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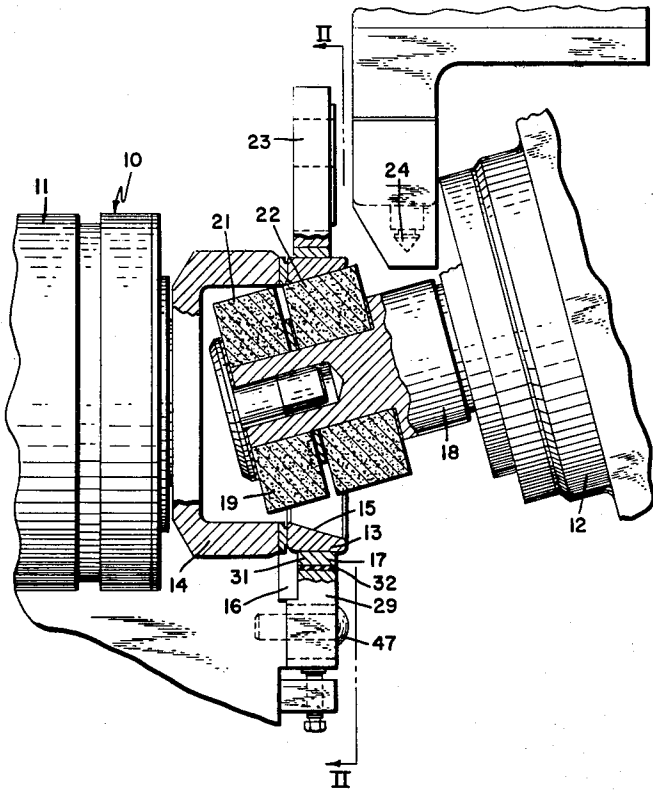
[54] **GRINDING MACHINE**
7 Claims, 3 Drawing Figs.

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51/236
[51] Int. Cl. **B24b 5/00,**
B24b 5/18, B24b 41/06
[50] Field of Search..... 51/236,
238.1, 238, 103; 269/274, 275; 279/1 Q; 82/38, 38
A, 39

[56] References Cited			
UNITED STATES PATENTS			
2,788,216	4/1957	Chasar	279/1 R
3,040,487	6/1962	Kampe	51/238
3,089,291	5/1963	Humes et al.	51/103
3,323,258	6/1967	Terp et al.	51/238.1 X
3,431,681	3/1969	Flohr, Jr.	51/236
3,449,867	6/1969	Lindsay et al.	51/238 X

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ABSTRACT: A grinding machine having fixed contact elements on which the workpiece is supported, the elements including a hardened metal insert floating on an elastomer bed.



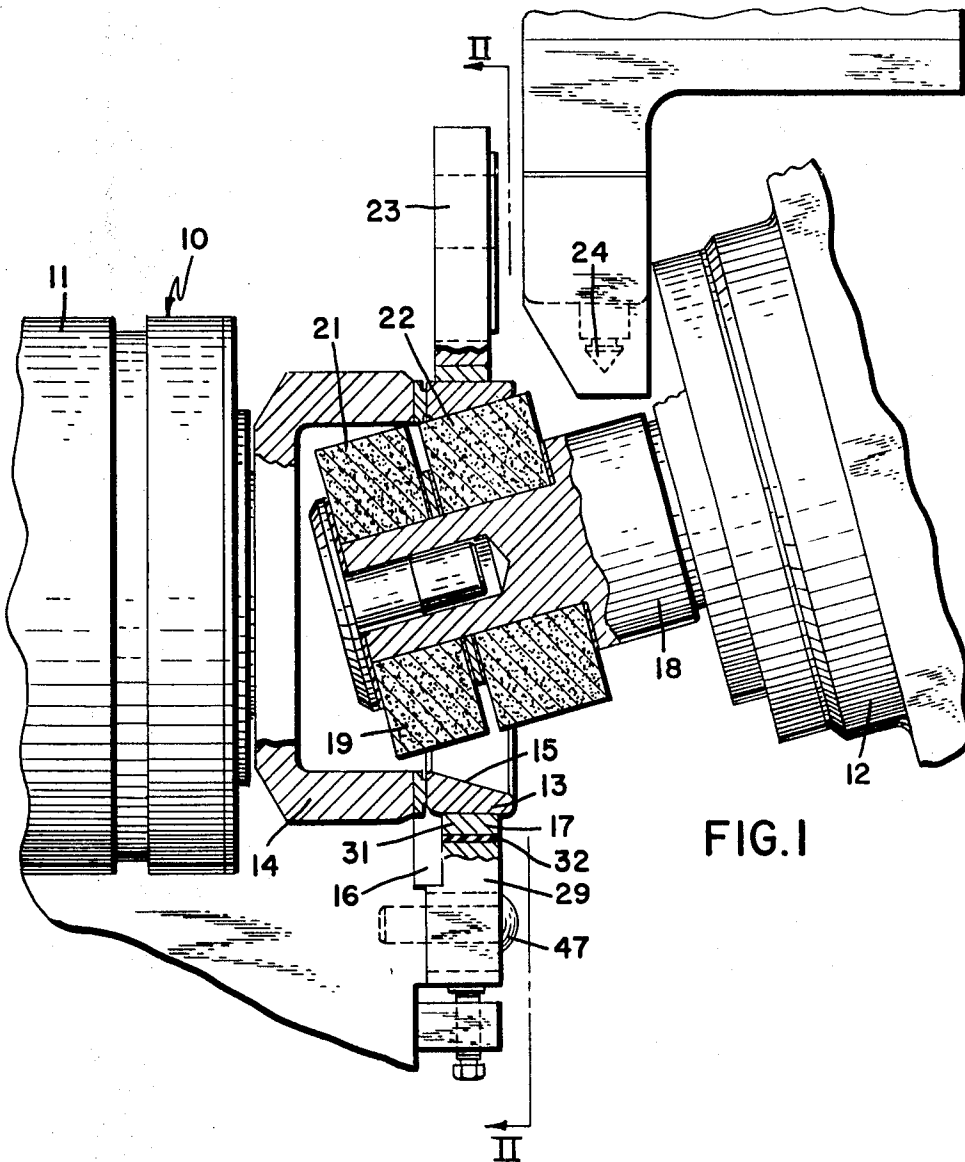


FIG. 1

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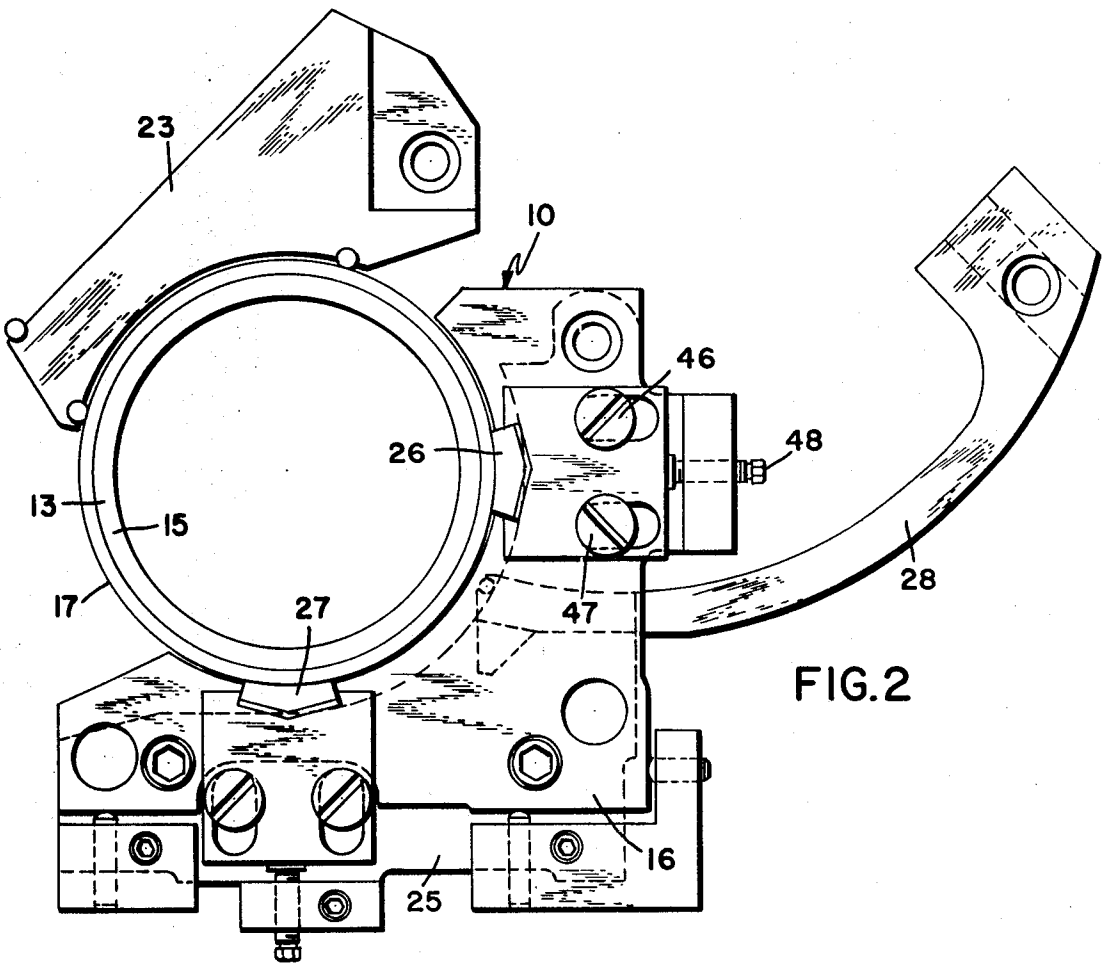


FIG. 2

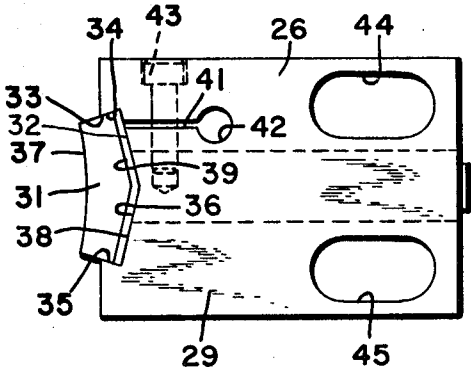


FIG. 3

GRINDING MACHINE

BACKGROUND OF THE INVENTION

In the art of finishing surfaces of revolution of workpieces by the abrasive process, the problem has always existed that the supporting of the workpiece determines, to a great extent, the geometry and quality of the finished surface. The problem has always been particularly acute in the case of the outer race of a ball bearing, where the outer cylindrical surface need not be especially accurate in size, roundness, quality of finish, etc. Nevertheless, this outer surface is the only available to support the workpiece while grinding the inner cylindrical (or tapered) surface which must be finished to a high degree of excellence in every respect. When rollers are used for supporting the workpiece, they roll up and down on the nodes and other inaccuracies on the outer surface of the workpiece, thus causing the defects to be duplicated on the inner surface. Even when fixed shoes with flat surfaces are used as supports, there is line contact between the outer surface of the workpiece, and this also means that the defects of the outer surface are carried over onto the inner surface, sometimes even in amplified form.

In the reissue U.S. Pat. of Blood No. Re.24,202, it was suggested that the workpiece be supported on fixed shoes which have a curved surface closely approximating the curvature of the surface of the workpiece that is to be used for supporting it. It was contemplated that such support shoes would be made of a hard substance, such as tungsten carbide, and this type of workpiece support became quite important commercially. However, attempts continued in the grinding industry to improve the quality of the ground surface even more, and it was found that the use of a block of a tough elastomer, such as a diisocyanate, resulted in an improved surface; this concept was the subject of the U.S. Pat. of Humes No. 3,089,291. Although the resilience of these shoes resulted in an improved surface, there was some tendency to wear, and this has presented some problems in maintaining a predetermined size of ground surface, particularly in a long run on an automatic grinding machine. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a grinding machine for producing a surface of revolution of high quality.

Another object of this invention is the provision of a grinding machine for grinding a surface of revolution on a workpiece while using another surface of revolution to support the workpiece, the apparatus including fixed supporting shoes having a combination of resilience and wear resistance.

A further object of the present invention is the provision of a shoe for a grinding machine which locates the workpiece accurately while, at the same time, preventing duplication of defects from the supporting surface of the workpiece on the surface to be finished.

It is another object of the instant invention to provide a shoe for an internal grinding machine combining the advantages of resilience for good surface finish and resistance to wear for good size repeatability.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

SUMMARY OF THE INVENTION

In general, the present invention relates to a grinding machine consisting of a support element, a hardened metal contact element attached to the support element, and an elastomer material interposed between the two elements. The contact element is in the form of a block of tungsten carbide. The support element is provided with a groove in which the contact element and the elastomer material reside. The elastomer material is in the form of a layer lying between the

bottom of the groove and the corresponding surface of the contact element.

More specifically, the groove is formed with two opposed sides and a bottom; the sides reside at an angle to one another with the wider part at the bottom. The bottom is formed as two flat surfaces forming a wide-angle V, and the adjacent surface of the contact element is similarly formed.

BRIEF DESCRIPTION OF THE DRAWINGS

The character of the invention, however, may be best understood by reference to one of its structural forms, as illustrated by the accompanying drawings, in which:

FIG. 1 horizontal sectional view of a grinding machine embodying the principles of the present invention,

FIG. 2 if a sectional view of the machine taken on the line II—II of FIG. 1, and

FIG. 3 is an enlarged view of a support shoe forming part of the machine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, wherein are best shown the general features of the invention, the grinding machine, indicated generally by the reference numeral 10, having a workhead 11 and a wheel head 12. The workhead and wheel head are mounted in the usual way on a base (not shown) and provided with actuating and control elements normally associated with an automatic internal grinding machine. The workhead 11 serves to support and rotate a workpiece 13 which, for the purpose of illustration, is shown as the outer race of a tapered roller bearing. The workhead is provided with a drive platen 14 which engages a radial end surface of the workpiece to rotate it about the axis of an internal surface 15 of revolution. This surface is in the form of a truncated cone and is the surface to be finished by the abrasion process. Also associated with the workhead is a support means 16 which engages an external surface 17 of revolution of the workpiece; in the case of the roller bearing outer race, the outer surface cannot economically be finished to any degree of fineness (whether it be with regard to its dimension, its roundness, or surface quality) because its only ultimate purpose is as a means of mounting the finished bearing in a machine. In other words, it is logically finished before the inner bore and is considerably rougher in every respect.

A spindle 18 extends from the wheel head 12 and carries an abrasive wheel 19. As illustrated, the wheel has a first portion 21 which is used for a rough grinding operation and a second portion 22 which is used for a finish grinding operation. The portion 22 is shown finishing the conical bore surface 15 of the workpiece. Also forming part of the machine is a locating arm 23 and a diamond dresser 24.

FIG. 2 illustrates the construction of the support means 16 which supports the outer periphery of the workpiece. It consists of a plate 25 which may be fastened to the workhead 11 and which extends around a substantial portion of the workpiece. The plate carries a support shoe 26 which contacts the workpiece at the so-called "three o'clock" position, i.e., directly in line with the grinding pressure of the abrasive wheel on the inner bore of the workpiece. Also carried by the plate is a support shoe 27 which contacts the workpiece at the "six o'clock" portion. The pivoted locating arm 23 positions the workpiece during loading in the shoes 26 and 27. A pivoted ejector finger 28 operates on occasion for unloading on the part of the workpiece between the shoes 26 and 27.

The details of the shoe 26 are shown in FIG. 3. It consists of a support element 29 to which is attached a hard-material contact element 31, there being a layer 32 of elastomer such as polytetrafluorethylene interposed between the two elements. The contact element is in the form of a block of tungsten carbide. The support element is provided with a groove 33 and the contact element and the elastomer layer reside in the groove. The groove is formed with two opposed sides 34 and 35 and a bottom 36. A substantial portion of the contact ele-

ment extends exteriorly of the groove to present a cylindrical surface 37 for engagement with the workpiece. The sides 34 and 35 reside at an angle to one another, such that they are farther apart adjacent said bottom 36. The bottom 36 is formed as two flat surfaces 38 and 39 forming a wide-angle V.

An elongated slit 41 is formed in the support element extending away from the groove and terminating in a bore 42. The slit divides the support element into two parts, and a threaded fastener, such as a cap screw 43, extends between the two parts to draw the sides of the groove closer together to clamp the contact element loosely in place the contact element has a bottom surface opposite the surface 37 and it is shaped as a wide-angled V exactly matching the bottom 36 of the groove, so that the layer 32 of elastomer material is of the same thickness at all points.

The support element 29 is provided with two elongated apertures 44 and 45 by which it is adjustably attached to the plate 25 by use of bolts 46 and 47 (see FIG. 2). An abutment 48 extends from the support element and is contacted by an adjusting screw 48 threadedly mounted in the plate.

The operation of the apparatus will now be readily understood in view of the above description. The workhead 11 serves to rotate the workpiece about the axis of the tapered bore to be finished. Irregularities in the outer surface 17 make themselves felt against the shoes 26 and 27. If these shoes resist the forces brought against them by the irregularities the effect would be to move the workpiece laterally or vertically (depending on which shoe is involved), and this causes the abrasive wheel to press with correspondingly greater or lesser force on the internal bore. However, with the present construction, the increase in force on the contact element due to a protuberance on the outer surface of the workpiece will cause a compression of the elastomer layer 32. Instead therefore, of the shoe pushing the workpiece, the contact element retracts. A proper selection of the thickness of the elastomer layer and its spring constant will result in the absorption of the common irregularities in the O.D. of workpieces, whether these irregularities be poor surface quality; and out-of-round or out-of-square condition, the present of regularly spaced nodes or cusps, protuberances, or hollows. These irregularities are absorbed during the high forces present while rough grinding, yet the shoe must return to its normal position and remain there under the light forces of finish grinding to assure accuracy of part size and taper. The V-shaped arrangement of contact element and groove bottom assures that the grinding of the portion of the element to form the contact surface 37 will not cause breakage due to reaction forces cracking the carbide at a thinner section. In other words, the carbide contact element is substantially the same thickness across its width (from side 34 to side 35), so that dynamic forces will not cause excessive stresses at any particular part.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described,

but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A grinding machine comprising
 - a. a plate adapted to be fastened to a base of the machine and to extend around a substantial portion of a cylindrical workpiece,
 - b. two support elements fastened to the plate at substantially spaced portions of the workpiece, each element having a groove with opposed sides and a bottom, the sides being inclined to one another and farther apart close to the bottom, the bottom being formed as two plane surfaces related in a wide-angled V,
 - c. a carbide contact element for contact with the workpiece associated with the groove of each support element and having sides and a bottom corresponding substantially to the corresponding portions of the groove, and
 - d. a elastomer element interposed between the bottoms of each groove and its contact element.
2. A grinding machine for generating a surface of revolution on a workpiece, comprising
 - a. a base,
 - b. means mounted on the base for rotating the workpiece about the axis of the said surface,
 - c. a support element mounted on the base,
 - d. a hard-material contact element attached to the support element for engaging and supporting the workpiece, and
 - e. an elastomer material layer interposed between the two elements, the support element being provided with a groove and the contact element and the elastomer material residing in the groove, the groove being formed with two opposed sides and a bottom formed as two flat surfaces forming a wide-angled V, a substantial portion of the contact element extending exteriorly of the groove to present an operative surface for engagement with a workpiece.
3. A grinding machine as recited in claim 2, wherein the contact element is in the form of a block of tungsten carbide.
4. A grinding machine as recited in claim 2, wherein the sides reside at an angle to one another, such that they are farther apart adjacent the said bottom.
5. A grinding machine as recited in claim 2, wherein an elongated slit is formed in the support element extending away from the groove and dividing the support into two parts.
6. A grinding machine as recited in claim 5, wherein the slit terminates at the end away from the groove in a bore extending through the support element and wherein a threaded fastener extends between the two parts separated by the slit to draw the sides of the groove closer together to clamp the contact element loosely in place.
7. A grinding machine as recited in claim 2, wherein the elastomer material is in the form of a layer lying between the bottom of the groove and the corresponding surface of the contact element.