

March 13, 1928.

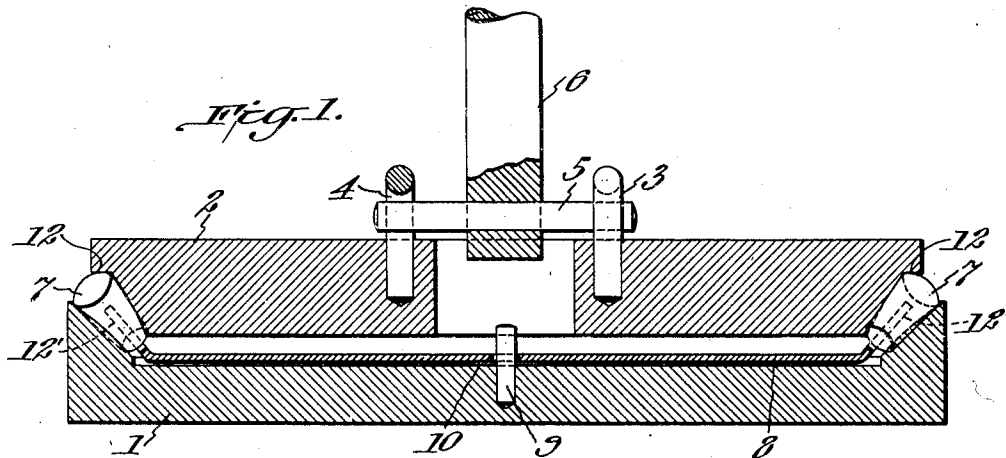
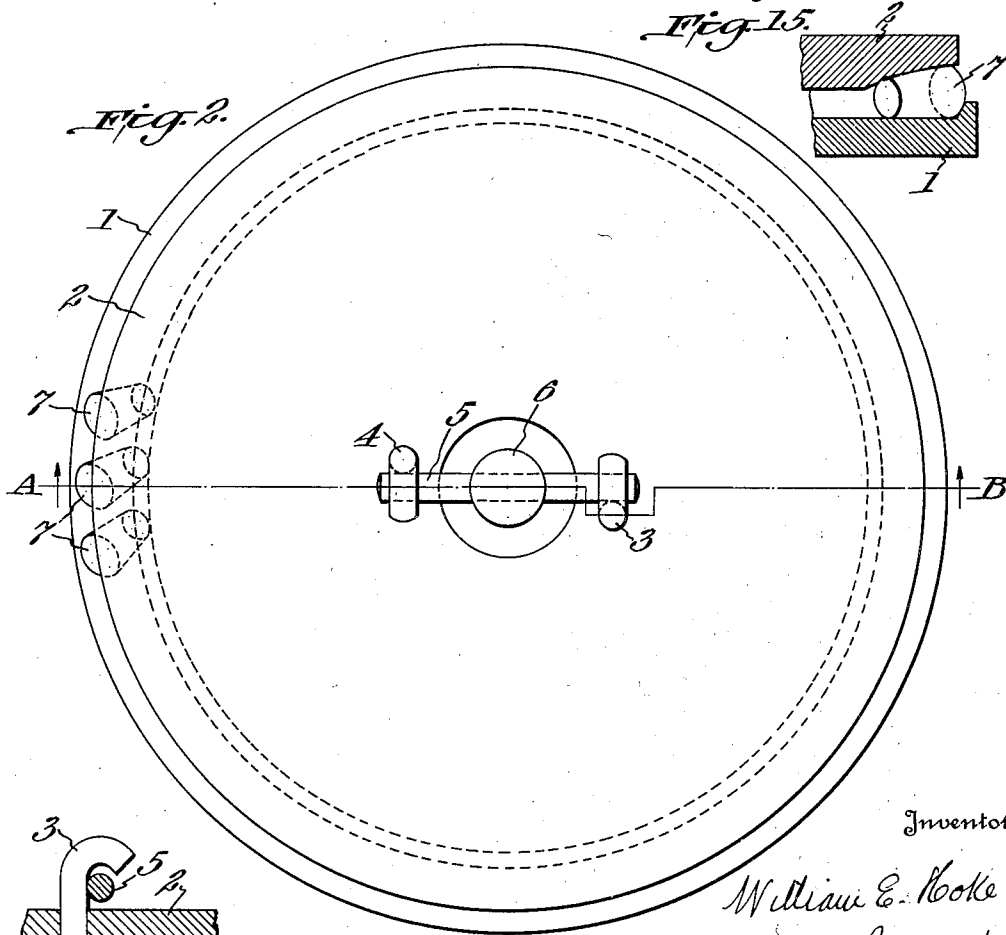
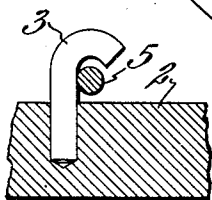
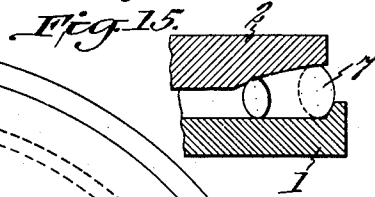
1,662,672

W. E. HOKE

METHOD AND APPARATUS FOR GRINDING

Filed Dec. 23, 1924

4 Sheets-Sheet 1



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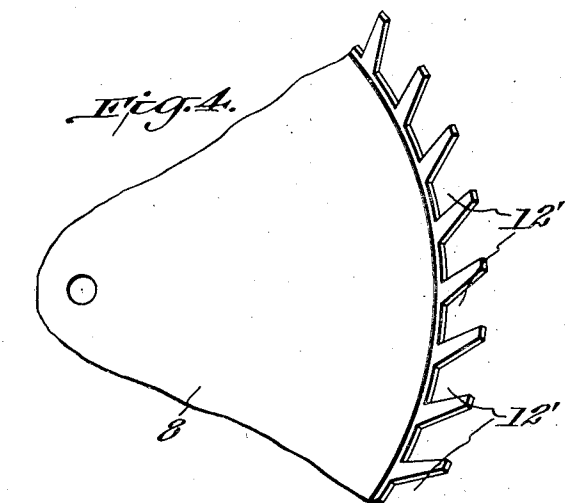
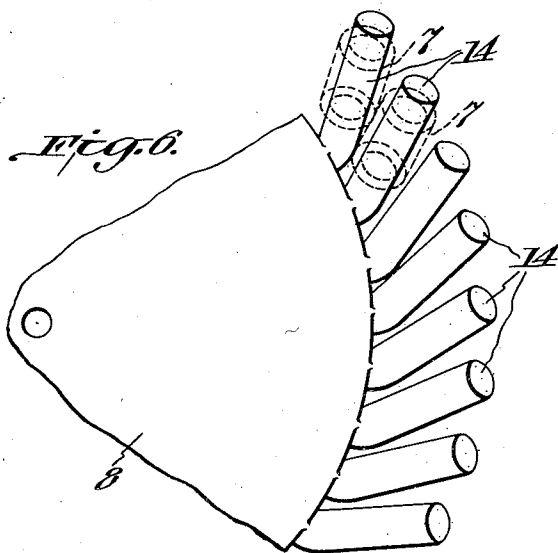
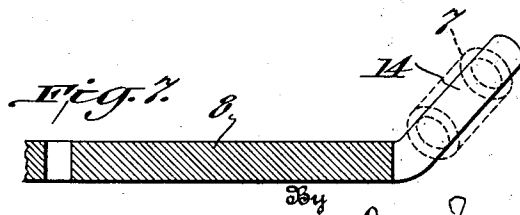
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4 Sheets-Sheet 2



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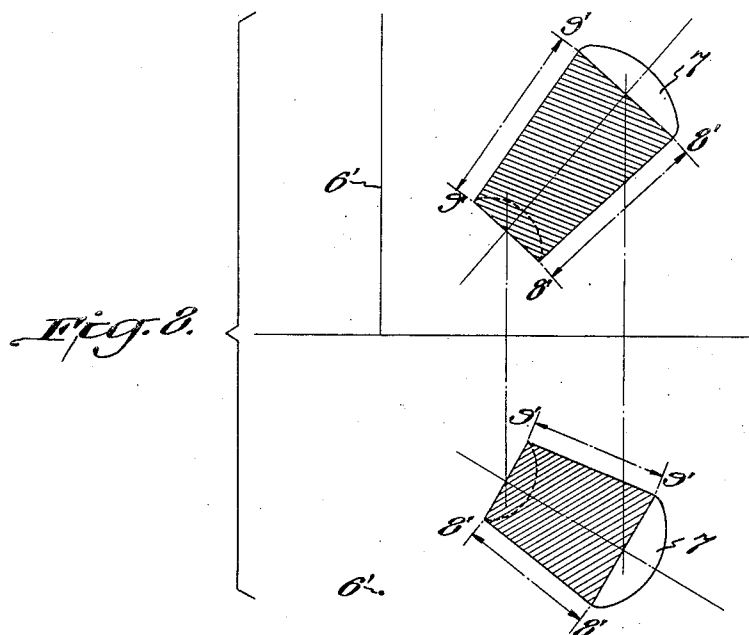
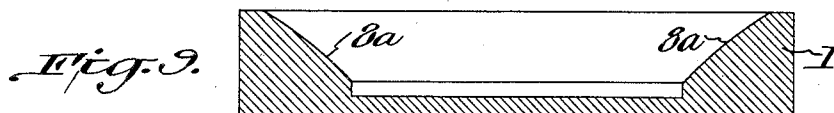
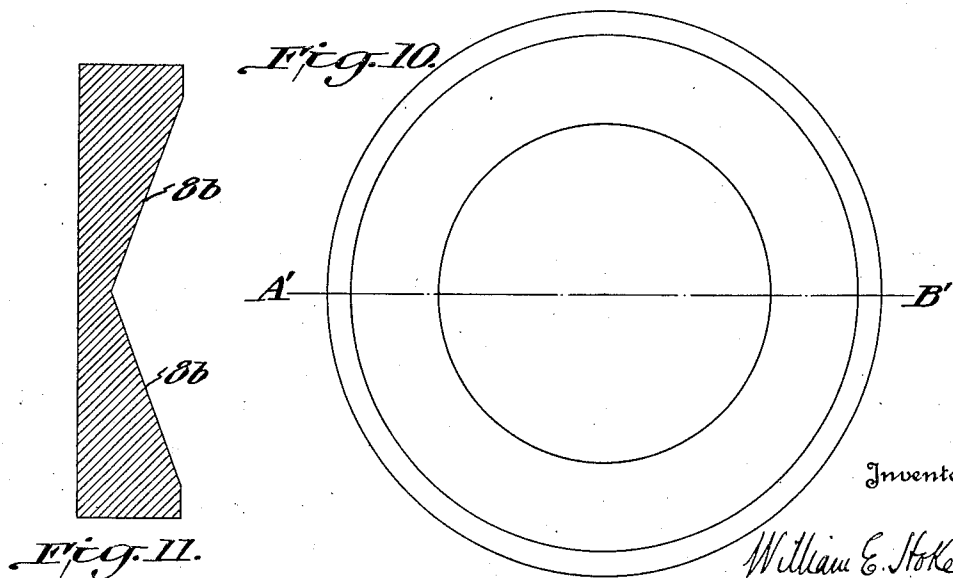
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METHOD AND APPARATUS FOR GRINDING

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4 Sheets-Sheet 3



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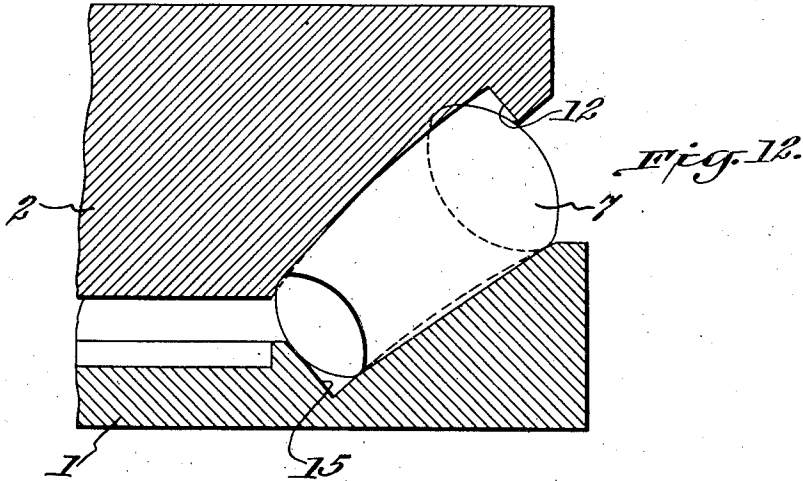
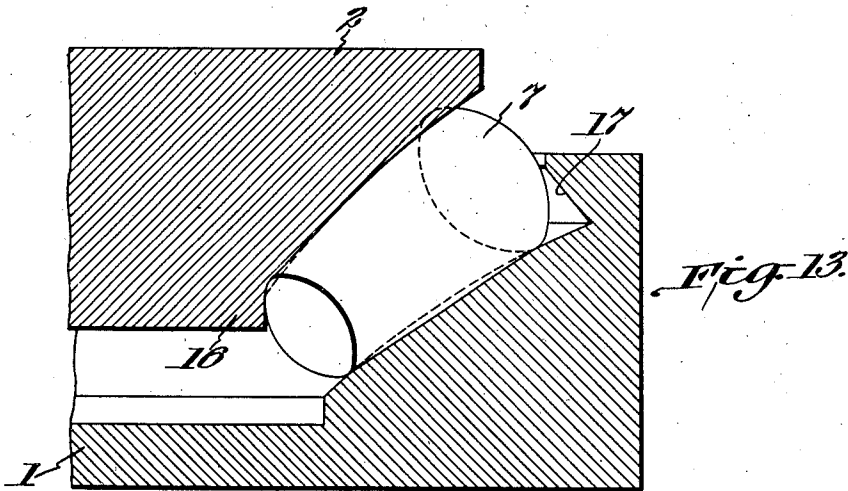
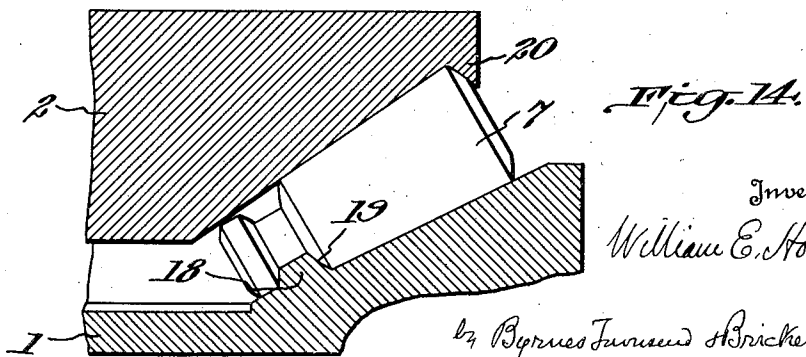
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W. E. HOKE

METHOD AND APPARATUS FOR GRINDING

Filed Dec. 23, 1924

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR GRINDING.

Application filed December 23, 1924. Serial No. 757,740.

My invention relates to a method and apparatus for grinding or abrading, preferably by lapping, cylindrical or conical steel articles such as are commonly used in roller bearings, wrist pins, plug gauges, etc. My invention is particularly designed for bringing articles of this type, after they have been hardened, to a highly accurate predetermined final form and polish.

My invention is a new application of the method described in my United States Patent No. 1,486,338, patented March 11, 1924, in which I have described the method of making a multiplicity of identical articles by repeated lapping and systematic interchange of the relative position of the articles. This same system or mode of operation is utilized in finishing articles of the kind above described, but is based on what I believe to be an entirely new principle or idea which consists in finishing the articles by lapping between curved surfaces of revolution. These lapping surfaces may be considered as generated by the revolution of a line about a rectilinear axis not in the plane of the generatrix and are, when the generating line is straight, portions of surfaces of "hyperboloids of revolution", and have the characteristic that through any point of the surface two rectilinear elements of the surface may be drawn.

The articles to be ground or lapped, whether cones or cylinders, will therefore be abraded or ground by what is substantially a line contact between the surfaces of the article being ground and the surface of the lap.

While I have referred to cylindrical and conical articles, the generating line of which is straight, my invention is also applicable for the finishing of articles having curved generating lines, either concave or convex, the articles being spool shaped or barrel shaped; or the invention may also be applied to the finishing of articles having other more or less curved outlines, as long as the surfaces of such articles are surfaces of revolution.

The invention will be readily understood by reference to the accompanying description and drawings in which

Fig. 1 is a sectional elevation on plane A—B of Fig. 2 of one form of device;

Fig. 2 is a plan of Fig. 1;

Fig. 3 is a detail;

Fig. 4 is a partial plan of one form of work holder;

Fig. 5 is an elevation of Fig. 4;

Fig. 6 is a partial plan of another form of work holder;

Fig. 7 is an elevation of Fig. 6;

Figs. 8, 9, 10 and 11 are diagrams; and

Figs. 12, 13, 14 and 15 show in section details of lap construction.

Referring to Fig. 1 in which the machine is diagrammatically illustrated, 1 is a non-revoluble lap of cast iron or other suitable material; 2 is a like cooperating lap resting upon the articles being ground, but is preferably free to move in any direction, or in other words, is freely floating. The lap 2 is provided with upstanding pins 3, 4 having an upper hooked portion as shown in the detail, Fig. 3. Loosely engaging these pins is a cross-bar or dog 5 carried by the shaft 6 which is rotated by any suitable mechanism, such as the spindle of a drill press.

Either the non-rotatable or the revoluble lap may be freely floating.

The articles to be lapped such as cylinders or coned rollers 7, are held in proper position by means of a work holder or spider 8, this spider being free to rotate on an axially located pin 9, the spider being spaced from the lower lap 1 by means of a washer or boss 10. This spider or work holder serves to maintain the articles 7 with their axes at an angle to the vertical plane passing through the axis of rotation of the shaft 6. The lapping surfaces 8 and 9 are, in this particular instance, doubly ruled warped surfaces generated by lines which are at an angle to the horizontal plane and also at an angle to the vertical plane in which is the axis of revolution of the lap.

This will be apparent in accordance with well known principles of descriptive geometry from the diagram Fig. 8, since the revolution of the line 8'—8' about the axis 6' will generate one hyperboloidal surface of revolution, while the line 9'—9' will generate a second hyperboloidal surface. If the article being lapped is a cylinder, then the two warped surfaces will be generated by parallel lines.

The characteristics of such warped surfaces are shown in Figs. 9, 10 and 11, in which Fig. 9 is a meridional or axial section on plane A—B of the lower lap, the lines 8*, 8*, being on this plane portions of a

hyperbola, while on a properly taken section the lines 8^a, 8^b are straight lines.

The article being lapped has its axis in a plane passing through these generating lines on the upper and lower laps, and therefore is engaged by these cooperating lapping surfaces with what is theoretically, and in practice substantially, a line engagement. It will be noted that, as shown in Fig. 1, the working space between the surfaces 8 and 9 is upwardly inclined, although, as will be pointed out later, this particular arrangement is not essential to my invention.

As shown in Fig. 15, one of the lapping surfaces may have a plane surface, while the other cooperating surface is a hyperboloid surface of revolution.

In operation, a multiplicity of the articles to be lapped, arranged in the work holder (see Fig. 2) are placed in position on the lower non-revoluble lap and the upper rotatable freely floating lap is then placed in position resting on the articles. As the upper lap is rotated, the articles will be moved around in the working space between the two lapping surfaces and will be given at the same time a movement of rotation about their individual axes and a longitudinal movement along those axes, or some combination of these movements, as the result of which they are not simply rolled around, but are subjected to a grinding action. At the outset the upper lap will rest upon those articles which are of greater dimension than other articles in the group, and the dimensions of these particular articles will gradually be reduced until the upper lapping surface bears upon a larger number of these separate articles. The articles are then symmetrically transposed according to the method described in my Patent No. 1,486,338, and again subjected to the lapping operation; and this alternate lapping and transposition is continued until each one of the articles is brought to its predetermined final exactly accurate size.

When the articles being lapped are so arranged as to have substantially line contact, as above described, with the lapping surfaces, the articles are ground along their straight line generatrices. If their axes are inclined still further in either direction, the surfaces will be ground with correspondingly curved surfaces.

So also, if the generating lines are curved, articles of a general convex or barrel shaped or of a concave or spool shaped cross-section can be ground.

The working space between the two laps is most conveniently arranged as shown in Fig. 1, but the opening may be peripherally arranged.

The upper lap 2 has at its periphery shoulders 12, 12, which bear upon the upper

or butt ends of the articles, the weight of the upper lap thus tending to force the article downwardly and inwardly, so that sufficient grinding pressure is applied, while at the same time the periphery of the butts of the articles is dubbed off.

The grinding surfaces of these shoulders may be either plane or curved to fit the work.

As shown in Fig. 12, the lower lap may also be provided with a shoulder 15. Or as shown in Fig. 13, the upper lap may have a shoulder 16 and the lower lap a shoulder 17.

In Fig. 14, the lower lap is shown as provided with a shoulder 18, so shaped as to lap on its upper surface 19, the lower end of a cone roller, such as are used in roller bearings, the upper lap having a properly shaped shoulder 20.

The purpose of these shoulders, whether one or more than one is used, is to limit the movement of the article in the direction of its own axis.

These shoulders are particularly desirable when frusto-conical articles are being lapped, and have the particular advantage that in addition to the accurate finishing of the conical surface, the end-portions or butts of the frusto-conical articles are simultaneously lapped to the exact desired relation between the diameter of the butt portion and the longitudinal dimensions of the cone. By the use of properly shaped shoulders on one or both laps, any of the many shapes of cone-rollers now commonly used may thus be brought to exceedingly accurate dimensions and to the shape desired for use. It is not essential that both lapping surfaces should be surfaces of revolution. As shown in Fig. 15, one of the laps, e. g. the lower lap, may be a plane surface, and the other a hyperboloidal or other suitable surface of revolution.

The work holder 8 may consist (as shown in Figs. 4 and 5) of a suitable disk-shaped device having an upturned rim with openings 12', 12' corresponding in shape to the article being ground; or if the article, such as a wrist pin, is hollow, the work carrier disk may have supporting pins 14, 14 extending into the holes in the wrist pins. In any case, the work holder acts as a guide to hold the articles at the proper angle of inclination, the articles being otherwise free to move under the influence of the laps.

In the construction shown in Fig. 1, the floating lap is self-centering, but in other forms of the device it may be necessary to provide means for centering the revoluble lap.

While my invention is mainly designed for bringing articles of the kind described to a final exceedingly accurate form or contour by the use of lapping surfaces, it is obvious

that the same principles apply to coarser grinding by the use of other commonly used abrasive surfaces.

While I preferably make one of the laps 5 freely floating, so that it can adjust its position and rest upon the articles being abraded, this construction is not strictly essential, as even if the revoluble lap be mounted on a fixed axis, results sufficiently 10 accurate for commercial purposes may be obtained.

I claim:

1. The method of grinding articles having curved surfaces which consists in sub- 15 jecting said articles to abrasion between relatively moving abrading surfaces at least one of which is a curved surface of revolution having the characteristic that through any point of the surface two rectilinear sur- 20 face elements may be drawn.

2. The method of grinding articles having curved surfaces which consists in subject- 25 ing them to abrasion between grinding means at least one of which has a hyperboloidal surface of revolution.

3. The method according to claim 1 in which the grinding means are laps one of which is non-rotatable and the other is ro- 30 tatable, one of said laps being freely floating.

4. An apparatus for grinding articles com- 35 prising one non-rotatable lap and a cooperating rotatable lap, said laps having abrading surfaces at least one of which is a surface of double curvature having the char- 40 acteristic that through any point of the surface two rectilinear surface elements may be drawn, and means for rotating said rotatable lap.

5. An apparatus for grinding articles com- 45 prising one non-rotatable lap and a cooperating rotatable lap, said laps having abrading surfaces at least one of which is a hyperboloid of revolution, and means for rotating said rotatable lap.

6. An apparatus as claimed in claim 4 45 having a work holder for articles to be ground between the laps, said holder having means for holding the articles at the desired angle.

7. An apparatus for grinding articles com- 50 prising two laps, one of which is revoluble, the lower lap having an abrading surface which is a hyperboloid of revolution, the upper lap having a corresponding hyper- 55 boloid surface of revolution, said upper lap having a shoulder surrounding the abrading surface and adapted to bear on the articles

being ground, and a work holder having means for holding the articles at a proper inclination. 60

8. An apparatus for grinding articles as claimed in claim 4 having a work holder for articles to be ground between the laps, said holder having means for holding the arti- 65 cles at the desired angle and in which one of the laps is freely floating.

9. An apparatus for grinding articles hav- 70 ing curved surfaces, such as cones or cylinders, comprising one lap having a hyperboloid surface of revolution, a cooperating lap having a corresponding hyperboloid sur- 75 face of revolution, a work holder having means for holding the articles while being ground between such lapping surfaces at such angle that generating lines on the sur- 80 faces of the articles will coincide with generating lines on each of the hyperboloid lapping surfaces, and means for rotating one of said laps.

10. An apparatus as claimed in claim 9 in 80 which the laps are positioned one above the other, one of such laps arranged to be non-rotatable and the other to be freely floating, said upper lap having a shoulder surround- 85 ing the grinding surface and adapted to bear on the articles being ground.

11. An apparatus for grinding articles 90 having curved surfaces comprising a pair of laps one of which is revoluble, said laps having abrading surfaces at least one of which is a hyperboloid of revolution, a work holder having means for holding the articles while being ground at the desired angle, and means comprising a shoulder or shoulders 95 for limiting the movement of the articles being ground in the direction of their axes.

12. An apparatus for grinding articles 100 having curved surfaces comprising a pair of laps one of which is revoluble, said laps having abrading surfaces at least one of which is a hyperboloid of revolution, a work holder having means for holding the articles while being ground at the desired angle, and means comprising a shoulder or shoulders for lim- 105 iting the movement of the articles being ground in the direction of their axes, said means having abrasive surfaces of the proper shape to accurately form the surfaces of those portions of the articles with which they engage. 110

In testimony whereof, I affix my signa- 115 ture.

WILLIAM E. HOKE.