June 1, 1948. G. M. GREEN 2,442,683

GRINDING MACHINE

Filed March 15, 1945 2 Sheets-Sheet 1

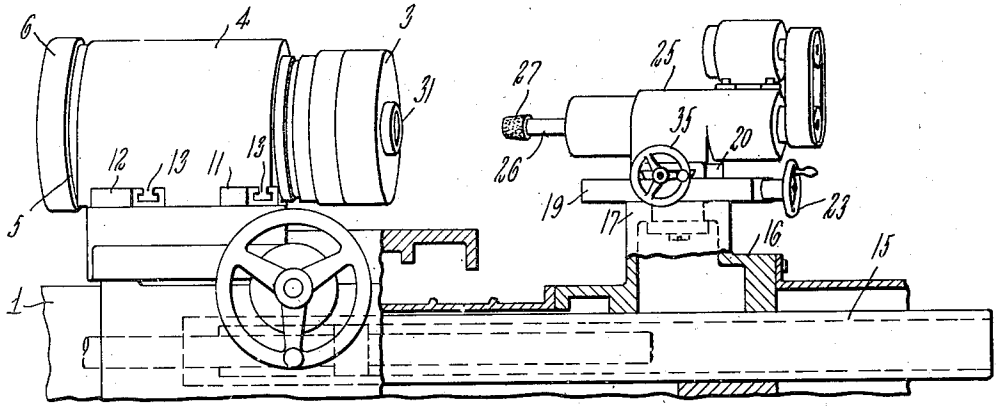


Fig. 1.

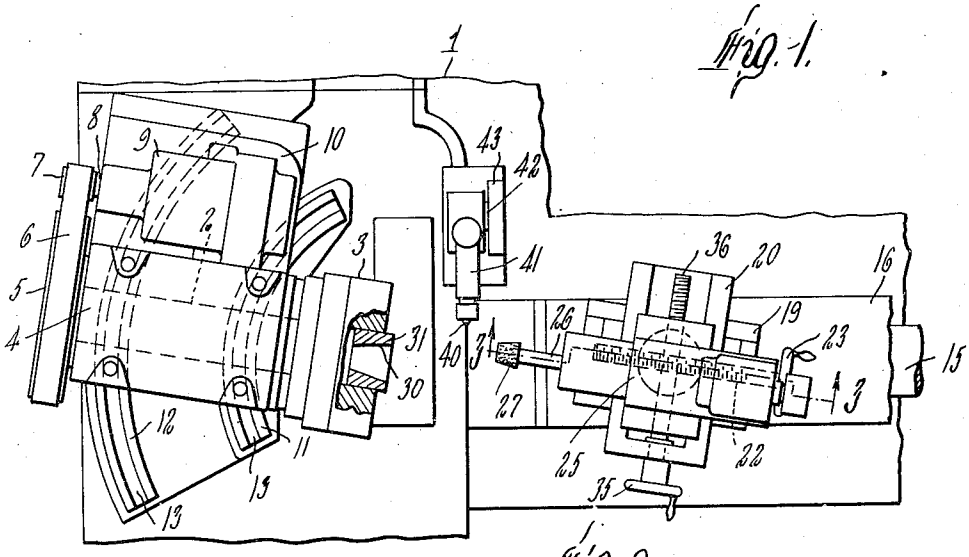


Fig. 2.

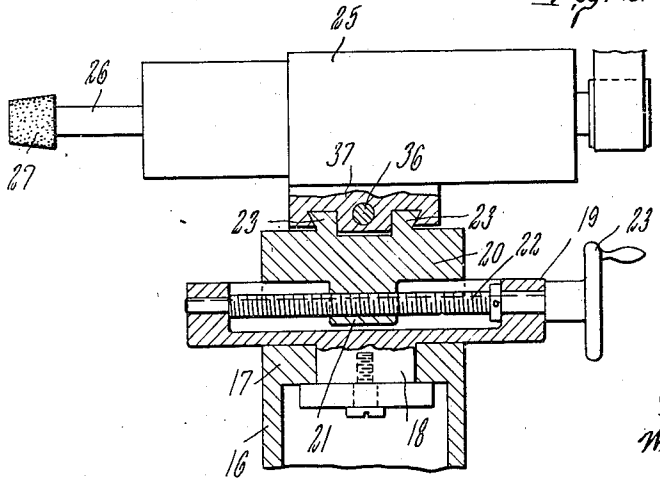


Fig. 3.

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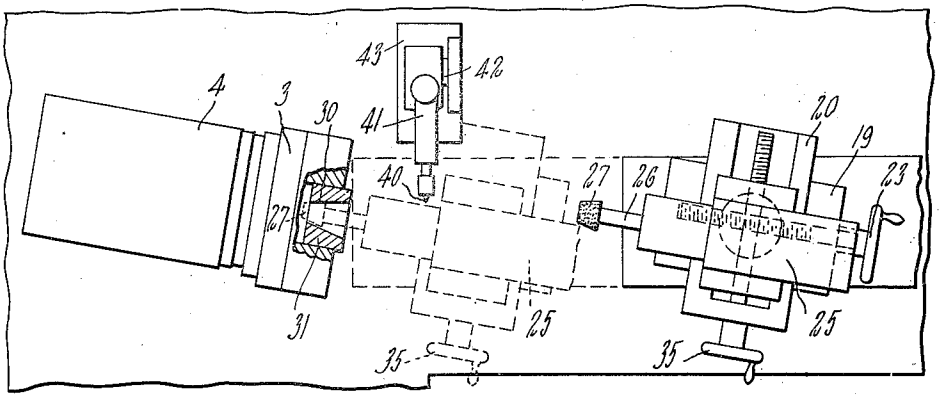


Fig. 4.

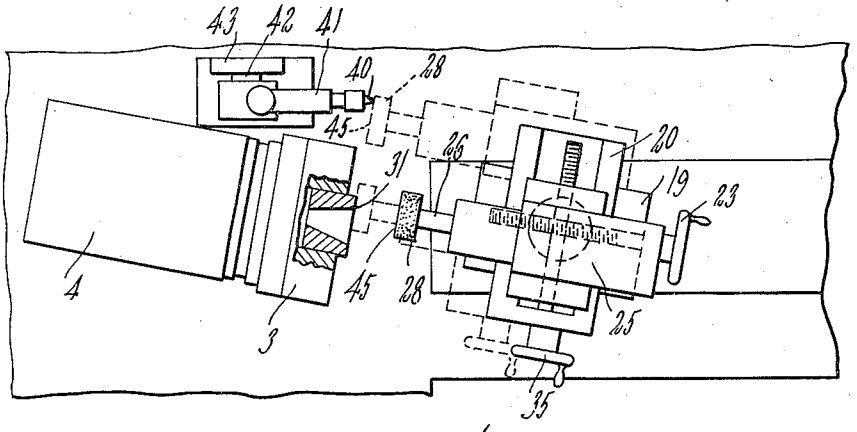


Fig. 5.

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GRINDING MACHINE

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4 Claims. (Cl. 51—50)

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In the grinding of taper holes, the smaller diameter end portion of the hole is of less circumference than the larger end portion, and consequently for each complete rotation of the work, less surface has to be ground. If a cylindrical grinding wheel is employed to grind this surface, both ends of the wheel rotate at the same peripheral speed, and as the grinding at the smaller end of the hole acts on a smaller area per unit of length than at the larger end, over-grinding of the smaller end is likely to result. Similarly when external taper grinding is produced with a cylindrical wheel, over-grinding of the smaller end is liable to occur.

This invention, therefore, has for one of its objects to provide a grinding machine having means for holding and rotating work about the axis of a tapered surface and to present a tapered grinding wheel to such surface with the taper of the wheel facing in the general direction of the taper of the surface, but with its periphery on one side of its axis parallel to the same side of the surface. This requires that the work and the wheel spindle axes be out of line with the line of traverse, the latter being parallel to one side of the taper surface of the work.

This invention, therefore, has for a further object to provide a mounting for the work and a tapered wheel by which the desired relative motion may be effected. It is also found that with this arrangement of wheel and work a much improved surface finish of work is obtained.

A further object of the invention is to provide for relative feed motion between the work and grinding wheel substantially perpendicular to the axis of rotation of the spindle.

A further object is to provide for motion of the grinding wheel lengthwise and crosswise of the work axis.

The motions of the grinding wheel lengthwise and perpendicular to the wheel axis make possible the substitution of a face grinding wheel in place of the internal wheel for truing off the face of the work perpendicular to its axis of rotation. This permits the grinding of the internal face and end face truing to be accomplished with a single chucking of the work piece so that the ground faces are maintained accurately in predetermined relation.

The grinding machine of this invention is therefore provided with work and wheel mountings adjustable to bring their rotational axes out of parallelism with the traverse directions, and at least one movable lengthwise and transverse to its own axis.

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For a more complete understanding of this invention, reference may be had to the accompanying drawings in which

Figure 1 is a fragmentary view partly in side elevation and partly in vertical section of an internal grinding machine embodying the invention.

Figure 2 is a fragmentary top plan of the same, a portion of the work and its holding chuck being shown in central horizontal cross section.

Figure 3 is a sectional view on line 3—3 of Figure 2.

Figure 4 is a somewhat diagrammatic view similar to Figure 2, but illustrating the direction of traverse for taper grinding and truing.

Figure 5 is a view similar to Figure 4, but illustrating traverse motion for face grinding and truing.

Referring first to Figures 1 to 3, at 1 is shown a machine bed on the upper face of which is carried a rotary work spindle 2 provided at one end with a work holder or support 3 indicated conventionally as a chuck. The spindle 2 is journaled in a bearing 4 and on its rear end may be provided with a pulley 5 over which a driving belt 6 may be passed, this belt also passing around the driving pulley 7 on the shaft 8 of a motor 9 mounted on a support 10 which also carries the bearing 4. The support 10 may be adjustable angularly in a plane, for this purpose, the bed 1 being provided with a pair of arcuate tracks 11 and 12 having T slots 13 therein for the reception of suitable fastening devices by which the support 10 may be secured in adjusted position. A guide bar 15 is shown as extending out from beneath the upper face of the bed 1 and upon this guide bar 15 is mounted a carriage 16 movable therealong. The carriage 16 has a supporting head 17 journaled thereon about a trunnion 18 which depends from a slideway 19.

A second carriage 20 is mounted for axial motion on the slideway 19, and as shown best in Figure 3, it may be provided with a nut portion 21 for engagement with a feed screw 22 extending longitudinally of the slideway 19 and journaled therein. As shown it has a hand wheel 23 at its outer end by which it may be turned, thus to move the carriage 20 longitudinally of the slideway 19, which, in turn, is angularly adjustable about the trunnion 18.

The carriage 20 is provided with ways 23 disposed at right angles to the ways of the slideway 19, and slidably guided thereby is a wheel spindle carriage 25 having journaled therein a

wheel spindle 26 to which may be attached either a taper grinding wheel 27, as shown in Figures 2, 3 and 4, or a face grinding wheel 28, as shown in Figure 5. As shown in Figure 2, the work spindle 2 is adjusted in a horizontal plane angularly such that one side face 30 of a work piece 31, having a tapered bore, lies in parallel relation to the axis of the guide bar 15. A tapered grinding wheel 27 carried by the spindle 26 and of a corresponding taper to the taper bore of the work is, adjustable angularly by angular adjustment of the wheel spindle about the trunnion 18 so that one of its side faces is parallel to the side face 30 of the work bore, both being parallel to the axis of the guide bar 15. The grinding wheel is maintained in position to traverse the work throughout all the positions of angular adjustment of the spindle, the adjustment selected depending upon the taper of the wheel, for best results this being correlated with the taper of the hole being ground.

By relatively moving the work spindle and wheel spindle in the direction of the guide bar 15, in the construction shown the wheel spindle being so moved by motion of the carriage 16 along the guide bar 15, the tapered grinding wheel may be caused to traverse the bore of the work as shown in Figure 4, thus to grind the interior of the bore to the desired taper. It will be noted that the larger diameter end of the grinding wheel engages the larger diameter portion of the work, while the smaller diameter portion of the grinding wheel engages the smaller diameter portion of the work, and with the tapers substantially equal, it will be evident that the grinding effect of both end portions of the wheel on the work will be equalized, a slower moving end portion of the wheel engaging the slower moving surface portion of the work at the smaller diameter. Thus the grinding effect is substantially equalized throughout the entire length of the work so that no over-grinding of any portion is produced and a much improved finish of the work is produced.

Feed of the grinding wheel with reference to the work may be produced by either axial or transverse motion of the wheel spindle, each having a component transverse to the work face. The axial motion may be produced by rotation of the hand wheel 23, while transverse motion may be produced by rotation of the hand wheel 35 secured to a feed screw 36, journaled in the carriage 20 and threaded into a portion 37 of the wheel mounting 25.

During traverse of the wheel its desired taper contour may be maintained by including in the traverse a truing device 40 carried by an arm 41 pivotally mounted on a horizontal shaft 42 carried by a stand 43. The pivotal mounting of the truing device on the pivot 42 permits the truing device to be swung back out of the way when it is desired, or to be swung down so as to lie in the path of motion of the wheel when the latter is retracted from the work. The stand 43 may be pivoted about a vertical pivot so as to be turnable from the position shown in Figure 4 to the position shown in Figure 5 at right angles thereto. When in the position shown in Figure 5, the truing device 40 is presented, when it is swung downwardly, into position to true the end face 45 of the face truing wheel 28, when this is substituted for the taper grinding wheel 27.

Axial motion of the wheel spindle when the face truing wheel 28 is employed will act to move this wheel toward and from the end face of the work as shown in Figure 5. Motion of the wheel spindle 26 transversely of its axis, as by turning the hand wheel 35, will cause this face grinding wheel to be moved between positions where it is effective to grind the outer face of the work, or where its grinding face passes across the truing device 40, thereby to true the wheel 28 for face grinding. With the axes of the work spindle and the wheel in parallel relation, the face grinding is accurately produced. In this case the motion of the carriage 16 axially along the guide bar 15 will serve to bring the face grinding wheel toward and from the face of the work, but the actual feed of grinding is preferably produced by axial motion of the spindle which is directly in line with the direction of feed desired.

From the foregoing description of an embodiment of this invention, it should be evident to those skilled in the art that various changes and modifications might be made without departing from its spirit or scope.

I claim:

1. A grinding machine comprising a rotary work support and a rotary grinding wheel spindle mounted for relative traversing motion, means for rotating said work support, means for rotating said grinding wheel spindle, means for adjusting said support and spindle angularly in a plane relative to the line of traverse while each is maintained in position for relative operative traverse, means for moving said spindle axially, and means for moving said spindle laterally of its axis.

2. A grinding machine comprising a rotary work support and a rotary grinding wheel spindle, said spindle being mounted for traversing motion relative to said work support, means for rotating said work support, means for rotating said grinding wheel spindle, means for adjusting said support and spindle angularly in a plane relative to the line of traverse while each is maintained in position for relative operative traverse, means for moving said spindle axially, and means for moving said spindle laterally of its axis.

3. A grinding machine, comprising a rotary work support, means for rotating said work support, a rotary grinding wheel spindle, means for rotating said spindle, means for relatively moving said support and spindle to cause a wheel on said spindle to traverse work on said work support, means for adjusting said work support angularly to thereby adjust its axis of rotation relative to the line of traverse, means for adjusting said spindle angularly in the plane of angular adjustment of said work support and while a wheel on said spindle is maintained in operative traversing relation to work on said work support, means for relatively moving said support and spindle axially of said spindle, and means for relatively moving said spindle and work support transverse to the axis of said spindle.

4. A grinding machine, comprising a rotary work support, means for rotating said work support, a rotary grinding wheel spindle, means for rotating said spindle, means for moving said spindle to cause a wheel on said spindle to traverse work on said work support, means for adjusting said work support angularly to thereby adjust its axis of rotation relative to the line of traverse, means for adjusting said spindle angularly in the plane of angular adjustment of said work support and while a wheel on said spindle is maintained in operative traversing

relation to work on said work support, means for moving said spindle axially, and means for moving said spindle transverse to its axis.

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