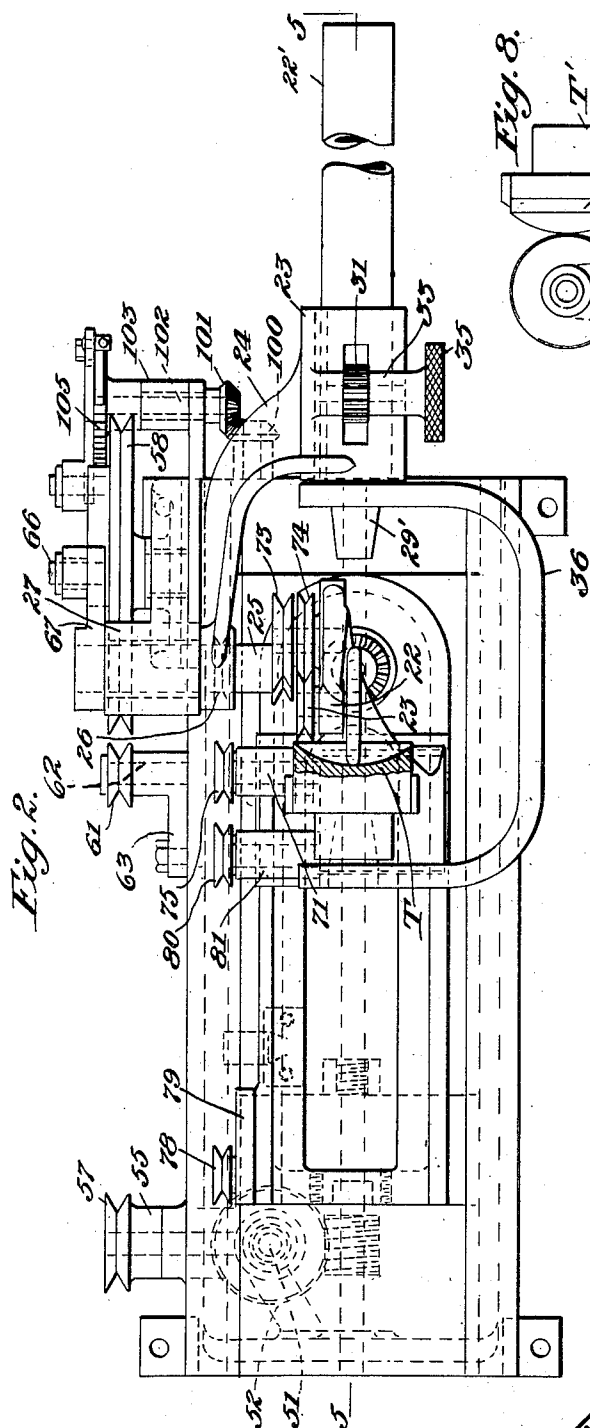
1,475,626

J. S. GALESKI

LENS TOOL GRINDING MACHINE

Filed Nov. 17, 1920

4 Sheets-Sheet 2



Inventor:
J. S. Galeski,

By *Charles B. Burt & Son*
Att'ys.

Nov. 27, 1923.

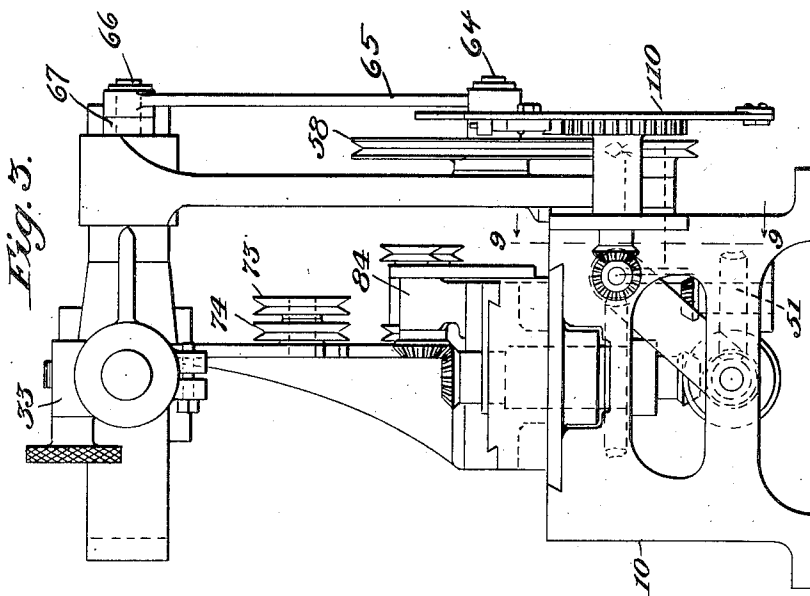
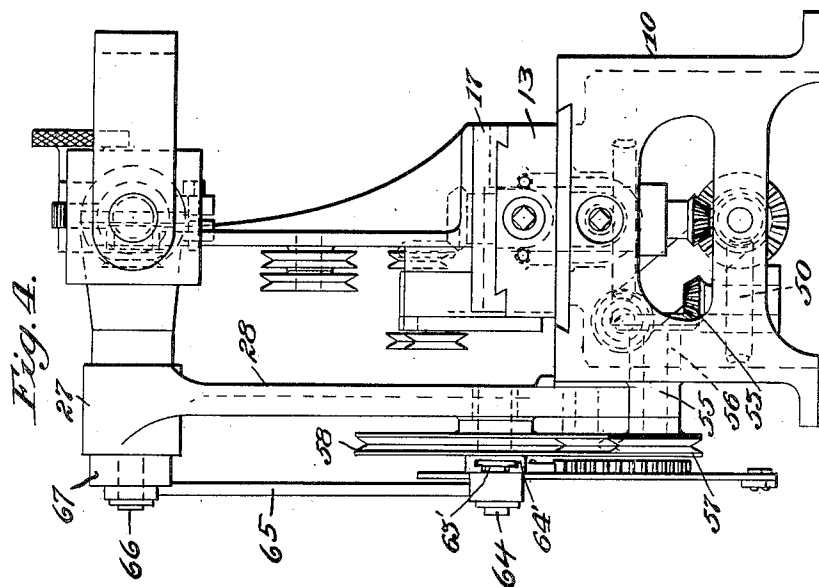
1,475,626

J. S. GALESKI

LENS TOOL GRINDING MACHINE

Filed Nov. 17, 1920

4 Sheets-Sheet 3



Inventor:
J. S. Galeski,

By Leahman B. Bryant & Warley
Attys.

Nov. 27, 1923.

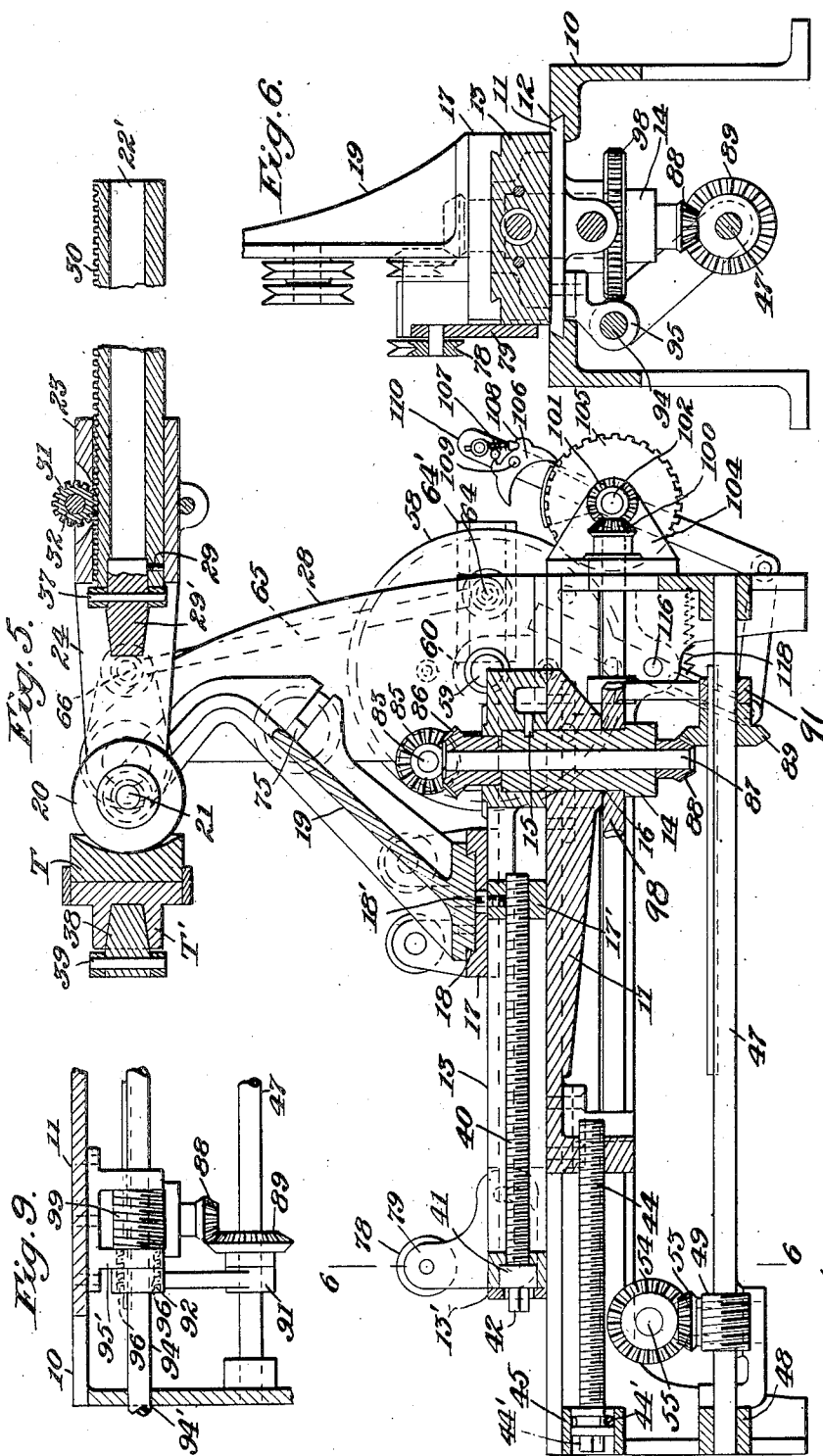
1,475,626

J. S. GALESKI

LENS TOOL GRINDING MACHINE

Filed Nov. 17, 1920

4 Sheets-Sheet 4



Inventor:
J. S. Galeski.

By *Leahman, Bryant & Morley*
Att'ys.

UNITED STATES PATENT OFFICE.

JOSEPH S. GALESKI, OF RICHMOND, VIRGINIA.

LENS-TOOL-GRINDING MACHINE.

Application filed November 17, 1920. Serial No. 424,757.

To all whom it may concern:

Be it known that I, JOSEPH S. GALESKI, a citizen of the United States, residing at Richmond, in the county of Henrico and State of Virginia, have invented new and useful Improvements in Lens-Tool-Grinding Machines, of which the following is a specification.

This invention relates to improvements in grinders, and more particularly, though not exclusively, to improvements in machines intended primarily for grinding or retrueing tools, laps or molds used in grinding toric lenses.

A toric tool is a lens grinding tool having a double curved surface, that is, a surface with curvatures in two meridians at right angles to each other, the curves in parallel planes being the same.

It is highly desirable that these tools be made with the greatest accuracy, and for this reason it is generally preferred, when manufacturing tools and retrueing them, to use a grinding machine which, of course, will perform the work with greater accuracy than a cutter.

In a patent granted to John Harvey Pearson, Dec. 10, 1918, No. 1,287,091, there is disclosed a machine intended for the same purpose as the machine of this invention and reference to that patent will convey a very clear idea of the nature of this invention. In machines such as that disclosed in the patent above referred to, and now employed for the grinding of toric tools, the curvature of the tool in one meridian is dependent upon the circumferential curvature of the grinding wheel, variations of the curvature being obtained by the substitution of grinding wheels having different circumferential curvatures. Moreover, so far as I am aware, there is, in the art, no toric tool grinding machine which will grind tools with either convex or concave surfaces, as may be desired.

The present invention has among its objects to provide a machine in which the curvature of the surface being ground is, in both meridians, independent of the circumferential curvature of the grinding wheel, and a machine which will grind tools with either plus or minus curves, that is, with either convex or concave surfaces.

The above are the primary objects of the invention, but other more minute objects,

such as the provision of a machine which is comparatively similar in construction, and which may be readily adjusted to grind tools of any desired curvature, will become obvious from a reading of the following detailed description in connection with the accompanying drawings, wherein there is illustrated one form of a machine in which the invention may be embodied.

In the drawings:—

Fig. 1 is a side elevational view,

Fig. 2 a top plan view,

Fig. 3 a rear end view,

Fig. 4 a front end view,

Fig. 5 a vertical longitudinal section on the line 5—5 of Fig. 2,

Fig. 6 a vertical cross section on the line 6—6 of Fig. 5,

Fig. 7 a partial plan view on the line 7—7 of Fig. 1,

Fig. 8 is a view showing a modified form of grinding wheel support which is used when convex surfaces are to be ground, and

Fig. 9 is a vertical section of a portion of the machine.

Referring to the drawings, and more particularly to Figs. 5 and 6, 10 indicates a bed upon which rests a slide 11, the lateral edges of the slide resting upon the rabbeted edges 12 of an opening formed in the top of the bed. Pivotaly supported upon the slide is a base 13 formed upon its under face and at its rear end with a socket which fixedly receives a sleeve 14, a set screw 15 holding the sleeve in position in its socket. The sleeve extends through an opening 16 in the slide 11 to a position beneath the bed of the machine, the opening in the slide serving as a bearing for the sleeve, which is rotated therein in a manner hereinafter described. The bed 13 upon its top surface supports a slide block 17 transversely channeled as at 18 (Fig. 5) to support a removable arm 19, in the upper end of which is journaled a grinding member in the form of a revoluble grinding wheel 20. The wheel is fixedly mounted upon a shaft 21 extending through a bearing 22 (Fig. 2) in the upper end of the arm and having secured to its outer end, upon the opposite side of the bearing, a pulley 23 from which the wheel is driven in a manner later to be described.

The lens tool, indicated at T, may be supported upon a hollow shaft 22' which

is slidably mounted in a bearing 23 at the rear of the grinding wheel. This bearing is formed in a rocking arm 24 which extends laterally and forwardly and is fixedly mounted at 26 upon a short rock shaft 25, having a bearing 27 in the upper end of an arm 28 secured at its lower end to the bed of the machine. The tool supporting shaft 22' may be slidably adjusted in the bearing 23 by a pinion 31 meshing with a rack 30, the pinion being fixedly secured to a stub shaft 32 having bearings at 33 in the arm 24 and provided at its outer end with a knurled thumb disk 35, by means of which the shaft and its pinion may be rotated. The forward end of the shaft 22' may have fixedly held therein, as by means of a set screw 29, a tapering plug 29' which has secured thereto a yoke 36, a pin 37 (Fig. 5) being shown as passing through aligned openings in the arm and yoke. It will be noted that this yoke straddles the grinding wheel, and at the front of the grinding wheel has positioned therein a stud 38, a pin 39 passing through the yoke and stud. It will be noted that the stud resembles, in shape, the plug 29', the latter mentioned parts being thus formed to fit into a shank T' of the tool holder formed with a socket for the reception of the tool T. Obviously, any other suitable tool supporting means might be employed, and it will be clear that, while in the drawings the tool is shown as being supported at the front of the grinding wheel on the opposite side of the grinding wheel from the shaft 25, which serves as the axis for the tool support so that a concave surface is ground, the tool might well be positioned at the rear of the grinding wheel between the axis of the tool support and the grinding wheel, in which event a convex surface would be ground, as shown in Fig. 8. By reference to Fig. 8 it will be noted that it will be found desirable to employ a substantially vertically extending grinding wheel supporting arm 19', when a convex surface is to be ground, since the supporting arm 19, used when a concave surface is ground, is provided with an elbow which would interfere with the oscillations of the tool support when the tool is positioned between the axis of its support and the grinding wheel.

In operating this machine it is desirable that one of the supports, preferably the tool support, be given an oscillatory motion in a vertical plane, this movement being obtained in the illustrated embodiment of the invention by imparting a rocking motion to the shaft 25 which has a bearing in the upper end of the arm 28. At the same time the revolving grinding wheel should be moved in an arcuate path across the face of the tool, which may be accomplished by intermittently rotating, step by step, the

sleeve 14 a few degrees and thus swinging the bed 13 and the supporting arm 19 in an arcuate path with the sleeve as an axis. From the description of the device thus far given, it will be clear that the length of the radius of the arc of travel of the tool T may be adjusted by sliding the tool supporting shaft 22' in its bearing 23. At the same time, it is also possible to adjust the length of the radius of the arc of travel of the grinding wheel, this being done by moving the slide block 17 and the supporting arm 19 (or 19' if a convex tool is to be ground, as in Fig. 8) along the bed 13. For this purpose the block 17 has secured to its under face an internally threaded eye 17' (Fig. 5) by means of a screw 18' which fits through the base of the block into the eye. The slide block may be moved to and fro upon the bed by means of a screw 40 rotatably positioned and held in a socket 41 in the forward end of the base 13 by means of an end plate 13' through which extends the squared end 42 of the screw, by means of which the screw may be rotated to adjust the slide block as desired. It will be clear that as the slide block is adjusted along the base 13 it moves relatively to the axis of the base 13, which has a pivotal movement with the sleeve 14 and thus the length of the radius of the arcuate path of travel of the block and grinding wheel support is adjusted.

Subsequent to the adjustment of the radii of the arcs of travel of the lens tool and the grinding wheel, it will generally be found necessary to bring the grinding wheel and lens tool into operative relation, and this should, of course, be accomplished without in any way interfering with or disturbing the above mentioned adjustments. In the illustrated embodiment of my invention this is accomplished through movement of the slide 11 along the base 10 by a screw 44 having its forward end extending into a downward projection at the front end of the slide 11 and being held for rotation, but against longitudinal movement, in a bearing 45 at the front of the bed. A pin 44' extending through the bearing and projecting into a groove formed in the screw will hold the latter in position. It will be noted that the movement of the slide 11 not only results in the carrying of the grinding wheel toward or away from the lens tool, but, at the same time, moves the sleeve 14 and the base 13 upon which the grinding wheel support 19 is mounted. Hence, adjustment of the slide 11 in no way alters the radial adjustment of the slide block 17 and grinding wheel supporting arm, since movement of the base results in movement of the axis (the sleeve 14) of the arcuate movement of the grinding wheel.

My invention contemplates the provision

of mechanically operated means for oscillating the work support in a vertical plane, for rotating the grinding wheel, and for imparting a step by step, arcuate movement to the grinding wheel across the face of the lens tool. For this purpose there may be journalled beneath the bed of the machine a shaft 47 having a bearing 48 at each end of the machine, and having located thereon, at its forward end, a worm 49 meshing with a worm gear 50 (Fig. 4) fixedly secured to a vertical shaft 51 having a bearing in the outer end of a bracket 52 (Fig. 2). The upper end of the shaft has fixed thereto a bevel gear 53 meshing with a bevel gear 54 upon a shaft 55 which has a bearing 56 in the side of the machine bed. The outer end of this shaft has fixed thereto a pulley 57 which is in line with a larger wheel or pulley 58 at the rear end of the machine. The wheel 58 is mounted upon a shaft 59 which has a bearing in a bracket 60 secured to the machine bed. An idler 61 (Fig. 2) may be positioned adjacent the wheel 58 upon a shaft 62 located in a bearing bracket 63, the belt passing beneath this idler and around the wheel 58, as will be observed from an inspection of Fig. 1. Upon the outer face of the wheel 58 is fixedly mounted (Figs. 1 and 4) a radially extending raceway 64' housing the roller 63' upon the end of a short sliding eccentric pin 64. The roller 63' and its eccentric move with the wheel 58. A pitman 65 is pivotally connected at its lower end to the eccentric pin, and at its upper end is pivotally secured by means of a pin 66 to the outer end of a rock arm 67 which is mounted upon the end of the rock shaft 25. Rotation of the wheel 58 results in reciprocation of the pitman, which, of course, produces a rocking of the shaft 25. Power may be applied from any suitable source to the shaft 47 beneath the machine bed, and rotation of this shaft will result in rotation of the pulley 57 which, through the belt drive, will transmit movement to the wheel 58. It will be clear that rotation of the wheel 58 will result through the eccentric and link connection in the imparting of a rocking movement to the arm 67 and shaft 25. Thus, the work support, which is supported by the shaft 25 through the rock arm 24, will be given an oscillatory movement in a vertical plane, the shaft 25 serving as the center of oscillation.

The grinding wheel shaft 21 is constantly rotated from a belt 21' which traverses the pulley 23 upon the end of the grinding wheel shaft and pulley 70 (Fig. 7) fixedly secured upon a shaft 71 having a bearing in a bracket 72 positioned upon the slide block 17 at the base of the grinding wheel support 19. The belt 21', on its upward and downward runs, traverses idlers 73, 74 supported upon an axle 75 fixedly secured in a

slot formed at an intermediate point in the grinding wheel supporting arm. The outer end of the shaft 71 has fixed thereto (Fig. 2) a pulley 75' which is constantly rotated by a belt 76 which runs beneath this pulley, as indicated in Figures 1 and 7. The belt 76 traverses an idler 78 supported in a bracket 79 at the forward end of the base 13, has an upper run passing over an idler 80 adjacent the base of the grinding wheel arm 19 and suitably supported in a bracket 81 and passes around a driven pulley 82 (Fig. 7) which is fixedly secured to a short horizontal shaft 83 at the rear of the bed 13. The shaft 83 is journalled in a bracket 84 mounted upon the slidable bed 13 and has a bevel gear 85 meshing with a bevel gear 66 fixedly secured upon the upper end of a vertical shaft 87 which passes through the bed 13, the slide 11 and the sleeve 14 to a point below the sleeve, where it has a bevel gear 88 secured thereto, and meshing with a bevel gear 89 splined to the shaft 47. The bevel gear 89, as shown in Fig. 5, is slidably keyed to the shaft 47 and is connected to the bed 10 so as to be movable therewith by means of an arm 90, the lower end 91 of which encircles the shaft 47.

The upper end 92 of the arm 90 (Fig. 9) encircles a shaft 94 paralleling the shaft 47 and having a bearing 94' in the rear end of the machine bed and at its forward end has another bearing in a bracket 95 (Fig. 6) depending from the machine bed. The end 92 of the arm 90 is connected to a bracket 95' by means of screws 96, the bracket being supported upon the under face of the slide 11. As the slide 11 is moved along the bed the arm 92 moves with the slide and carries the gear 89 along the shaft 47, this maintaining the driving connection between gears 88 and 89 no matter to what forward position the slide 11 is moved. Obviously, upon rearward movement of the slide 11, the gear 88 will push the gear 89 along its shaft. It should be clear that movement of the drive shaft 47 imparts movement to the vertical shaft 87 through bevel gears 88, 89 and thus the shaft 83 driven through the gears 85, 86 drives the belt 76, which, in turn, transmits its movement to the grinding wheel belt 21' through the pulley connections hereinbefore described. It will also be noted that no matter to what position the slide 11 and slide block 17 are moved along the bed of the machine, the driving connections for rotation of the grinding wheel will not be broken since the gearing 89 and vertical shaft 87 move with the slide 11, thus efficiently driving the belt 76, and since movement of the slide block 17 along the bed 13 will merely position the pulley 75 at various points along the belt 76.

The grinding wheel is given a step by step movement across the face of the lens

tool by means of mechanism which imparts such a movement to the bed 13 which is fixedly secured to the upper end of the sleeve 14. Mechanism is provided which will rotate this sleeve step by step, and thus move the bed and the grinding wheel. Upon the lower end of the sleeve beneath the slide 11 is fixed a worm gear 98 meshing with a worm 99 (Fig. 9) slidably keyed upon the shaft 94 between depending portions of the bracket 95' so as to be moved along the shaft 94 when the slide 11 is adjusted. The shaft 94 extends through the rear end of the machine bed and at the rear of the bed has affixed thereto a bevel gear 100 meshing with a bevel gear 101 secured upon the end of a shaft 102 having a bearing 103 in the outer end of a bracket 104 secured to the bed of the machine. The opposite end of the shaft 102 has affixed thereto a ratchet wheel 105 which may be engaged by a pawl 106 yieldingly held in the position shown in Figure 1 by means of a plunger 107, the lower end of which engages a shoulder 108 upon the pawl. The pawl is pivotally mounted upon a pin 109 formed upon an arm 110 which is pivotally mounted upon the shaft 102. It will be noted, by reference to Figure 1, that the pawl is provided with a second shoulder 111 which engages a stop 112 upon the arm 110 and is thus prevented from rocking any further about its pivot 109 under the influence of the plunger 107. The lower end of the arm 110 is pivotally connected to a link 114, the other end of which has a pin and slot connection with a substantially vertically extending arm 115 pivotally supported at 116 upon the side of the machine bed (Figs. 1 and 5).

At diametrically opposite points on the outer face of the wheel 58 are located eccentric pins 117 which engage the upper end of the arm 116, as shown in Figs. 1 and 5, and rock the latter about its pivot 116 in opposition to the spring 118 which tends to throw the arm in the opposite direction. Rotation of the wheel 58 in a clockwise direction will thus result in the transmission of a rocking movement to the arm 110 about the shaft 102 and the pawl 108 will be moved in a clockwise direction around the ratchet to impart to the latter and its shaft 102 a clockwise rotation. It will be understood that it is desirable to move the shaft 102 only a few degrees at every rotation of the wheel 68 so that the grinding wheel will move across the face of the lens tool only a small fraction of an inch at the end of each oscillation of the lens tool support. For this reason a shield 119 is mounted so as to cover a majority of the teeth which will be in the path of the pawl 108 as it moves in a clockwise direction. The pawl being pressed downwardly by the plunger 107 and thus

urged into engagement with the teeth will engage the teeth of the ratchet only upon the last portion of its movement, and thus will move the ratchet and the shaft 102 but slightly upon every rotation of the drive wheel 58. It should be obvious from the above description that the intermittent or periodic movement of the shaft 102 will result in a similar movement in the sleeve 14 and the bed 13 through the driving connection hereinbefore mentioned, and thus the slide block 17 upon the bed will be moved in an arcuate path with the grinding wheel which it supports.

In operating this machine it should first be determined whether a convex or concave surface is to be ground upon a lens tool. If a concave surface is to be ground the tool is mounted upon a supporting yoke, as indicated in Figures 1 and 5, the tool being positioned upon the opposite side of the grinding wheel from the axis of the tool support. On the other hand, if a concave surface is to be ground the tool support 19, shown in Fig. 1, should be replaced by the substantially straight supporting arm 19' indicated in Fig. 8, and the tool should be placed upon the extension 22' of the supporting arm 22, it being possible to dispense with the yoke if desired. The slide 11 should be adjusted so that the lens grinding tool will be positioned at the rear of the grinding wheel and between the axis of its support and the wheel. Having placed the tool upon its support in this manner it is necessary to adjust the radius of the arc of travel of the tool support and the radius of the arc of travel of the grinding wheel support so that the curves which are ground in the vertical and horizontal meridians will be those desired. In order to adjust the radius of the travel arc of the tool support it is simply necessary to move the arm 22 by means of the thumb disk 35 and ratchet wheel 31 to any desired position relative to the axis 25 about which the arm oscillates. In order to adjust the radius of the arc of travel of the grinding wheel the slide block 17 and the supporting arm 19 are moved along the base 13 by rotating the screw 40. These adjustments having been made, the grinding wheel is brought into operative engagement with the work by moving the slide 11 along the bed of the machine, this being done by operating the adjusting screw 44. Power may then be applied to the shaft 47 and there will result the oscillation of the work support in a vertical plane, rotation of the grinding wheel, and a periodic movement of the grinding wheel across the face of the work, this periodic movement taking place about the vertical axis identified by the sleeve 14.

It will be obvious from a reading of the above description that in this machine the

curvature which is produced upon the surface of the lens tool is, in both meridians, independent of the circumferential curvature of the grinding wheel, the curvature in the vertical meridian being dependent upon the adjustment given the arm 22 with respect to its center of oscillation, and the curvature in a horizontal meridian being dependent upon the adjustment of the slide block 17 relatively to the axis of movement of its supporting base 13.

It should be understood that while I have described and shown a detailed construction of a machine, the description is of only one of many forms in which the invention might be embodied, and many modifications might be made in the construction shown and described without departing from the scope of the invention, which is more definitely defined in the following claims.

What I claim is:

1. A device of the class described, comprising a revoluble grinding wheel, means for revolving said wheel, a work support, and means for obtaining between the work support and the wheel a relative step by step movement through an arcuate path and at the same time a relative back and forth movement through an arcuate path in a plane at right angles to the plane of the step by step movement.

2. A device of the class described comprising a revoluble grinding wheel, means for revolving said wheel, a work support, and means for obtaining between the work support and the wheel a relative step by step movement through an arcuate path and at the same time a relative back and forth movement through an arcuate path in a plane at right angles to the plane of the step by step movement without moving either the wheel or the work toward the other.

3. A device of the class described comprising a revoluble grinding wheel, means for revolving said wheel, a work support, and means for obtaining between the work support and the wheel a relative step by step movement through an arcuate path and at the same time moving the work support back and forth through an arcuate path in a plane at right angles to the plane of said step by step movement.

4. A device as specified in claim 1, having means for positioning the work on opposite sides of the grinding wheel at the same side of the work support axis whereby either convex or concave surfaces may be ground.

5. A device as set forth in claim 2, having means for positioning the work on opposite sides of the grinding wheel at the same side of the work support axis whereby either convex or concave surfaces may be ground.

6. A machine of the class described, comprising a revoluble grinding member, an oscillatable support for said member, means

for revolving said member, an oscillatable work support, means for moving said supports through arcuate paths in planes at right angles to each other without moving either the work or the grinding member toward the other during the grinding operation, and means for adjusting the length of the radius of the arc of travel of each of said supports.

7. A machine of the class described, comprising a movable grinding member, means for moving said member, a pivotally movable support for said member, an arcuately movable work support having an axis of movement at right angles to the axis of said first mentioned support, said support being adapted to position the work in a plurality of positions relative to said grinding member whereby convex or concave surfaces may be selectively ground, and means for moving said work support through its path of travel.

8. A machine of the class described, comprising a movable grinding member, means for moving said member, an arcuately movable support for said member, an arcuately movable work support having an axis of movement at right angles to the axis of said first mentioned support, said support being adapted to position the work in a plurality of positions relative to the axis of said grinding member whereby convex or concave surfaces may be selectively ground, and means for moving said supports through their paths of travel.

9. A machine of the class described, comprising a revoluble grinding wheel, means for revolving said wheel, an arcuately movable support for said wheel, a pivotable work support having its axis at the rear of said grinding wheel, said support being adapted to hold the work either between the axis of the work support and the grinding wheel or on the opposite side of the grinding wheel from the axis of the work support whereby either convex or concave surfaces may be ground, and means for moving each of said supports about its axis.

10. A machine of the class described comprising a revoluble grinding wheel, means for revolving said wheel, an arcuately movable support for said wheel, a pivotable work support having its axis at the rear of said grinding wheel said support being adapted to hold the work either between the axis of the work support and the grinding wheel or on the opposite side of the grinding wheel from the axis of the work support whereby either convex or concave surfaces may be ground, mechanically operated means for oscillating one of said supports and mechanically operated means for moving the other of said supports through an arcuate path of travel.

11. A machine of the class described com-

prising a revoluble grinding wheel, means for revolving said wheel, an arcuately movable support for said wheel, a pivotable work support having its axis at the rear of said grinding wheel, said support being adapted to hold the work either between the axis of the work support and the grinding wheel or on the opposite side of the grinding wheel from the axis of the work support whereby either convex or concave surfaces may be ground, mechanically operated means for oscillating one of said supports and mechanically operated means for moving the other of said supports through an arcuate path of travel.

12. A machine of the class described comprising a revoluble grinding wheel, means for revolving said wheel, an arcuately movable support for said wheel, a pivotable work support having its axis at the rear of said grinding wheel, said support being adapted to hold the work either between the axis of the work support and the grinding wheel or on the opposite side of the grinding wheel from the axis of the work support whereby either convex or concave surfaces may be ground, mechanically operated means for oscillating said work support and mechanically operated means for moving the other of said supports through an arcuate path of travel.

13. A machine of the class described comprising a revoluble grinding wheel, means for revolving said wheel, a pivotally mounted support for said wheel, a pivotally mounted work support having an axis at right angles to the axis of said grinding wheel support, means for oscillating said work support, and means for moving said grinding wheel support step by step about its axis.

14. A machine of the class described comprising a revoluble grinding wheel, means for revolving said wheel, a pivotally mounted support for said wheel, a pivotally mounted work support having an axis at right angles to the axis of said grinding wheel support, means for oscillating said work support, means for moving said grinding wheel support step by step about its axis, and means for varying the length of the radius of the arc of travel of each of said supports.

15. A machine of the class described comprising a revoluble grinding wheel, means for revolving said wheel, a pivotally mounted support for said wheel, a work support oscillatable about an axis at right angles to the axis of said wheel support, means for oscillating said work support, means for moving the grinding wheel support step by step through an arcuate path, means for adjusting the radius of the travel arc of each of said supports, and means for relatively moving said supports to bring the

grinding wheel and work to operative relation without varying the adjustment of said radii.

16. A machine of the class described comprising a revoluble grinding wheel, means for revolving said wheel, a pivotally mounted support for said wheel, a work support oscillatable about an axis at right angles to the axis of said wheel support, means for oscillating said work support, means for moving the grinding wheel support step by step through an arcuate path, means for adjusting the radius of the travel arc of each of said supports, and means for moving the grinding wheel support relatively to said work support without varying the adjustment of said radii to thereby bring the grinding wheel and work into operative relation.

17. A machine of the class described comprising a bed, a slide mounted upon said bed, a second slide above said first mentioned slide and movable both with and relatively to said first mentioned slide, a support on said second mentioned slide, a support on said bed, a revoluble grinding wheel on one of said supports, means for holding work on the other of said supports, one of said supports being oscillatable, means for oscillating said oscillatable support, the other of said supports being movable through an arcuate path, means for moving the other of said supports through an arcuate path of travel, and means for revolving said grinding wheel.

18. A machine of the class described comprising a bed, a slide mounted upon said bed, a second slide above said first mentioned slide and movable both with and relatively to said first mentioned slide, a support on said second mentioned slide, a support on said bed, a revoluble grinding wheel on one of said supports, means for holding work on the other of said supports, one of said supports being oscillatable, means for oscillating said oscillatable support, the other of said supports being movable through an arcuate path of travel, means for moving the other of said supports through an arcuate path of travel, and means for adjusting the length of the radius of the arc of travel of each of said supports.

19. A machine of the class described comprising a bed, a slide upon said bed, a second slide positioned above said first mentioned slide and movable with said first mentioned slide, said second slide being movable relatively to the first mentioned slide in both rectilinear and arcuate paths, a support upon said second mentioned slide, a support upon said bed, one of said supports being oscillatable and the other of said supports being movable through an arcuate path of travel, means for oscillating said oscillatable support and for moving the

other of said supports through its arcuate path of travel, a revoluble grinding wheel on one of said supports, means for revolving said wheel, the other support serving to position the work adjacent the grinding wheel, and means for adjusting the length of the radius of the arc of travel of each of said supports.

20. A machine of the class described comprising a bed, a slide on said bed, a second slide above said first mentioned slide and movable therewith, said second slide being movable relatively to said first mentioned slide in both rectilinear and arcuate paths, a grinding wheel support on said second slide, a revoluble grinding wheel on said support, means for revolving said wheel, a work support on said bed, one of said supports being oscillatable and the other of said supports being movable through an arcuate path, means for oscillating the oscillatable support and for moving the other support through its arcuate path of travel about an axis at right angles to the axis of oscillation of the oscillatable support, and means for adjusting the radius of the arc of movement of each of said supports.

21. A machine of the class described comprising a bed, a slide on said bed, a second slide above said first mentioned slide and movable therewith, said second slide being movable relatively to said first mentioned slide in both rectilinear and arcuate paths, a movable grinding wheel support on said second slide, a revoluble grinding wheel on said support, means for revolving said wheel, an oscillatable work support on said bed, means for oscillating said work support, means for moving the other of said supports step by step in an arcuate path about an axis of oscillation of said work support, and means for adjusting the radius of the arc of movement of each of said supports.

22. A machine of the class described comprising a revoluble grinding wheel, a support for said wheel, means for revolving said wheel, a work support pivotally mounted about an axis parallel to the axis of said grinding wheel, and mechanically operating means for moving the grinding wheel and the work supports through arcuate paths in planes at right angles to each other without moving either the work or support toward the other during the grinding operation.

23. A machine of the class described comprising a revoluble grinding wheel, means for revolving said wheel, a support for said wheel, an oscillatable work support, said support being adapted to position the work on opposite sides of the grinding wheel at the same side of the work support axis whereby the oscillations of the support will grind either convex or concave surfaces, and means for oscillating said work support.

24. A device as set forth in claim 22, having means for positioning the work on opposite sides of the grinding wheel at the same side of the work support axis whereby either concave or convex surfaces may be ground.

25. In a surfacing machine, a frame, means for mounting an object to be surfaced on said frame for bodily movement in a curved path in a plane and adjustable to vary the radius of curvature of its path of movement, means for imparting to said object equal amplitudes of movement for all variations in the radius of curvature of the path, an arc bar pivoted for movement in a plane transverse to the plane of movement of the object, and a continuously rotating surfacing element carried by the bar and adjustable thereon to different distances laterally from the axis of movement of the bar.

In testimony whereof I have hereunto set my hand.

JOSEPH S. GALESKI.