

Jan. 16, 1940.

P. H. HUTCHINSON

2,187,471

GRINDING

Filed Nov. 3, 1937

2 Sheets-Sheet 1

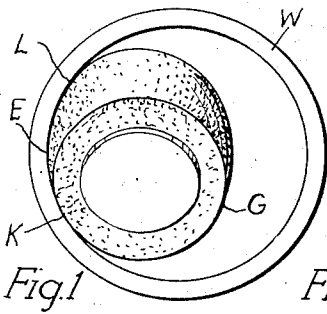


Fig. 1

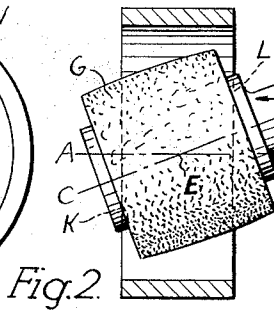


Fig. 2

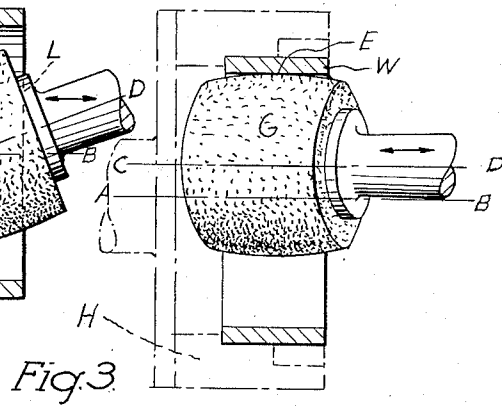


Fig. 3

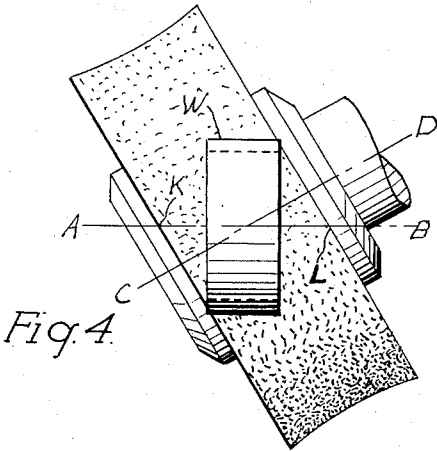


Fig. 4

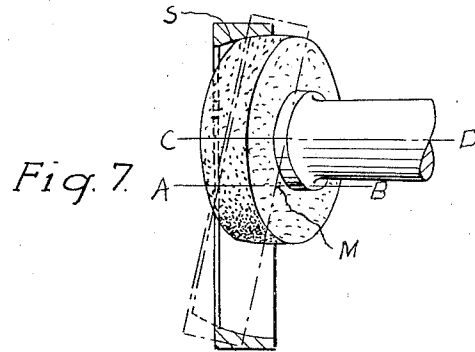


Fig. 7

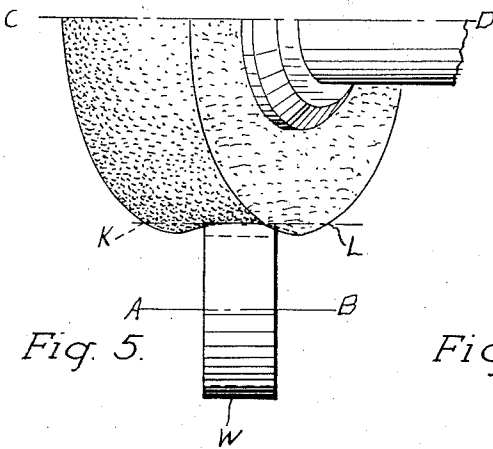
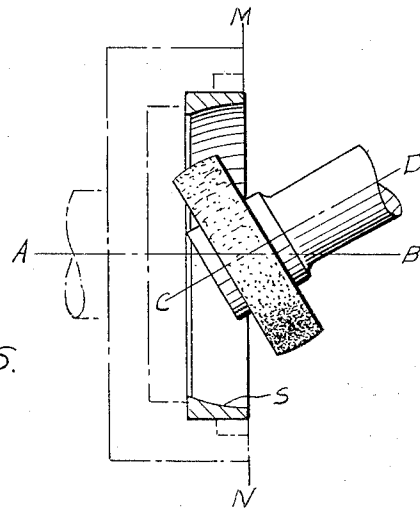


Fig. 5

Fig. 6



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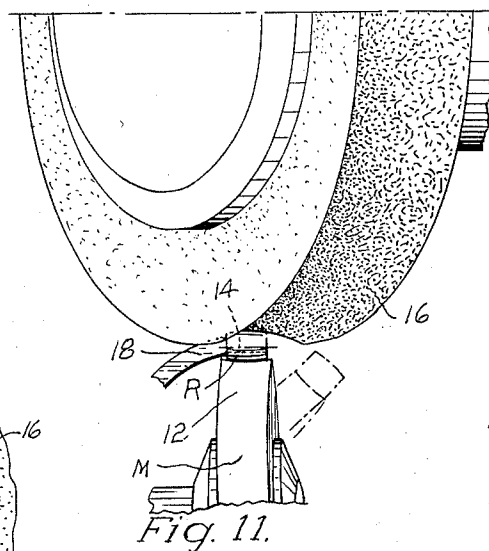
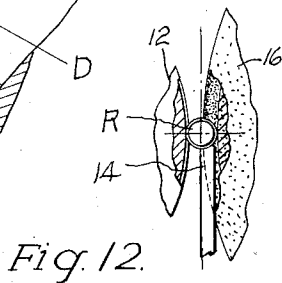
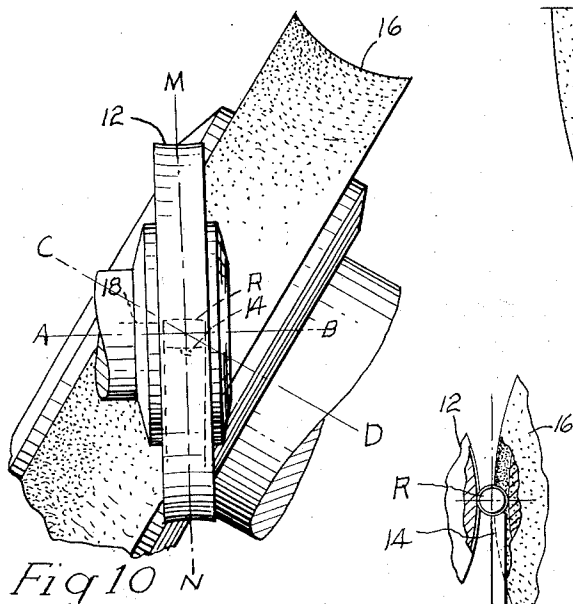
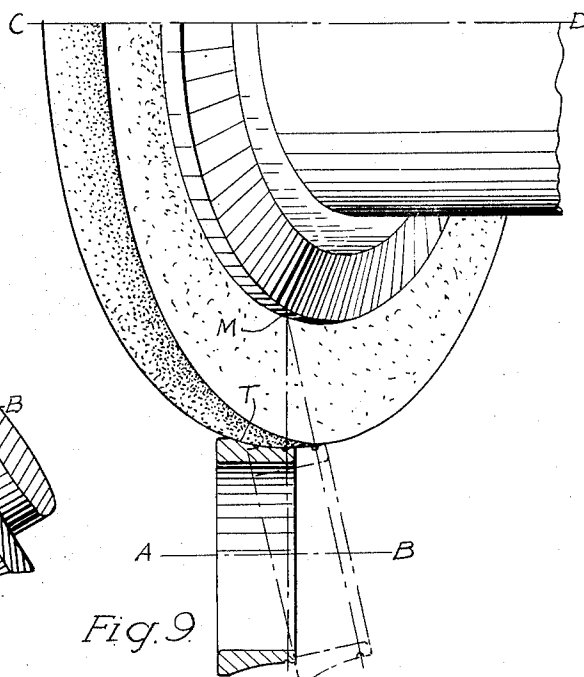
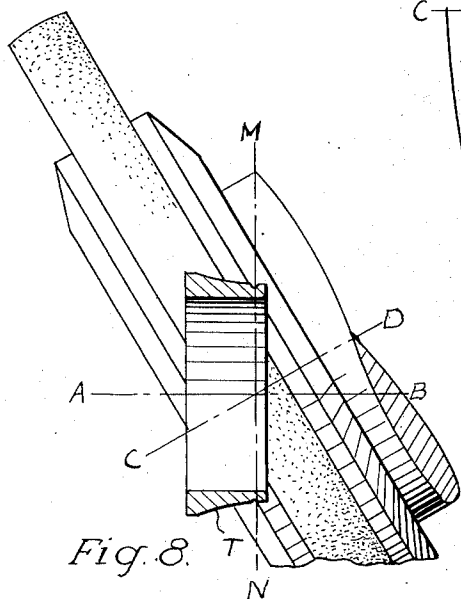
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UNITED STATES PATENT OFFICE

2,187,471

GRINDING

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Application November 3, 1937, Serial No. 172,573

16 Claims. (Cl. 51—278)

This invention relates to grinding and comprises all of the features and aspects of novelty herein disclosed. An object of the invention is to provide an improved method and apparatus for grinding surfaces of revolution. Another object is to provide a method and apparatus for grinding surfaces of revolution in a manner which will minimize chatter and vibration, tend to clear the grinding members of grit, produce rapid grinding or abrading and a fine finish.

To these ends and also to improve generally upon devices of the character indicated, the invention consists in the various matters hereinafter described and claimed. In its broader aspects, the invention is not necessarily limited to the specific constructions and steps selected for illustrative purposes in the accompanying drawings in which:

Fig. 1 is an end view.

Fig. 2 is a side view of Fig. 1 with the work in vertical, diametrical section.

Fig. 3 is a plan view with the work in horizontal, diametrical section.

Fig. 4 is a side view of another embodiment.

Fig. 5 is a partial plan view of Fig. 4.

Fig. 6 is a side view of another embodiment, the work being in vertical section.

Fig. 7 is a plan view of Fig. 6, the work being in horizontal section.

Fig. 8 is a side view of another application of the invention, the work being in vertical section.

Fig. 9 is a plan view of Fig. 8, the work being in horizontal section.

Fig. 10 is a side view of another form.

Fig. 11 is a plan view of Fig. 10.

Fig. 12 is an end view of Fig. 10, the wheels being broken away and in section.

In the usual internal grinding machine, a hollow work-piece is rotated upon its axis by a suitable chuck while a cylindrical grinding wheel is fed against the internal surface to be ground. The wheel spindle is parallel to the work axis and usually is fed rearwardly in the same horizontal plane, the wheel also being reciprocated in line with its axis. The wheel has little or no tendency to throw grit out of the work and it often chatters or vibrates such that the work surface is not accurate and smooth. The present invention has special reference to the improvement of such machines and methods but is not limited thereto. The terms "grinding" and "abrading" are intended to embrace analogous treatment such as honing and polishing.

In Figs. 1, 2, and 3, the letter W indicates a hollow work-piece to be internally ground, the in-

ternal surface being cylindrical. The piece is rotated upon its axis A—B by any suitable chuck or other work holder indicated generally at H. A grinding wheel G is fed rearwardly against the surface to be ground and it can also be reciprocated parallel to the work-surface or to the work axis. As distinguished from prior devices, the wheel axis C—D is tipped or inclined in a vertical plane which is always on the same side of the work axis and parallel to the work axis when the work surface is cylindrical. This plane is also offset from the work axis and parallel to that element of the work surface towards which the wheel is fed. The periphery of the wheel is transversely curved or convex to a degree dependent upon the inclination or obliquity of its axis, the convexity increasing with an increase in inclination. The convexity is such that the wheel will have a continuous line of contact extending obliquely of the work surface. This line will extend through a point E in a horizontal diameter of the work at its middle portion and through points K and L at the ends of the work, the point K being below the horizontal diameter and the point L above it. Thus the line of contact extends obliquely or diagonally across the work surface instead of directly along an element of the cylinder. The tilting of the wheel axis brings the wheel surface up to the ends of the work in a manner to compensate for the convexity which, without such tilting, would make the surface recede from the work in both directions from the middle point E towards the ends. Although the wheel would wear down in time to the desired shape in use, it is desirable to generate the surface by a suitable dressing device.

An important result of the tilting of the wheel is that the wheel tends to discharge grit from one end of the work as it wipes across the work diagonally or obliquely. The cutting movement has a component which extends lengthwise of the work and lengthwise of the fibers or grain structure. The cutting action is faster than it otherwise would be and there is a longer line of contact on the work than in the usual case where a cylindrical wheel is in parallelism with the work. Another important advantage contributing to rapid cutting and fine finish is the lack of chatter and vibration which is attributed to the relative inclination of the wheel spindle and the spindle which supports the work holder.

Figs. 4 and 5 show an application of the invention to external grinding of a cylindrical surface. The wheel axis C—D is tilted in a vertical

plane parallel to the work axis A—B. The grinding wheel has a concave surface but has diagonal straight line elements K—L which make a straight line of contact directly across the work surface. This line is parallel to the work axis and hence to an element of the cylindrical work surface. The corresponding line on the wheel is at an inclination to the wheel axis and so there is a wiping action between the relatively movable surfaces.

In Figs. 6 and 7, the work-piece is a bearing outer race ring having an internal surface S which is a segment of a sphere. This surface is generated by a circular arc revolved around the work axis. The center of the spherical surface is in the plane of one end face of the work where the vertical line M—N intersects the work axis A—B. The wheel axis C—D is tilted in a vertical plane parallel to the work axis so that the wheel and the work are out of parallelism. The surface of the wheel is convex and presents a line of contact with the work surface. The work is desirably oscillated around an axis M—N to carry its whole width across the wheel but the wheel can be made wide enough to grind the entire width of the work without oscillation. The line M—N passes through the center of the spherical surface S, this center being the center of curvature of the generating arc. If the work is thus oscillated to change its place of contact with the wheel, an inclined relation of these members is maintained. The work head and its spindle may be mounted on a suitable oscillating plate as in Van Norman Reissue Patent 13,892.

In Figs. 8 and 9, the invention is shown applied to the grinding of a bearing inner race ring having a surface T generated by a circular arc revolved about the work axis. The grinding wheel has a convex surface and its axis is tipped with respect to the work axis. The work is desirably oscillated around a vertical axis M—N which is outside the piece. This axis is in a plane perpendicular to the work axis and at a distance from the work surface corresponding to the radius of the generating arc. The wheel can be made wide enough to grind the entire width of the work surface without necessity for oscillation.

In Figs. 10, 11 and 12, the invention is applied to the external grinding of barrel shaped rollers R adapted for use with race rings such as shown in Figs. 6 and 8. The surface of such a roller is generated by a circular arc revolved about its axis. The roller is supported against the transversely curved or concave periphery of a regulating wheel 12 by a work rest 14 having its upper surface curved to fit the roller. Opposed to the regulating wheel to form a grinding throat is a wide grinding wheel 16 having a transversely curved or concave periphery. The wheel 16 has its axis C—D tipped with respect to the work axis and the axis of the regulating wheel, and the grinding wheel is out of parallelism with the regulating wheel. At one end of the work rest is an end stop or pusher 18 which locates the roller lengthwise and pushes it through the grinding throat, the work rest, regulating wheel, work, and pusher desirably oscillating as a unit around a vertical axis M—N. This axis lies in the middle plane of the regulating wheel and its distance from the grinding wheel depends on the radius of the convex surface of the roller. Besides having the desirable effect of the wiping cut, the inclination of the grinding wheel provides an appreciably longer path for the roller in each passage through the

machine. The regulating wheel is slightly tipped with respect to the work rest.

In all of the foregoing forms, the inclination of the wheel axis C—D with respect to the work axis A—B is substantially less than 45° so that a wheel but little wider axially than the work surface will nevertheless extend across the whole width of such surface and will grind the same even in the absence of a relative oscillation.

I claim:

1. The method of abrading a surface of revolution on a work-piece, which consists in rotating the piece on its axis, presenting an abrading member to the surface along substantially the whole length thereof, and causing the abrading member to move obliquely of the work surface at its place of contact therewith by inclining the axis of the abrading member at an angle substantially less than 45 degrees to the work axis, and rotating the abrading member on its axis while maintaining the axis in a plane always lying on the same side of the work axis and parallel to the work axis; substantially as described.

2. The method of abrading a surface of revolution on a work-piece, which consists in rotating the piece on its axis, presenting an abrading member to the surface, causing the abrading member to move obliquely of the work surface at its place of contact therewith by rotating the abrading member around an axis inclined at an angle substantially less than 45 degrees with respect to the work axis and lying in a plane parallel to the work axis, and causing a relative oscillation between the work-piece and the abrading member to change the place of contact; substantially as described.

3. The method of abrading a surface of revolution on a work-piece, which consists in rotating the piece on its axis, presenting an abrading member to the surface, causing the abrading member to move obliquely of the work surface at its place of contact therewith by rotating the abrading member around an axis inclined at an angle less than 45 degrees with respect to the work axis, and causing the work-piece to oscillate around an axis to change the place of contact while maintaining a relative oblique movement of the contacting surfaces; substantially as described.

4. The method of abrading a surface of revolution on a work-piece, which consists in rotating the piece on its axis, presenting a rotating abrading wheel to the surface with the wheel and the work-piece out of parallelism to procure a wiping cut at the place of contact, and causing the work-piece to oscillate around a center to change the place of contact while maintaining the wheel and the work-piece out of parallelism; substantially as described.

5. The method of abrading a curved surface of revolution generated by a circular arc revolved around the axis of a work-piece, which consists in rotating the piece on its axis, presenting a transversely curved abrading wheel to the surface with the wheel axis oblique to the work axis, and oscillating the work-piece around an axis which is inclined with respect to the plane of the wheel; substantially as described.

6. The method of abrading a surface of revolution on a work-piece, which consists in rotating the piece on its axis, and presenting a rotating abrading wheel to substantially the whole length of the surface with the axis of the wheel inclined at an angle less than 45 degrees to the axis of the work-piece and always lying on the same side of

the work axis and in a plane offset from and parallel to the work axis; substantially as described.

7. The method of abrading an internal surface of revolution on a hollow work-piece, which consists in rotating the piece on its axis, and presenting a rotating abrading wheel to the internal surface with the axis of the wheel inclined at an angle less than 45 degrees to the axis of the work and always lying on the same side of the work axis and in a plane parallel to and offset from the work axis; substantially as described.

8. The method of abrading an internal surface of revolution on a hollow work-piece, which consists in rotating the piece on its axis, and presenting a rotating abrading wheel to the internal surface with the axis of the wheel inclined with respect to the work axis and always lying on the same side of the work axis and in a plane parallel to that element of the work surface which is nearest to the wheel axis; substantially as described.

9. The method of abrading an internal surface of revolution on a hollow work-piece, which consists in feeding a rotating abrading wheel against the internal surface substantially along a radius thereof while the axis of the wheel is maintained at an inclination of less than 45 degrees to the work axis and always in a plane substantially perpendicular to the direction of feed; substantially as described.

10. The method of abrading an internal surface of revolution generated by a circular arc revolved around the axis of a hollow work-piece, which consists in rotating the piece on its axis, engaging such internal surface by a rotating abrading wheel having its axis maintained at a fixed inclination to the work axis in a plane parallel to and offset from the work axis to procure a wiping cut, and giving the piece and the abrading wheel a relative oscillation around another axis passing through the center of curvature of said generating arc; substantially as described.

11. The method of abrading an internal cylindrical surface on a hollow work-piece, which consists in rotating the piece on a fixed axis, presenting a transversely curved abrading wheel to the internal surface with the axis of the wheel inclined at less than 45 degrees to the work axis and always lying on the same side of the work axis in a plane parallel to the work axis, and rotating the wheel on such inclined axis to cause the periphery of the wheel to move obliquely of the work surface at its place of contact therewith; substantially as described.

12. In an internal grinding machine, means for

rotating a hollow work-piece upon its axis, a rotatable grinding wheel having a transversely curved periphery engaging the inner surface of the piece, and a spindle supporting the wheel with its axis inclined at less than 45 degrees to the work axis and always lying on the same side of the work axis in a plane offset from but parallel to the work axis to make said curved periphery have a line of contact extending obliquely of the work surface; substantially as described.

13. In a grinding machine, a work rest and a regulating wheel having a transversely curved periphery supporting a work-piece for rotation on its axis, a grinding wheel opposed to the regulating wheel and having a transversely curved periphery engaging the work surface, and the grinding wheel having its axis inclined with respect to the axes of both the regulating wheel and the work; substantially as described.

14. In a grinding machine, a work rest and a regulating wheel having a transversely curved periphery supporting a work-piece for rotation on its axis, a grinding wheel opposed to the regulating wheel and having a transversely curved periphery engaging the work surface, the grinding wheel having its axis inclined with respect to the axes of both the regulating wheel and the work, and the work rest, work and regulating wheel being oscillated as a unit around an axis to carry the work-piece diagonally across the periphery of the grinding wheel; substantially as described.

15. In a machine for grinding an internal surface of revolution generated by a circular arc revolved around the axis of a hollow work-piece, means for rotating the piece about such axis, a grinding wheel having a transversely curved periphery engaging the work surface, and means for supporting the grinding wheel with its axis inclined at less than 45 degrees to the work axis and always lying on the same side of the work axis in a plane offset from the work axis; substantially as described.

16. In a machine for grinding a surface of revolution generated by a circular arc revolved around the axis of a work-piece, a grinding wheel having a transversely curved periphery engaging the work surface, means for supporting the grinding wheel for rotation in a plane extending diagonally of the work surface, and means for rotating the piece on its axis and oscillating it around another axis at the center of said generating arc; substantially as described.

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