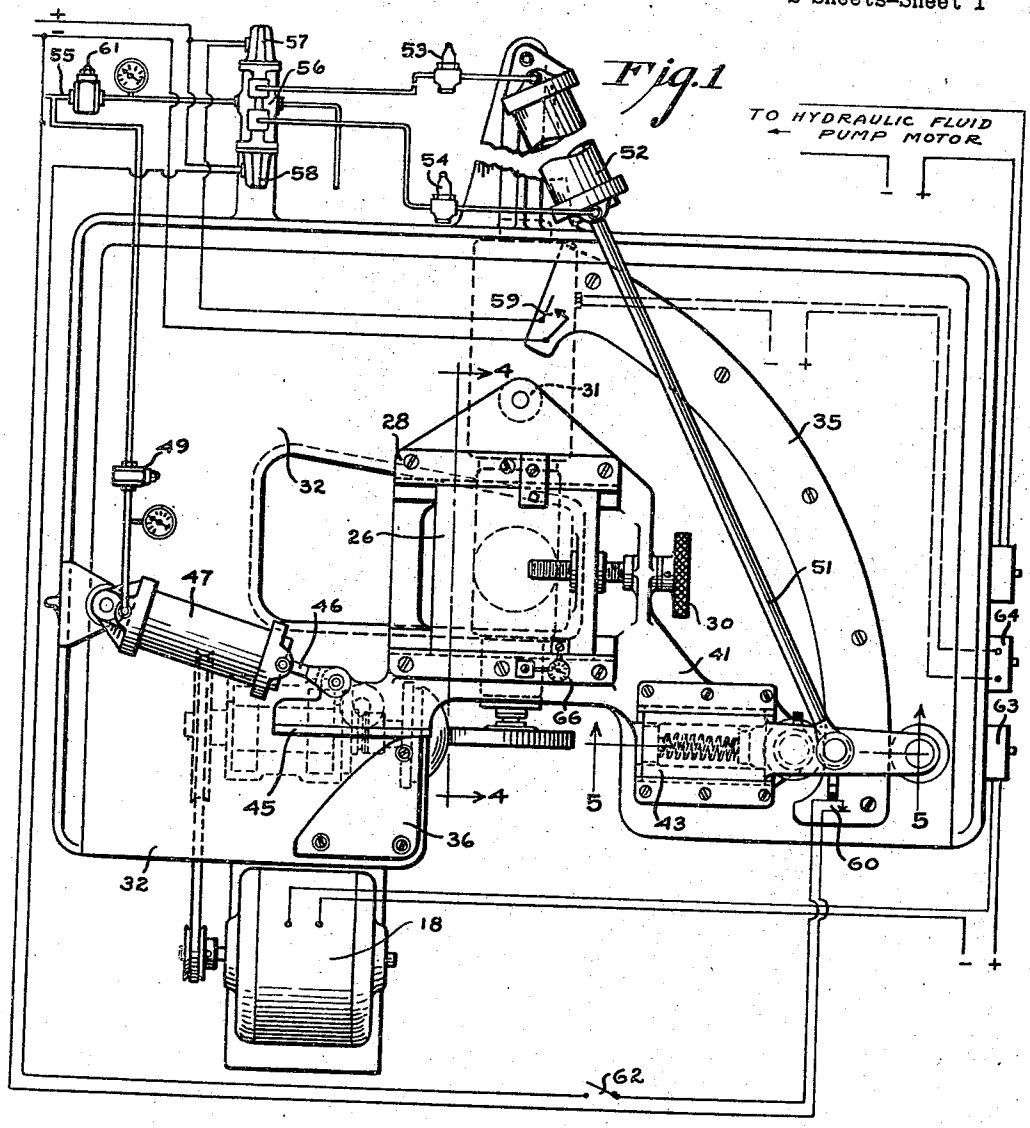
July 14, 1942. R. A. HINKLEY ET AL 2,290,051

CONTOUR GRINDING APPARATUS

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Fig. 1



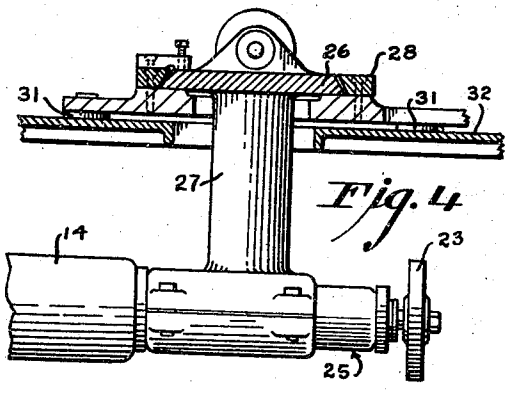


Fig. 4

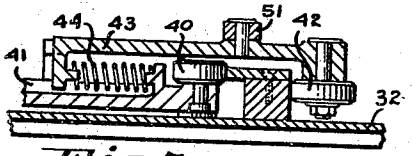


Fig. 5

INVENTORS.
RAY A. HINKLEY
AND WALTER C. WEBER
BY
ATTORNEY.

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Fig. 2

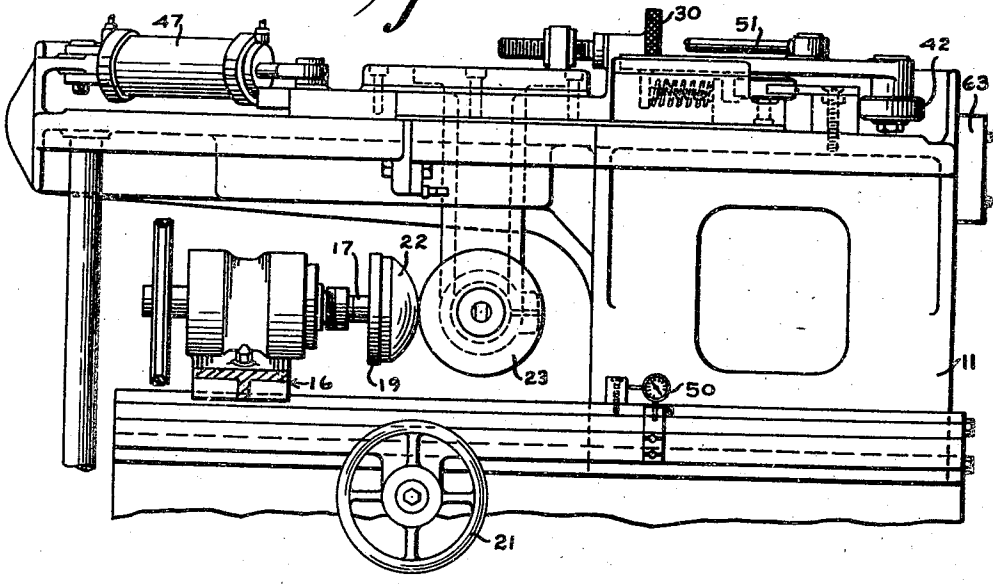
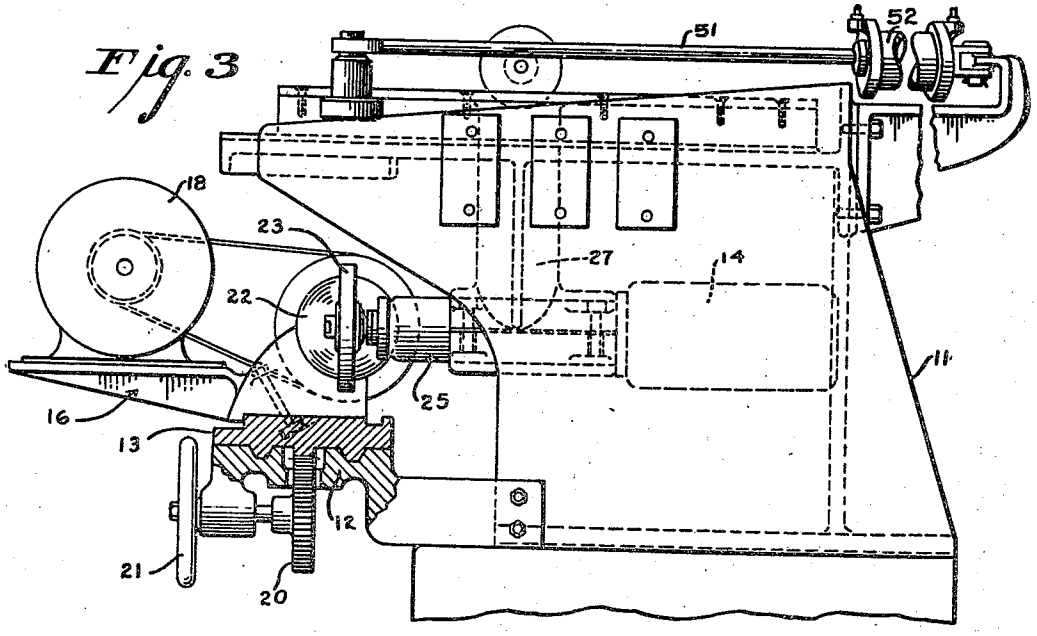


Fig. 3



INVENTORS.
RAY A. HINKLEY
AND WALTER C. WEBER.
BY F. H. Knight
ATTORNEY.

Patented July 14, 1942

2,290,051

UNITED STATES PATENT OFFICE

2,290,051

CONTOUR GRINDING APPARATUS

Ray A. Hinkley, Corning, N. Y., and Walter C. Weber, West Hartford, Conn., assignors to Corning Glass Works, Corning, N. Y., a corporation of New York

Application October 5, 1939, Serial No. 298,134

9 Claims. (Cl. 51—33)

The present invention relates to grinding and polishing methods and apparatus and particularly to grinding machines capable of doing precision grinding of work to a desired contour.

Such work has been ground in the past by subjecting it to an abrasive wheel, the face of which has previously been dressed to the exact contour to be imparted to the work-piece. This form of apparatus has the drawback that if the contour of the work-piece is such that it is held stationary while its entire surface is simultaneously contacted by the abrasive wheel, grooving is likely to result, whereas if the work-piece surface contour is such that the work-piece can be rotated as the work wheel advances across the work-piece, elaborate work-wheel shifting apparatus is required. In either case, a second elaborate and precision apparatus is required to frequently redress the work-wheel to the exact contour it is to impart to the work-piece. In order to reduce the amount of equipment to a minimum, applicants have designed a machine capable of doing precision contour grinding with a work-wheel having a flat work surface, which although also requiring frequent redressing of the work-wheel, has the advantage that a flat surfaced wheel is employed which can be dressed with comparatively simple equipment.

The prime object of the present invention is a grinding and/or polishing machine which does extremely accurate work and yet is practicable and efficient.

A further object of the present invention is a contour grinding and/or polishing machine whose work-wheel has a flat work surface rather than one shaped to the contour to which the work-piece is to be ground.

The invention embodies among its features a work piece support which can be readily adjusted to bring a piece of work into contactual relation with the working wheel of a grinding or polishing unit, a motor for rotating the work about its own axial center, a motor for driving the work-wheel, hydraulic means for shifting the work-wheel over the work at a predetermined, but adjustable speed, and cams for guiding the movement of the work-wheel over a path corresponding to the precise contour to which the work-piece is to be finished.

Other objects and features of the invention will become apparent from a further perusal of the specification and the accompanying drawings.

Fig. 1 of the drawings is a plan view of a preferred form of apparatus embodying the invention as used in grinding plungers such as are employed in pressing glass into shapes suitable for use as reflectors in automobile head light units and similar applications;

Fig. 2 is a front elevation of the apparatus;

Fig. 3 is an end elevation of the apparatus;

Fig. 4 is a view taken on line 4—4 of Fig. 1; and

Fig. 5 is a sectional view taken on line 5—5 of Fig. 1.

The various working parts of the apparatus are mounted on a suitable upright 11 having a laterally extending V-grooved bed 12 (Fig. 3) for supporting a carriage 13. This carriage carries a work supporting and rotating assembly generally designated 16 comprising a work-piece spindle 17 (Fig. 2) driven by a belt connected motor 18 (Figs. 1 and 3) and carrying a work-piece face plate or chuck 19 (Fig. 2). The carriage 13 has a rack formed on the under side thereof which is in mesh with a gear 20 (Fig. 3) adapted to be rotated by a hand wheel 21, thereby enabling movement of the unit 16 as required to bring a work-piece 22, mounted in the chuck 19, into proper position with respect to the working surface of a work-wheel 23 of a grinding or polishing unit 25.

The grinding unit 25 is suspended from a slide 26 (Figs. 1 and 2) by means of a column 27. The slide 26 is mounted in a frame 28 in which it is slidably adjustable by means of an adjusting screw 30. The frame 28 has three pads 31 on the under surface thereof which rest on a flat table or bed 32 rigidly mounted on the upright 11.

The frame 28 is slidable on the surface of table 32, but its range of movement is definitely restricted to that necessary to maintain the work-wheel 23 in proper position with respect to the work-piece 22 by a contour cam 35 rigidly mounted on the bed 32 and by a properly contoured fulcrum plate 36 also rigidly mounted on the bed. The contour of the plate 36 is such that the grinding wheel 23 is at all times perpendicular to a tangent at any point on the work-piece 22 with which it is in point contact.

The frame 28 is held in predetermined relation with respect to cam 35 by a pair of rollers 40 and 42 (Fig. 5). The roller 40 is carried by an extension 41 of the frame 28, whereas the roller 42 is carried by a slide 43. An associated compression spring 44 forces the rollers 40 and 42 to hug the precision surfaces of the cam 35. An extension 45 of the frame 28 is forced against the fulcrum plate 36 by the piston rod 46 of a hydraulic unit 47 connected with a suitable fluid supply line 55. The position of this unit is also

such that it holds roller 40 tightly against the cam 35. A pressure regulating valve 49 is provided in the fluid supply line to unit 47 so as to enable just the proper amount of pressure to be applied to overcome any side play in the assembly as the unit 25 travels over the path defined by the contour of cam 35. Oscillatory movment of the unit is effected by means of a piston rod 51 of a hydraulic power unit 52. Operating fluid is alternately supplied to the opposite ends of unit 52 from fluid supply line 55 under control of an electromagnetically actuated valve 56. Magnets 57 and 58 of this valve are alternately energized to actuate the valve upon closure of contacts 59 and 60 in their respective circuits at the end of a travel of the piston rod 51. A regulating valve 61 enables adjustment of the pressure applied to unit 52. The fluid feed lines to unit 52 are also supplied with valves 53 and 54 so that the speed of movement of the unit can be modified as desired.

The adjustment of the work-wheel with respect to a work-piece is effected by first bringing the face of the work-wheel in a position normal to the axis of the work-piece, as shown in Fig. 1. This is accomplished by opening switch 62 in the circuit of magnet 58 so that the magnet 58 will remain deenergized after contacts 60 are closed and, accordingly, the supply of operating fluid to the front end of unit 52 is prevented. With the work-wheel 23 in the position shown, handle 21 is rotated as required to bring the work 22 within a predetermined distance of cam 35 as determined by a suitable gauge 50 provided for this purpose. The adjusting screw 30 is then manipulated to bring the work-wheel 23 in contact with the work 22. A gauge 66 carried by slide 26 and cooperative with a stop on the frame 28 affords a convenient means of setting the work wheel to obtain the amount of cut desired.

After the foregoing adjustments have been made the machine is started by closing switches 63 and 64 through which operating current is supplied to motors 18 and 14 of the work piece supporting and grinding units respectively, and by closing contacts 62 to enable energization of magnet 58.

As will be evident, the contour of the finished work-piece is primarily determined by the contour of cam 35. To insure the highest degree of accuracy, however, the contour of fulcrum plate 36 is such that the pivot point of the frame 28 is always such as to maintain the working surface of the work-wheel 23 normal to the surface being ground. To grind a work-piece of a different contour than illustrated, suitable cam and plate elements, finished to the contour desired, are substituted for the illustrated elements 35 and 36.

It will be observed from the drawings that grinding wheel 23 is of substantial thickness. However, as will be appreciated, with the face of the wheel arranged at right angles to the axis of the work-piece only a minute width of the wheel face is actually brought into contact with the work-piece. It is entirely possible therefore to employ a much thinner wheel than that shown. It has been found, however, that a wheel of substantial thickness is preferable since it can be operated with greater precision due to its freedom from vibration.

While in the foregoing there has been shown and described the preferred embodiment of our invention, it is to be understood that minor changes in the details of construction and combination of parts may be resorted to without departing from the spirit and scope of our invention as claimed.

What is claimed is:

1. In a machine for precision grinding of irregularly contoured surfaces of revolution, a support for rotating a blank about its longitudinal axis, a rotatable work-wheel, support means for said work-wheel including a plain horizontal surface parallel to and spaced from said axis and a wheel mounting, means for oscillating said mounting on said surface and control means located at spaced points for determining the path of movement of said mounting on said surface, one of said control means comprising an accurately contoured cam engaging said mounting adjacent the point of attachment of said oscillating means, another of said control means comprising an accurately contoured cam engaging a flat surface on said mounting means remote from the point of atachment of said oscillating means.

2. In a machine for precision grinding of irregularly contoured surfaces of revolution, a support for rotating a blank about its longitudinal axis, a table, a rotatable work-wheel, a support for said work-wheel resting on but unattached to said table, means for sliding said support over the surface of said table, a cam fixed to the upper surface of said table, means for holding said support in engagement with said cam at all times to confine and guide the movement of said support to an accurately determined course corresponding to the generatrix for the desired surface of revolution, and a second cam cooperative with said work-wheel support to change the angular position of the axis of said work-wheel with respect to the axis of said work-piece support as required to maintain the same peripheral surface area of the work-wheel in contact with the work-piece at all times.

3. In a machine for precision grinding of irregularly contoured surfaces of revolution, a support for rotating a blank about its longitudinal axis, a mounting having lateral extensions and a rotatable work-wheel arranged intermediate the extensions, a table for supporting said mounting having a plain top surface upon which said mounting rests, means for oscillating the mounting on the table surface, means located at spaced points on the surface of said table for determining the path of movement of said mounting on said surface, one of said means comprising an accurately contoured cam cooperative with one of the lateral extensions of said mounting to change the angular position of the axis of the work wheel with respect to that of the support for the blank.

4. In a machine for precision grinding of irregularly contoured surfaces of revolution, a support for rotating a blank about its longitudinal axis, a mounting having a surface for engagement with a guide cam and carrying a rotatable work-wheel, a table having a plain top surface upon which said mounting rests, means attached to said mounting for oscillating the portion thereof to which it is attached over the surface of said table, means located at spaced points on said table for determining the path of movement of such attached portion of said mounting on said table, one of said means comprising an accurately contoured guide cam fixed to said table and about which said mounting surface rocks during the oscillation of the portion of the mounting to which said oscillating means is at-

tached, and means for maintaining a surface of said mounting in engagement with said cam.

5. In a contour grinding machine, a table having fixed thereon a cam track with a surface of a contour determined by the contour to be produced on a work-piece, a grinding unit slidably supported on said table, hydraulic means attached to one part of said grinding unit for maintaining such part in permanent engagement with said cam track, hydraulic means for moving such part to and fro between opposite ends of said cam track, and a cam plate fixed to said table having a surface about which another part of said grinding unit fulcrums as the one part thereof moves to and fro.

6. In a machine for the precision grinding of irregularly contoured surfaces of revolution, a support for rotating a blank about its axis, a rotatable work-wheel, support means for said work-wheel including a fixed table having a plain horizontal top surface with a wheel mounting support properly fixed with respect to the axis of the wheel and resting on the referred to table surface, hydraulic means for oscillating one lateral extremity of said mounting between predetermined spaced positions on said surface, means for guiding said mounting during its movement between such positions over a path depending on the contour to be imparted to the blank, means about which said support fulcrums during its movement between said spaced positions and hydraulic means for maintaining said support in contact with said last two means at all times.

7. In a machine of the character described, a support for rotating a blank about its longitudinal axis, a rotatable work-wheel, a mounting for said wheel having parts extending laterally in opposite directions therefrom, a table having a plain horizontal surface upon which said mounting rests, means for oscillating one part of said mounting between predetermined spaced points on the table surface, means cooperative with such part to determine the path of travel thereof in the course of its movement between said points, and other means cooperative with the other part of said mounting to determine its path of travel during the movement of the first part between said points.

8. In a machine for grinding an article with a paraboloidal surface, a support having a work-wheel thereon, a support for the article, means for bringing the work-wheel surface and a surface of the article into a predetermined contactual relation, means for rotating said article support and said work-wheel, means for shifting the position of one of said supports with respect to the other as required to progressively grind the entire paraboloidal surface of the article, and means for changing the angular relation of the axes of said article support and the work-wheel while such surface is being ground.

9. In a machine for precision grinding of irregularly contoured surfaces of revolution, a support for rotating a blank about its longitudinal axis, a support equipped with a rotatable work-wheel, means having a plain horizontal surface upon which one of said supports rests, means for oscillating said one support over said surface, control means located at spaced points for determining its path of movement thereover, one of said control means comprising an accurately contoured cam engaging the oscillated support adjacent the point of attachment of said oscillating means, another of said control means comprising an accurately contoured cam engaging a flat surface on such support remote from the point of attachment of said oscillating means.

RAY A. HINKLEY.
WALTER C. WEBER.