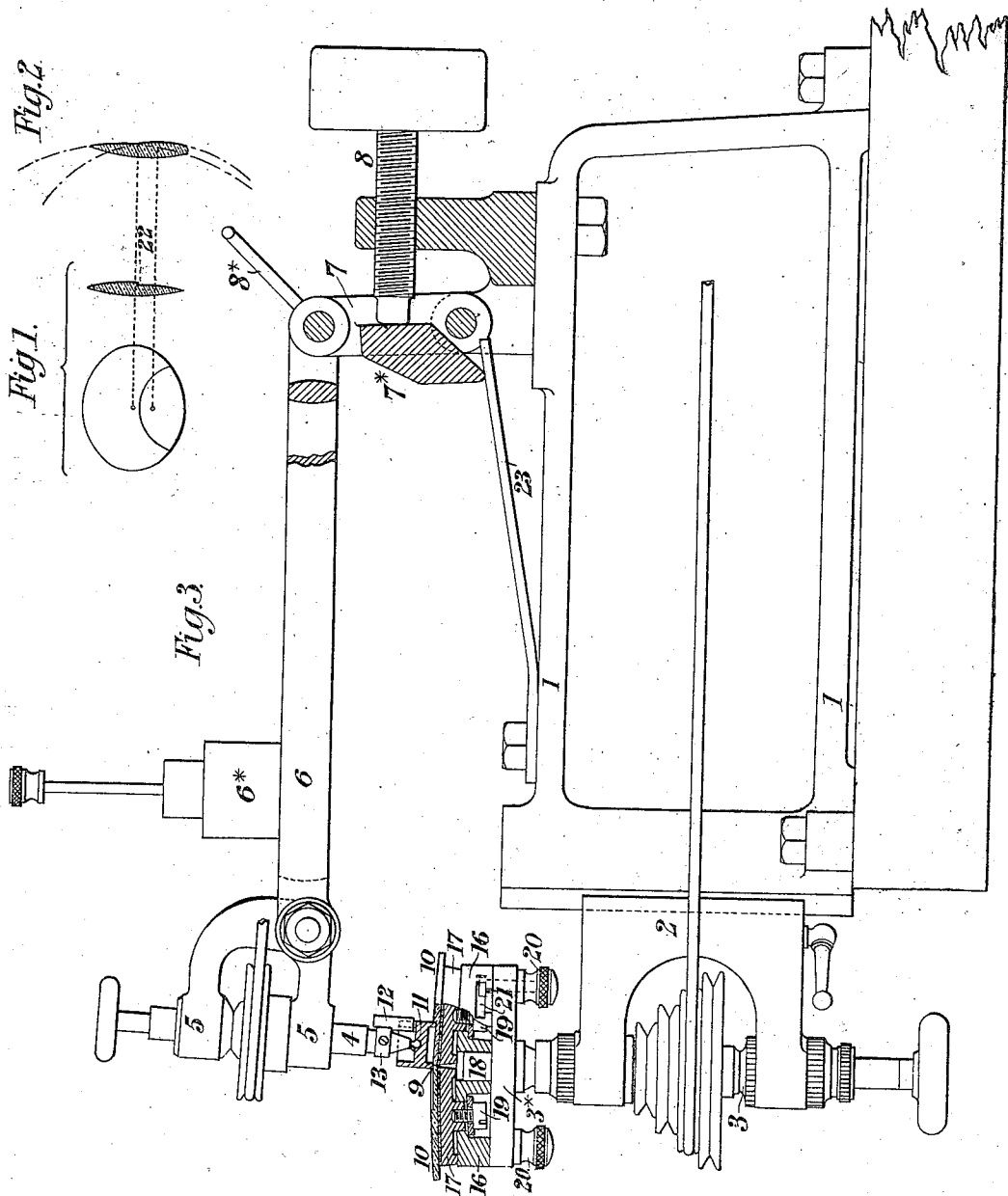


1,084,529.

3 SHEETS—SHEET 1.



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M. BENTZON & A. H. EMERSON.
 APPARATUS FOR THE MANUFACTURE OF BIFOCAL LENSES.
 APPLICATION FILED NOV. 18, 1909.

1,084,529.

Patented Jan. 13, 1914.

3 SHEETS—SHEET 2.

Fig. 4.

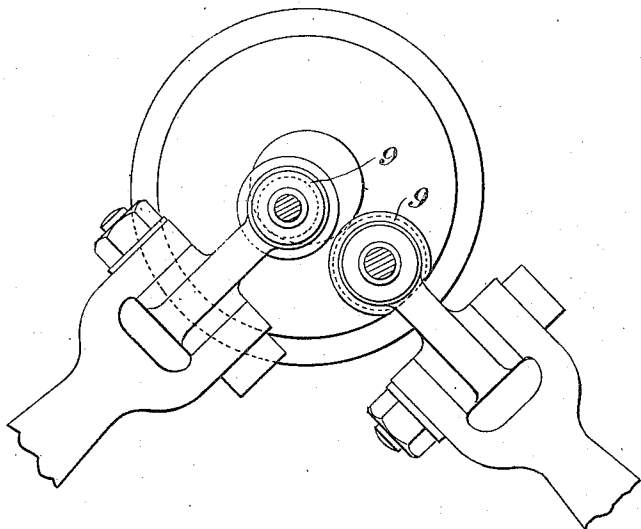


Fig. 6.

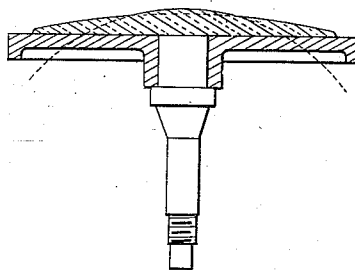


Fig. 7.

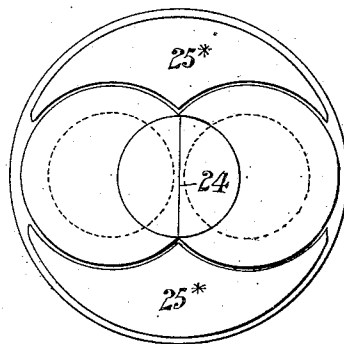
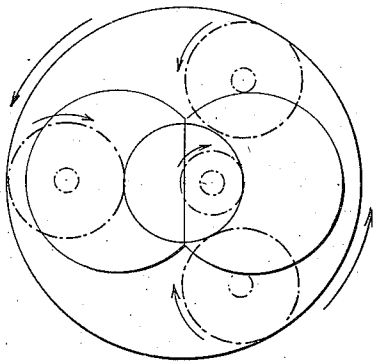


Fig. 5.



Witnesses.

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3 SHEETS—SHEET 3.

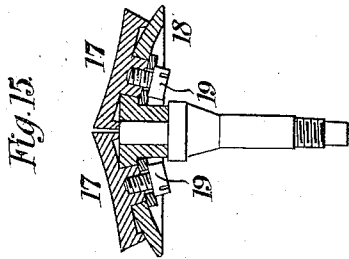


Fig. 15.

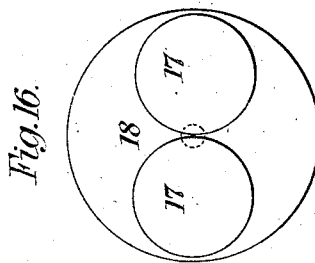


Fig. 16.

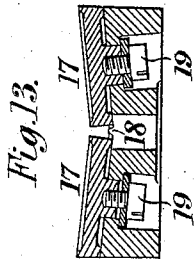


Fig. 13.

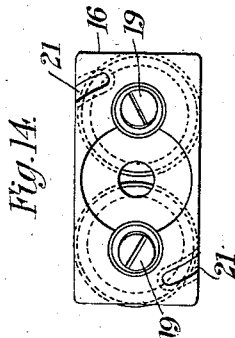


Fig. 14.

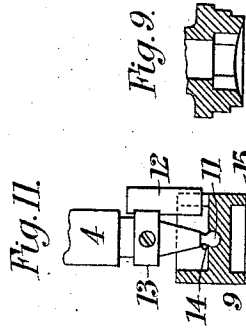


Fig. 11.

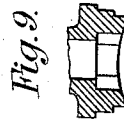


Fig. 9.



Fig. 10.

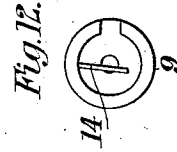


Fig. 12.

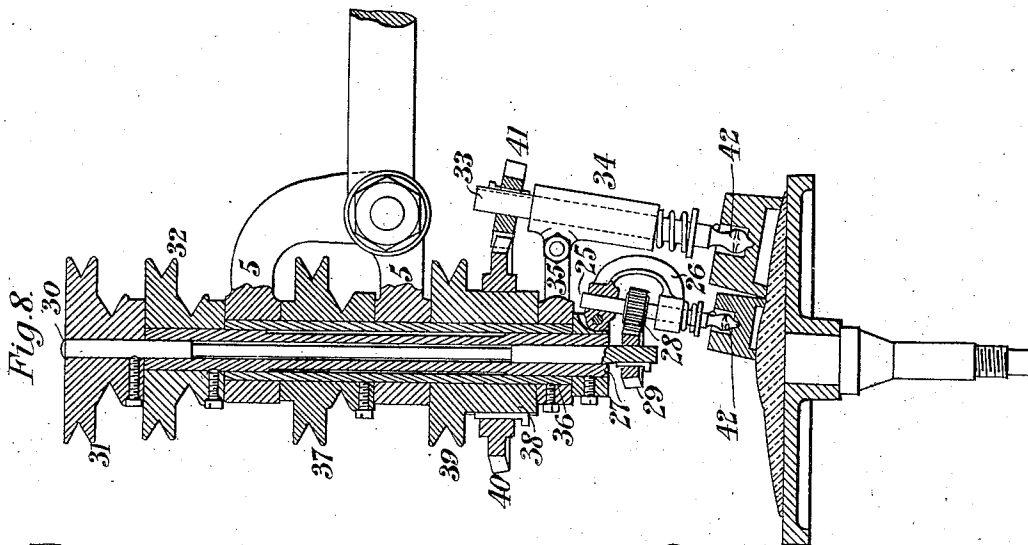


Fig. 8.

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APPARATUS FOR THE MANUFACTURE OF BIFOCAL LENSES.

1,084,529.

Specification of Letters Patent. Patented Jan. 13, 1914.

Original application filed December 18, 1905, Serial No. 292,393. Divided and this application filed November 18, 1909. Serial No. 528,800.

To all whom it may concern:

Be it known that we, MALCOLM BENTZON, residing at 188 Strand, and ALFRED HENRY EMERSON, residing at 26 Eyre Street Hill, Clerkenwell, both of London, England, subjects of the King of Great Britain, have invented new and useful Improvements in Apparatus for the Manufacture of Bifocal Lenses, of which the following is a specification, reference being had to the accompanying drawings.

This invention relates to apparatus for the manufacture of bi-focal lenses by the improved process forming the subject of our application for a patent filed on the 18th December 1905 Serial No. 292,393, of which this application is a division.

Figure 1 shows in elevation and section the ordinary form of bi-focal lens. Fig. 2 is a section illustrating the new form of bi-focal lens made by the improved apparatus. Fig. 3 is a sectional side elevation of a machine constructed according to this invention for grinding bi-focal lenses. Fig. 4 is a plan illustrating the simultaneous operation of two of the said machines. Fig. 5 is a plan illustrating a modified arrangement of the operating tools. Figs. 6 and 7 are respectively a sectional elevation and a plan illustrating a form of glass disk from which the lenses may be produced. Fig. 8 is a vertical section illustrating a machine provided with two tool spindles for the simultaneous grinding of two surfaces. Figs. 9 and 10 are respectively a vertical section and an underside view of one form of grinding tool to be used in carrying out the invention. Figs. 11 and 12 are respectively a sectional elevation and a plan of the lower part of another form of grinding tool. Figs. 13 and 14 are respectively a sectional elevation and an underside view of a holder for two lenses, while being ground. Figs. 15 and 16 are respectively a sectional elevation and a plan illustrating a modified form of lens holder.

Referring to Fig. 3, 1 is the frame carrying a bed 2, capable of adjustment in a vertical direction, and of fixation, and in this rotates the spindle 3 on which is fixed a disk 3*, for carrying the lens holder. The tool spindle 4 is carried in a carrier head 5 on an arm 6, and this has a weight 6*, by which the pressure on the work can be regulated. The arm 6 is pivoted at the end to a

lever 7. The lever 7 is in one piece with the block 7*, and the whole rests upon a spring 23, and can be adjusted by a screw 8, so that the other end of the arm 6 with the carrier head 5 can be moved in any required direction, so as to allow the tool 9 carried by the spindle 4 to be placed in any desired position over the glass or glasses 10. The arm 6 is held up by a support 8* when it is turned back. The grinding tool is constructed so that its grinding surface is located wholly at a distance from its axis of rotation. In the present instance the grinding tool is provided with an annular grinding surface as shown. The tool 9 is so attached to the spindle as to be on the one hand easily secured to or removed from it, and on the other hand to take up automatically the proper position upon the glass, and to retain it while the latter is being ground. In the example shown, this is attained by a joint consisting of a ball-point 11 on the end of the spindle 4, which enters a corresponding hollow in the axis of the tool. A tongue 12 lies in slots in the collar 13 on the spindle 4, and at the upper part of the tool 9, and thus transmits the motion of the spindle to the tool.

The spindles 3 and 4 are provided with pulleys, which allow of the alteration of the proportional velocities, so that by controlling the relative velocities of grinding between the work and the tool, any desired curvature can be obtained.

In Fig. 3 the tool is so set that the middle line of the acting surface passes through, on the periphery of the tool, the axis of rotation of the spindle 3, and so through the geometrical center of the surface which is being worked. If now it be desired to increase the curvature of a convex surface, or to diminish that of a concave one, the lower spindle must rotate rapidly, while the tool revolves slowly, and, most suitably, in the opposite direction. If, for instance, the work be set rotating at 400 revolutions per minute in one direction, and the tool executes 100 in the contrary direction, there will evidently be more friction at the periphery of the surface of the work than at its center. The edge will consequently be ground down faster than the center, and a convex surface will become more convex, while a concave one will become less concave, and, indeed,

convex if the grinding be continued long enough. If, on the other hand, the curvature of a concave surface is to be increased, the direction of rotation of either the work or the tool is changed, so that both revolve in the same direction. If now, for instance, the tools have 400 revolutions and the work 100 per minute, it is clear that the resultant velocity of grinding at the edge of the surface operated upon will come out very small, while in the center the tool will move rapidly over the surface, and will in consequence grind the glass away quickly at this point.

The exact curvature can be determined by spherometers. As soon as the desired curve is obtained, the tool for rough grinding is substituted by the tools for smoothing and polishing, and the glass is smoothed and polished without further alteration of the curve. The proportion of velocity which must be arranged so that no change in the curve shall occur, will soon be found by trial.

In Fig. 3 of the drawing for example the spindle 4 of the grinding tool is shown provided with two grooved pulleys, of different diameters for engaging a driving belt from a driving shaft which may be operated in any desired way, and the spindle 3 of the work holder is shown provided with four grooved pulleys for engaging a driving belt from a suitable driving shaft. When it is desired to drive the spindles or either of them in the opposite direction the driving may conveniently be accomplished by means of the same belts, by simply reversing the direction of rotation of the said driving shaft or shafts in any usual manner. We have not deemed it necessary herein to extend the illustration of the invention beyond the driving belts above mentioned, by which the said spindles or either of them may be driven at varying speed and in either direction.

In Fig. 3 the grinding machine is shown in action as arranged for grinding a second curve on a lens already possessing one curve *i. e.* on a finished spectacle lens, and there are attached to the lower spindle, by an arrangement to be described later, two lenses 10, for exact centering of the two sections of the lens, these meeting in the axis of rotation of the work spindle, so that both lenses can be ground and provided with a second curvature at the same time.

If two curves are to be ground at one operation, two machines of the kind shown in Fig. 3 can be used, their tools 9 being applied to the surface under treatment in the manner shown in Fig. 4. The tool of the one machine is so set that its periphery passes through the axis of rotation of the revolving work, and touches the line of separation between the two curves, while the other tool is set between the line of separation and the periphery of the surface of the

work. Instead of two machines there may be used a single one having on the frame 1 two arms with two tool spindles 4.

Instead of allowing the work carrier to rotate, it may be fixed, and the tool alone allowed to rotate, in which case the tool or tools rotate upon their spindles, and at the same time execute a motion in a circle around the center of the surface being worked, as shown in outline in Fig. 5.

The two curves may be worked upon a single flat disk, which is cut into several pieces, from which by grinding the under surfaces, the complete lenses are produced. Such a glass disk, with the two curves on the upper surface is shown with its holder in Fig. 6. Instead of this however, as shown in Fig. 7, the two glasses or lenses might be cut first so as to meet along a straight line, the spaces between them being filled up by fish-tail pieces 25^x, so that a coherent surface for grinding is obtained. In some cases it is advisable to use an ordinary tool before rough grinding, this tool being rigidly connected to a vertical upper spindle in order to remove the projecting surfaces of the lenses along their line of contact.

A machine with two tool spindles for the simultaneous grinding of two surfaces, in which the work carrier is stationary and only the tools revolve, is shown in Fig. 8. The inner tool is carried by a spindle 25 in bearings on an arm 26 which is attached to the sleeve 27. The spindle is driven by means of the toothed wheels 28, 29 of which the latter is fixed to the axle 30, and is driven by a belt passing around the pulley 31. The sleeve 27 is provided with driving pulleys 32. The outer tool is carried by the spindle 33, which has its bearing 34 on an arm 35. The arm 35 is removably attached to the sleeve 36 which is borne by the head 5 of the machine, and is provided with driving pulleys 37. A sleeve 38 with a pulley 39 carries a toothed wheel 40, which engages with a toothed wheel 41 on the spindle 33. In this way each has imparted to it a rotation upon its own axis and a planetary motion. The arm 35 which carries the bearing 34 for the outer tool may, according to the size of the glass, be replaced by longer or shorter arms.

In the drawing only one tool is shown at work upon the outer surface. Two or more tools may, however, be made use of, while a single tool may be appropriately used for the inner surface. (See Fig. 5.)

In producing bi-focal lenses by grinding a second curve on a lens already having a single curve (a finished spectacle lens) any desired position of the optical center of the lens may be attained by the following arrangement. The lens holders are secured to a block 16 of metal or other suitable material, Figs. 3, 13, 15, which is carried by a

chuck or work spindle. This block is best made of such a size that it will carry two lens holders 17 and is so shaped from the center toward the two ends that an angle is formed at the middle line 18, this angle corresponding to the curve of the lenses to be ground, the curves to be ground, i. e. super-added and the desired position of the optical center. By a calculation familiar to experts the correct angles for lenses of all curvatures can be readily determined.

According to Fig. 3, which shows an apparatus for grinding two convex lenses, the legs of the angle run outward and downward, while Figs. 13 and 14 show a block for grinding concave lenses, in which the legs run outward and upward. Fig. 13 is a vertical section, and Fig. 14 a view from beneath.

The block 16 has an aperture in each of the two inclined faces, in which the stem of a lens holder 17 is secured by means of screws, 19. The position of the holes naturally depends upon the magnitude of the angle under which the surfaces which carry the lens holders are inclined to each other. The block 16 is secured to the chuck 3* at the top of the spindle 3 by screw bolts, which are screwed down by nuts 20, so that the heads of the screw bolts rest against the undercut part of the slots 21, which, when the nuts 20 are slackened, allow the block 16 to be removed. Before the lenses (after being cemented to the lens holders) are secured to the block 16, they must be exactly centered upon the lens holders. A portion of each lens is cut away, so that both lenses can be brought under a single grinding or polishing tool and operated upon by it, as is shown in Fig. 3. The block 16 may have three or more surfaces instead of two, these being inclined to the axis of rotation of the work under the same angle, and having each an aperture for the reception of a lens holder. In this case three or more lenses can be worked simultaneously, and these again are to be so cut, that the portions of the lenses upon which the tool is to operate abut upon each other.

If the block 16 be employed for grinding a lens in which the part of it intended for reading exceeds a radius and the glass consequently projects over the lens holder, only one lens holder can be fixed to the block 16. Instead of the block 16 having flat bearing surfaces, it may consist of a curved head-piece, as shown in Fig. 15 in vertical section, and in plan in outline in Fig. 16. The lower sides of the lens holder 17 are then so cut out as to fit the curve of the block 16, and the calculations are made for tangents to the curved surfaces at the central point of the lens holder.

In bi-focal lenses with a prominent dividing line, or a ridge between the two portions

(Fig. 1) such as are obtained by consecutive grinding of the two curves the ridge forms a third reflecting surface, which is very irritating and injurious to the eye of the wearer, and since the edge of the ridge is sharp, the lens is very easily injured, if it comes into contact with a hard surface. The fault can be overcome by darkening or graying the ridge or leaving it unpolished, so that it offers no reflecting surface, and by chamfering the sharp edge off the ridge, so that the lens cannot be injured if it comes into contact with a hard surface. This may be effected in any convenient way, as for instance, by holding a copper strip against the ridge while the block 16 carrying the lens holder rotates. In cases in which the lenses have to be decentered, the lens holder can be tilted by laying packing disks under it to the desired amount.

Various forms of constructing the tools are shown in Figs. 9, 10, 11 and 12. Figs. 9 and 10 show in vertical section and from below the under part of a hollow tool in which the hollow instead of being merely annular is specially shaped so that the part of the grinding surface which grinds most heavily is the strongest, it being at the same time supposed that the tool is to be used for grinding convex lenses, in which case the glass is ground more strongly toward the edge than in the center. The grinding surface may be either flat or curved.

Figs. 11 and 12 show in vertical section and in plan another form of hollow tool. Fig. 11 specially shows the method of attaching the tool to the spindle. In the inside of the tool is a spring 14, so arranged that it holds the ball-point 11 at the end of the spindle in the recess of the tool, so that the tool can be removed from or attached to the spindle by pushing on one side the spring of the bar 11. The tool is one for polishing, and carries polishing material 15 on the working edge.

Instead of attaching the tools to the spindle in the way described, they may be secured by other methods, as for example, by a square portion at the end of the spindle entering a square hole inside the tool as shown at 42 in Fig. 8.

The annular form of tool shown in Figs. 11 and 12 is the most suitable for polishing, but can also be used for roughing and smoothing. The tool shown in Figs. 9 and 10 is more suitable for the two latter processes than for the former.

The polishing felt or corresponding material 15 must be made sufficiently hard, so that the surfaces produced upon the lenses may be perfectly polished spherical ones. For this purpose the felt or other material may be boiled in pitch. Rouge or any other suitable material may be used for polishing. The tools for smoothing may suitably be

made of a rather softer metal such as brass, than those for roughing, which may for example be made of steel.

In the following claims we have used the expression "relative rotary movement of the tool and work holder" to define the relations of these parts as the tool may be held stationary with its axis at one side of the axis of the work holder, which is revolved on its axis as in Fig. 3, or the tool may be given a bodily rotation around a point on the work holder as in Fig. 8. We have also referred in said claims to the fact that the tool is supported with its axis at a distance from the center of this "relative rotary movement," the axis of said relative rotary movement being obviously the axis of the work holder, where that revolves and being the axis about which the tool revolves bodily, where the tool is revolved with respect to the work holder.

It will be obvious that by placing the annular universally supported tool herein shown and described in engagement with any spherical surface of greater diameter than the tool, whether such surface be convex or concave, annular portions of the tool will accurately and operatively engage any such spherical surface, and the universal connection of the tool with its support permits the operative surface of the tool to freely follow the surface of the work, and the tool itself to maintain its axis at all times in substantial alinement with a radius of the spherical surface which it engages.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In a grinding apparatus for producing spherical surfaces, the combination of a rotatable grinding tool, having its entire grinding surface located at a distance from its axis of rotation, a workholder, means for causing a relative circular movement between the axis of the tool and the workholder, means for supporting said tool with its axis at a fixed distance from the center of the circle of said relative movement, said tool being movable toward the workholder and being free at all times to follow with its abrading surface, the surface of the work which it engages, whereby the speed and direction of rotation of the tool and the speed and direction of said circular relative movement will determine the character of the spherical surface produced by said tool.

2. In a grinding apparatus for producing spherical surfaces, the combination of a rotary grinding tool having its grinding surface located at a distance from its axis of rotation, whereby said tool abrades in an annular path, a workholder, means for causing a relative circular movement between the axis of the tool and the workholder,

means for supporting the said tool with its axis at a fixed distance from the center of the circle of said relative movement, said tool being movable toward the workholder and being free at all times to follow with its abrading surface the surface of the work which it engages, and means for driving said tool at different speeds.

3. In a grinding apparatus for producing spherical surfaces, the combination of a rotatable annular grinding tool having its grinding surface located at a distance from its axis of rotation, a workholder, means for supporting said tool with its axis at one side of the center of the workholder, and with annular portions of its grinding surface in operative relation with the surface operated upon, means for establishing a relative circular movement between the workholder and the axis of said tool, concentric with the center of the workholder and means for driving said tool.

4. In a grinding apparatus for producing spherical surfaces, the combination of a rotatable grinding tool having its grinding surface located at a distance from its axis of rotation, a rotatable workholder, means for supporting said tool with its axis between the axis of rotation of the workholder and the peripheral portions thereof, said tool being movable toward the workholder and being free to follow with its abrading surface the surface of the work.

5. In a grinding apparatus for producing spherical surfaces, the combination of a rotatable grinding tool having an annular grinding surface, a rotatable workholder, means for supporting said tool with its axis between the axis of rotation of the workholder and the periphery thereof, said tool being at all times free to follow with its abrading surface the surface of the work, means for driving said tool and means for rotating said workholder.

6. In a grinding apparatus for producing spherical surfaces, the combination of a rotatable workholder of a grinding tool having an annular grinding surface, a driving spindle for said tool connected thereto by means permitting the grinding surface of the tool to follow the surface of the work and means for supporting said spindle with its axis at a distance from the axis of rotation of the workholder, means for driving said workholder at different speeds and means for driving said tool spindle at different speeds.

7. In a grinding apparatus for producing spherical surfaces, the combination with a horizontal rotatable work holder, of a vertically disposed driving spindle, a carrier head provided with bearings for said spindle, a support for said carrier head connected thereto by a horizontally disposed pivot, and an annular grinding tool having a uni-

versal connection with the said spindle, said support and carrier head holding the spindle at all times in a position at one side of the axis of rotation of said work holder.

8. In a grinding apparatus for producing spherical surfaces, the combination with a horizontal rotatable work holder, of a vertically disposed driving spindle, a carrier head provided with bearings for said spindle, a support for said carrier head connected thereto by a horizontally disposed pivot, and an annular grinding tool having a universal connection with the said spindle, said support and carrier head holding the spindle at all times in a position at one side of the axis of rotation of said work holder, and means for adjusting said support to vary the position of said spindle with respect to the work holder.

9. In a grinding apparatus for producing spherical surfaces, the combination with a horizontal rotatable work holder, of a vertically disposed driving spindle, a carrier head provided with bearings for said spindle, a support for said carrier head connected thereto by a horizontally disposed pivot, and an annular grinding tool having a universal connection with the said spindle, said support and carrier head holding the spindle at all times in a position at one side of the axis of rotation of said work holder, said support being hinged to permit it and the carrier head and spindle to be raised and lowered out of and into operative position with respect to the work holder.

10. In a grinding apparatus for producing spherical surfaces, the combination with a horizontal rotatable work holder, of a vertically disposed driving spindle, a carrier head provided with bearings for said spindle, a support for said carrier head connected thereto by a horizontally disposed pivot, and an annular grinding tool having a universal connection with the said spindle, said support and carrier head holding the spindle at all times in a position at one side of the axis of rotation of said work holder, said support being hinged to permit it and the carrier head and spindle to be raised and lowered out of and into operative position with respect to the work holder and an adjustable stop for limiting the movement of said support and its connected parts in a direction toward the work holder, to determine the position of the spindle and tool with respect to the work holder.

11. In an apparatus for grinding spherical surfaces, the combination with a plurality of rotatable grinding tools each provided with a grinding surface located at a distance from its axis of rotation, a work holder, said tools being located with respect to the work holder, on opposite sides of the

line of demarcation between the spherical surfaces to be produced, and means for causing a relative circular movement between the work holder and the axes of said tools, means for holding the said tools between the axis of said relative rotation, and the periphery of the work, and at different distances from the said axis of rotation.

12. In an apparatus for grinding spherical surfaces, the combination with a plurality of rotary annular grinding tools, a rotatable work holder, means for holding said tools laterally of the axis of rotation of said work holder, and on opposite sides of the line of demarcation between the surfaces to be ground, means for driving said tools, and means for rotating said work holder.

13. In an apparatus for grinding spherical surfaces, the combination with a plurality of grinding spindles, a grinding tool for each spindle, connected therewith by a universal joint, and provided with means for securing its rotation with its connected spindle, a work holder, means for causing a relative circular movement between said work holder and the axes of said tools, and means for holding the said tools between the axis of said relative rotation, and the periphery of the work, and on opposite sides of the line of demarcation between the surfaces to be ground.

14. In an apparatus for grinding spherical surfaces, the combination with a rotatable grinding tool having its grinding surface located at a distance from its axis of rotation, whereby said tool abrades in an annular path, a work holder, means for rotating said tool, means for causing a relative circular movement of the tool and the work holder, means for supporting said tool so that it is free to move angularly with respect to its axis of rotation in all directions and means for holding said tool at a distance from the axis of relative rotation between the tool and the work holder.

15. In an apparatus for grinding spherical surfaces, the combination with a grinding tool having an annular grinding surface located at a distance from its axis of rotation and being capable of abrading in an annular path, a rotatable work holder having its supporting surface adjacent to the said annular grinding surface, means for supporting said tool at one side of the axis of the work holder, a driving spindle for said tool, a universal connection between the tool and said spindle and means for driving said spindle.

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