Nov. 28, 1933. H. W. HILL 1,937,459

ABRADING

Filed Feb. 10, 1928 3 Sheets-Sheet 1

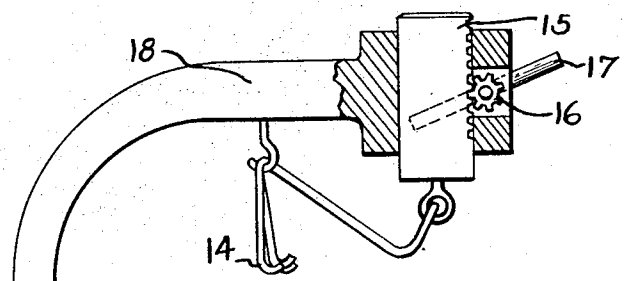


Fig. 1.

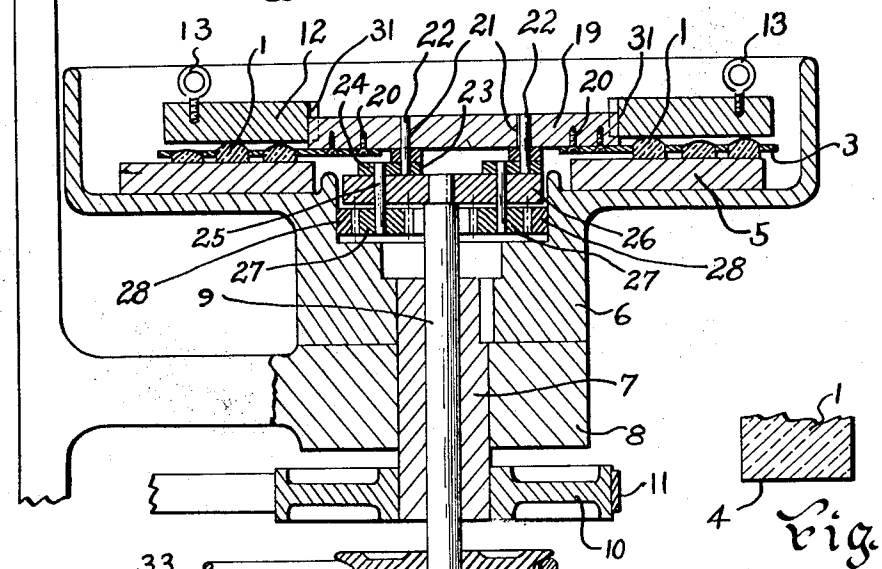


Fig. 4.

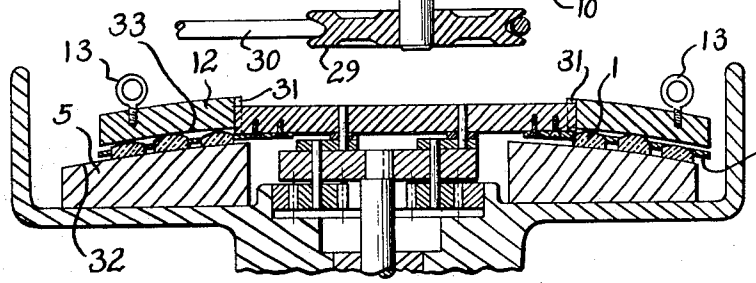


Fig. 2.

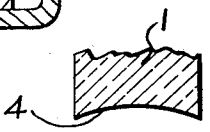


Fig. 5.

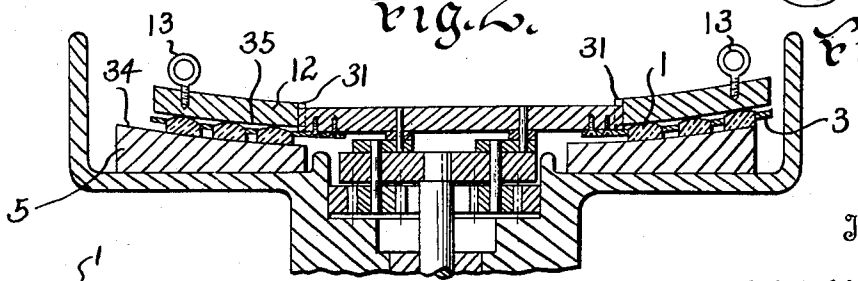


Fig. 3.



Fig. 6.

Inventor

Harry W. Hill.

By Harry H. Stull

Attorney

Nov. 28, 1933. H. W. HILL 1,937,459

ABRADING

Filed Feb. 10, 1928 3 Sheets-Sheet 2

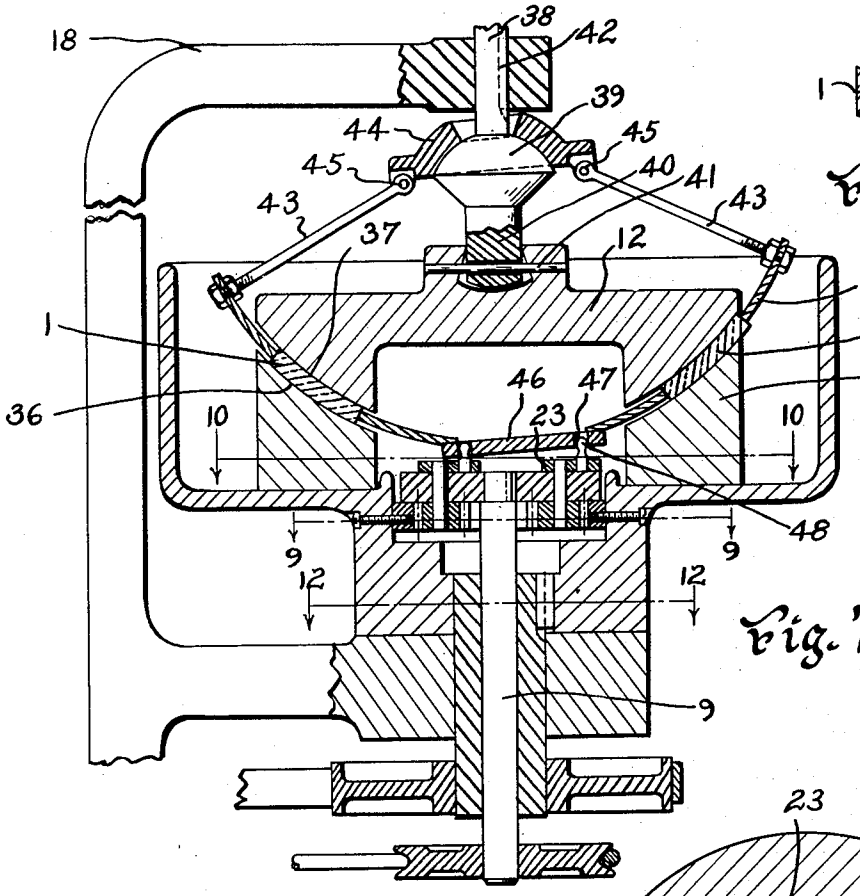


Fig. 7.



Fig. 8.

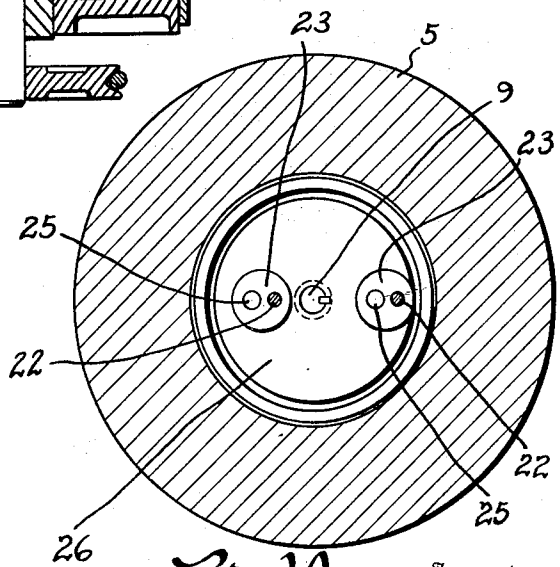


Fig. 10.

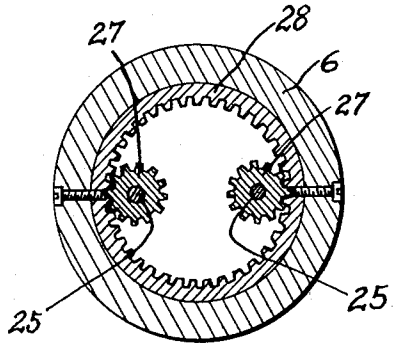


Fig. 9.

Inventor

Harry W. Hill.

By Harry H. Stull

Attorney

Nov. 28, 1933. H. W. HILL 1,937,459

ABRADING

Filed Feb. 10, 1928 3 Sheets-Sheet 3

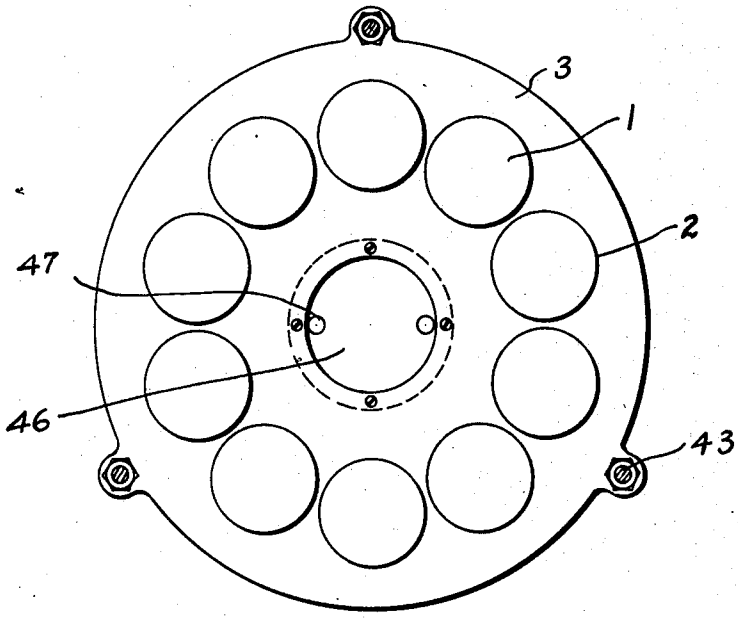


Fig. 11.

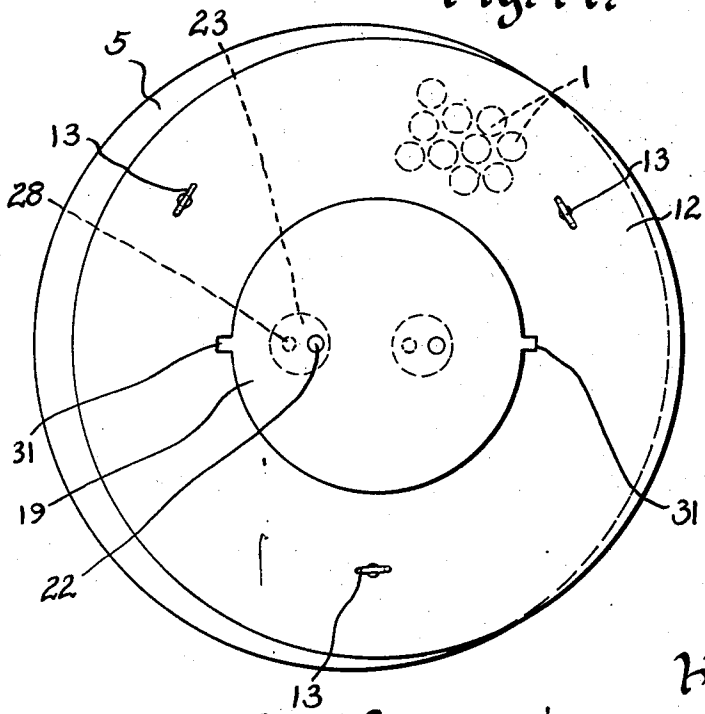


Fig. 13.

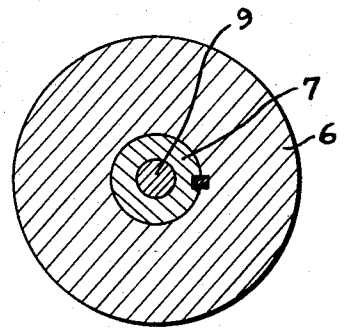


Fig. 12.

Inventor

Harry W. Hill.

By Harry H. Stull.

Attorney

Patented Nov. 28, 1933 1,937,459

UNITED STATES PATENT OFFICE

1,937,459

ABRADING

Harry W. Hill, Southbridge, Mass., assignor to American Optical Company, Southbridge, Mass., a voluntary association of Massachusetts

Application February 10, 1928. Serial No. 253,392

28 Claims. (Cl. 51—111)

This invention relates to improvements in abrading and has particular reference to improved abrading apparatus in which a plurality of articles to be abraded are loosely held in a holder during the abrading operation. It also has particular reference to an improved process for carrying out this abrading.

The principal object of the invention is to provide improved means for surfacing curved surfaces on a plurality of articles to be abraded which are loosely held in a work holder.

Another object of the invention is to provide improved means by which both surfaces of an article may be abraded to curved surfaces while held loosely in the work holder.

Another object of the invention is to provide means for imparting motion to the work holder whereby the lines of abrasion are broken up, that is, are not repeated in one cycle after another.

Another object of the invention is to provide improved means for rotating and gyrating the work holder.

Another object of the invention is to provide a work holder for a plurality of articles to be abraded which will permit of surfacing the article to be abraded to a curved surface.

Another object of the invention is to provide improved means by which all of the articles to be abraded will be abraded to an equal and like thickness.

Other objects and advantages of the invention should become apparent from the following description taken in connection with the accompanying drawings, and it will be apparent that many changes may be made in the details of construction, arrangement of parts and steps of the process without departing from the spirit of the invention as set forth in the accompanying claims. I, therefore, do not wish to be limited to the exact disclosures made as the preferred forms only have been shown by way of illustration.

Referring to the drawings:

Fig. 1 is a partial elevation in cross section showing one adaptation of the invention;

Fig. 2 is a similar partial elevation of a modification;

Fig. 3 is a similar cross section of another modification;

Fig. 4 is a partial cross section of the article to be abraded on the device of Fig. 1 showing that the bottom surface is the one to be abraded;

Fig. 5 is a similar cross section showing the article that is to be abraded on the device of Fig. 2, the bottom surface being that which is to be worked upon;

Fig. 6 is a similar cross section showing the article to be produced in the device of Fig. 3, the under surface being the surface worked upon;

Fig. 7 is a longitudinal cross section of still another modification;

Fig. 8 is a cross section of the article to be produced on the device of Fig. 7, both top and bottom surfaces being worked upon;

Fig. 9 is a cross section on line 9—9 of Fig. 7;

Fig. 10 is a cross section on line 10—10 of Fig. 7;

Fig. 11 is a top or plan view of the work holder shown in Fig. 7;

Fig. 12 is a cross section on line 12—12 of Fig. 7;

Fig. 13 is a fragmentary plan view of Fig. 1.

In the prior art it has been believed that in the abrading of surfaces on articles which are loosely held in a so-called ring work holder only plain or flat surfaces could be produced. There are a great many articles that require surfacing to a curvature, and it is, therefore, the principal object of the present invention to retain all the advantages of the prior art surfacing of articles wherein a plurality of these articles may be loosely held in the work holder, and at the same time extend those advantages and others to the production of a plurality of articles simultaneously, all of which shall have curved surfaces either on one side or on both sides thereof.

Referring to the drawings, wherein similar reference characters denote corresponding parts throughout, the articles 1 to be abraded are loosely carried in openings 2, Fig. 11, in a disc-like work holder 3. This work holder may be flat as shown in Fig. 1, convex as shown in Fig. 2, or concave as shown in Figs. 3 and 7, depending upon the character of the surface which is to be placed upon the article 1 that is to be abraded. As the apparatus depends somewhat upon the nature of the surface to be abraded, I will describe the construction and operations to produce each of the articles set forth in Figs. 4, 5, 6 and 8.

The bottom surface 4 of the article 1 shown in Fig. 4 is the surface that is to be abraded in the apparatus shown in Fig. 1. The articles 1 to be abraded are placed in the openings 2 of the work holder ring 3. The surface 4 which is to be abraded is placed in contact with the abrading wheel 5, which abrading wheel is carried by the support 6 which is keyed to the hollow shaft 7 carried by the frame 8, mounted on the shaft 9 and driven by the pulley 10 and belt 11. Over the articles 1 is placed the weight ring 12, which through the action of gravity supplies the abrad-

ing friction to the articles 1 on the abrading wheel 5, and at the same time works as a regulator for the thickness of the various articles 1 which are being abraded, as it will be apparent that the weight at the initial start of the grinding operation will bear only on the highest or thickest articles in the work holder 3. The weight 12 is provided with the lifting eyes 13 which may be lifted by the hooks 14 through the rack 15 and pinion 16 operated by the handle 17, said rack 15 being carried in the frame 18 of the machine.

The work holder comprises an annular disc 3 having a plurality of openings 2 to carry the articles 1, and is secured to the disc 19 by the screws 20 or other means. In the disc 19 are the openings 21 into which the pins 22 project. These pins 22 are carried by a crank disc 23 which has the openings 24 into which the pin 25 projects. The pin 25 is carried by the disc 26 which is keyed to the shaft 9. The lower end of the pin 25 projects into the gears 27 which mesh with the ring gear 28 as shown in Fig. 9. The shaft 9 is rotated by the pulley 29 and the belt 30. The plate or disc 19 interengages at 31 with the weight 12 whereby the weight takes the movement of the plate 19.

The operation is as follows: The grinding lap 5 is driven by the pulley 10 having a circular motion. The shaft 9 is driven by the pulley 29 which rotates the disc 26, which causes the gears 27 to rotate around the track of the rack 28, which rack 28 in turn causes the gears 27 to rotate, turning the pin 25, which rotates the crank plate 23 carrying the pins 22 in the plate 19, causing the plate 19 and the weight 12 to travel therewith. The plate 19 carries the lens holder 3; thus it will be seen that the lens holder 3 has a rotary and a gyratory movement and is of different speed than the rotation of the lap or abrading wheel 5, thus causing what is known as a break-up motion of the articles over the lap. In this way it will be seen that the under surface 4 of the article 1 is abraded. In removing the work the weight 12 may be lifted by the bolts 13 as has been described above and the finished articles removed and new articles placed therein.

The device of Fig. 2 is for abrading the surface 4 of Fig. 5, which is a concave curved surface. The construction and operation of the device of Fig. 2 are practically identical with that of Fig. 1 except that the surface 32 of the lap 5 has a convex curvature and the under surface 33 of the weight 12 has a concave surface. The work holder disc 3 is also a concavo-convex curved disc. The operation and construction of the device are otherwise identical with that of Fig. 1.

Fig. 6 shows the under surface 4 as a convex curvature which is to be abraded on the device of Fig. 3. The device of Fig. 3 in construction and operation is identical with that of Figs. 1 and 2 with the exception that the surface 34 of the lap 5 is a concave surface. The under surface 35 of the weight 12 is a convex surface and the work holder disc 3 is a concavo-convex surface having the convex surface on the under side.

Fig. 8 shows the surfaces 4 which are to be abraded by the device of Fig. 7, namely, a concave surface on the top and a convex surface on the bottom. The means for driving the lap 5 and the work holder disc 3 is practically identical with that described above for the other devices. The lap 5 has a concave surface 36 and the work holder disc 3 is a concavo-convex disc as above with the convex surface downward. In this instance, however, the weight 12 is held stationary and has the abrading surface 37 which is a concave surface. The weight 12 is supported by the frame 18 by means of the shaft 38 carrying the ball member 39 and the shank 40, to which the weight 12 is non-rotatably secured by the pin 41. The shaft 38 is keyed to the frame 18 at 42 and is slidably mounted therein. The disc 3 is supported by the rods 43 secured to a ball socket member 44, said rods being pivoted at 45 to the member 44. The work holder disc 3 is secured to the plate 46, said plate 46 having the openings 47 which fit over the pins 48 which are carried by the crank disc 23. This plate, therefore, has a movement like that of the weight 12 in Fig. 1 imparted to it through the rotation of the shaft 9. The pins 48 have a ball end so that the plate 46 may have a universal rocking movement thereon. In operation the lap 5 is rotated as before. The work holder plate has the circular and gyratory movement of Fig. 1, but the weight 12 is held stationary, as described, having an abrading surface 37 operating on the upper surface of the article 1. The weight 12, while held stationary, may ride up and down with the shaft 38 to accommodate for the thickness of the article and the abrading away thereof. The rods 43 merely act as a support for the lens holder 3. This support rocks or operates about the center of curvature of the work holder 3 although the work holder 3 might be used without the rods 43 and the supports 44.

From the foregoing description it will be seen that I have provided simple, efficient and economical means for producing either flat or curved surfaces upon a plurality of articles loosely held in a moving work holder well adapted to carry out and obtain all the advantages of the process and the apparatus.

Having described my invention, I claim:

1. In a device of the character described, a curved faced lap, a curved work holder adapted to fit the curve of the lap and hold the work on the lap, universal joint connections on the curved work holder, crank means having universal joint connections engaging the univeral joint connections on the curved work holder, means to rotate the crank means in a path eccentric to the center of the laps, and means to rotate the crank means bodily about the center of the laps to cause the curved work holder to move over the curved faced lap substantially about the center of the curve on the lap.

2. In a device of the character described, a rotatable lap having a curved abrading surface, means to rotate the lap, a work holder having substantially the same curvature as the lap and having a plurality of openings adapted to loosely hold the articles to be abraded in position on the lap, and means to simultaneously rotate the work holder and to give the same a gyratory motion in a path of the curvature of the lap to move the articles of work over the lap.

3. In a device of the character described, a rotatable lap having a spherical abrading surface, means to rotate the lap, a work holder having a spherical surface of substantially the same radius as the lap and having a plurality of openings adapted to loosely hold the articles of work in position on the lap, and means to simultaneously rotate the work holder and to give the same a gyratory motion in a spherical path to move the articles of work over the lap.

4. In a device of the character described, a curved lap, a weight member having substantially the same curvature as the lap and spaced

therefrom, a work holder of substantially the same curvature between the lap and weight member, and means to rotate and gyrate the work holder in a path substantially of the curvature of the lap and weight member.

5. In a device of the character described, a rotatable lap having a curved abrading surface, means to rotate the lap, a curved work holder having substantially the same curvature as the lap and having a plurality of openings adapted to loosely hold the work in place on the lap, a second lap opposite the first lap having an abrading surface substantially concentric with the abrading surface of the first lap and separated therefrom by the work holder, means for non-rotatably supporting the second lap, and means for rotating and gyrating the work holder between the two laps in a path of substantially the curvature of the laps to move the work over the abrading surfaces of the two laps to abrade the opposite sides of the work.

6. In a device of the character described, an annular lap, means to rotate the lap, a second lap opposite the first lap, a work holder between the two laps having portions extending beyond the outer edges of the laps, a support for the second lap, a universal joint connection on the support, and tie rods connecting portions of the universal connection and the extending portions of the work holder.

7. In a device of the character described, a lap, a second lap opposite the first lap, a work holder between the laps having portions extending beyond the outer edges of the laps, a support for the second lap, a ball joint on the support, a ball joint collar engaging the ball and tie members connecting the collar and extending portions of the work holder.

8. In a device of the character described, a lap, a second lap opposite the first lap, a work holder between the laps having portions extending beyond the outer edges of the laps, a support on the second lap mounted to allow the second lap to be moved towards and away from the first lap but held against rotation, a ball joint on the support, a ball joint collar engaging the ball, and tie members connecting the collar and the extending portions of the work holder.

9. In a device of the character described, a lap, a second lap opposite the first lap, a work holder between the laps, universal joint connections on the work holder, crank means having universal joint connections engaging the universal joint connections on the work holder, means to rotate the crank means in a path eccentric to the center of the laps, and means to rotate the crank means bodily about the center of the laps.

10. In a device of the character described, a lap having a curved surfacing face, a second lap having a curved surfacing face portion opposite the first lap, and a curved work holder between the laps movably supported so that its center of movement is located substantially at its center of curvature, the said laps being formed with contra generic curved surfaces which engage and abrade both sides of the work simultaneously.

11. In a device of the character described, a curved lap, a weight member having substantially the same curvature as the lap and spaced therefrom, a work holder of substantially the same curvature located between the lap and weight member and means to move the work holder to give the same a movement over the lap so that the work will be carried over the lap in an irregular path to prevent the repetition of lines of surfacing in each cycle of the work over the lap,

12. In a device of the character described, a lap having a curved surfacing face, a second lap having a curved surfacing face aligned with the first lap, a work holder adapted to hold the work between the laps, and means to move the work holder to give the same a movement over the lap so that the work will be carried over the lap in an irregular path to prevent the repetition of lines of surfacing in each cycle of the work over the lap.

13. In a device of the character described, a curved lap, a weight-like member having substantially the same curvature as the lap, a work holder of substantially the same curvature as the lap and weight-like member and located between them, and means to move the work holder to cause the work to move over the abrading surface of the lap.

14. In a device of the character described, a lap, a weight like member spaced from the lap, work holding means for holding a plurality of pieces of work between the lap and weight like member, interengaging means between the weight like member and work holding member and means for imparting an irregular movement to the work holder and interengaged weight like member to create an abrading action on the work, said interengaging means permitting the weight like member to impart an equal pressure on the plurality of pieces of work simultaneously during the abrading operation.

15. In a device of the character described, a lap, a weight like member spaced from the lap, work holding means for holding a plurality of pieces of work between the lap and weight like member, interengaging slide means between the lap and weight like member and means for imparting an irregular movement to the work holder and interengaged weight like member to create an abrading action on the work, said interengaging slide means permitting the weight like member to move downwardly to first engage and exert pressure on the pieces of work of the greatest thicknesses and cause the same to abrade quickly and then permit the weight like member to descend and exert an equal pressure on all of said pieces of work simultaneously and cause the said pieces to be abraded to equal finished thicknesses after the thickest pieces of work have been reduced.

16. In a device of the character described, a lap having a curved abrading surface, a weight like member having substantially the same curvature as the lap and spaced therefrom, a curved work holding member for holding a plurality of pieces of work between the curved lap and weight like member, interengaging means between the weight like member and work holding member and means for imparting an irregular movement to the work holder and interengaged weight like member to create an abrading action on the work, said interengaging means permitting the weight like member to impart an equal pressure on the plurality of pieces of work simultaneously during the abrading operation.

17. In a device of the character described, a lap having a curved abrading face, a weight like member having substantially the same curvature as the lap and spaced therefrom, curved work holding means for holding a plurality of pieces of work between the curved lap and weight like member, interengaging slide means between the lap and weight like member and means for im-

parting an irregular movement to the work holder and interengaged weight like member to create an abrading action on the work, said interengaging slide means permitting the weight like member to move downwardly to first engage and exert pressure on the pieces of work of the greatest thicknesses and cause the same to abrade quickly and then to permit the weight like member to descend and exert an equal pressure on all of said pieces of work simultaneously and cause the said pieces to be abraded to equal finished thicknesses after the thickest pieces of work have been reduced.

18. A lapping machine comprising a pair of spaced laps which have opposed surfaces shaped as spherical zones, a work cage mounted between the laps and shaped to move therebetween, and mechanism for revolving the cage and the laps relatively and means controlled by a lap to rock the cage laterally during such relative movement.

19. A lapping machine comprising two opposed laps having concave and convex surfaces respectively which are shaped as spherical zones, means to rotate one of the laps, a work cage shaped to move between the laps and arranged to hold a plurality of work pieces in contact with both laps and means to revolve the work cage relative to the laps with a compound motion and permit it to rock laterally so that the work pieces may follow the curvatures of the laps and be lapped thereby.

20. A lapping machine comprising two opposed abrading members having concave and convex surfaces respectively, each of which is a spherical zone, a work cage shaped to revolve and move laterally between said abrading members and arranged to hold a plurality of work pieces in contact with both of said members, driving mechanism to revolve the cage with a compound motion about two centers, and a universally jointed connection between the mechanism and the cage which permits the work to move with a compound motion over the surfaces of the abrading members and be abraded thereby.

21. A lapping machine comprising two opposed abrading laps having concave and convex surfaces respectively, each of which is shaped as a spherical zone, means to revolve one of the laps, a work cage having a portion shaped as a spherical zone which is arranged to hold a plurality of work pieces in contact with both of the laps and to move therebetween and driving mechanism including a revolved driving pin which is connected to said cage through a universal joint, serving to cause the work pieces to move across the surfaces of the laps with a compound lateral and circumferential motion and be abraded thereby.

22. A lapping machine comprising two opposed annular laps having concave and convex surfaces respectively which are shaped as spherical zones, a work cage shaped to hold a plurality of work pieces therebetween, a crank pin connected to said cage by a universal joint, means to rotate said crank pin and means to revolve said rotating means about a central axis and thereby move the work pieces over the laps with a compound gyratory motion.

23. The method of making a lens consisting in engaging the opposite faces of the lens with curved abrading surfaces, confining the lens to prevent free movement thereof and relatively moving the confined lens and said surfaces positively to abrade both faces thereof simultaneously.

24. The method of lapping a curved article which consists in supporting the article and positively rotating it while causing it to be abraded on its opposite faces simultaneously by abrading members having surfaces shaped as spherical zones.

25. The method of making lenses which consists of mounting in spaced relation two laps having opposed concave and convex surfaces shaped as spherical zones, supporting a lens between the laps with the opposite faces of the lens engaged with the laps, and relatively moving the support for the lens and the surfaces of the laps engaged by the faces of the lens in the support.

26. A lapping machine having, in combination, a concaved lap and a convexed lap mounted in spaced relation, means for supporting a plurality of work pieces between the laps with the opposite faces thereof engaged with the laps, and mechanism for relatively moving said means and the laps to transfer the work pieces over the surface of the laps in a series of differential noncircular orbital paths successively.

27. A lapping machine comprising two opposed laps having annular lapping surfaces concentric during the lapping operation, and located one above the other, which do not lie in parallel planes, but are shaped to contact with opposite elements of the work pieces therebetween, a work cage arranged to hold the opposite sides of a plurality of work pieces in operative contact with and movable relative to the laps, the laps and cage being so arranged that the work pieces may be both revolved and moved laterally to lap the same, and means including a driving mechanism connected to the cage to cause the cage to revolve and rock laterally and produce such lapping movement of the work pieces.

28. A machine for making a lens having a concavo-convex surface, comprising two opposed abrasive members provided with surfaces which are spherical zones corresponding with the curved surfaces of the finished lens, a lens supporting cage movable therebetween, and means to rotate and gyrate said cage with a rocking motion in such a manner that the work will move through an everchanging path between said abrasive members and be abraded upon both sides simultaneously and caused to conform with the surface curvatures of the opposed laps.

HARRY W. HILL.