Jan. 16, 1962 R. G. ELLIS 3,016,662

BALL HONING TOOL

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Fig. 1.

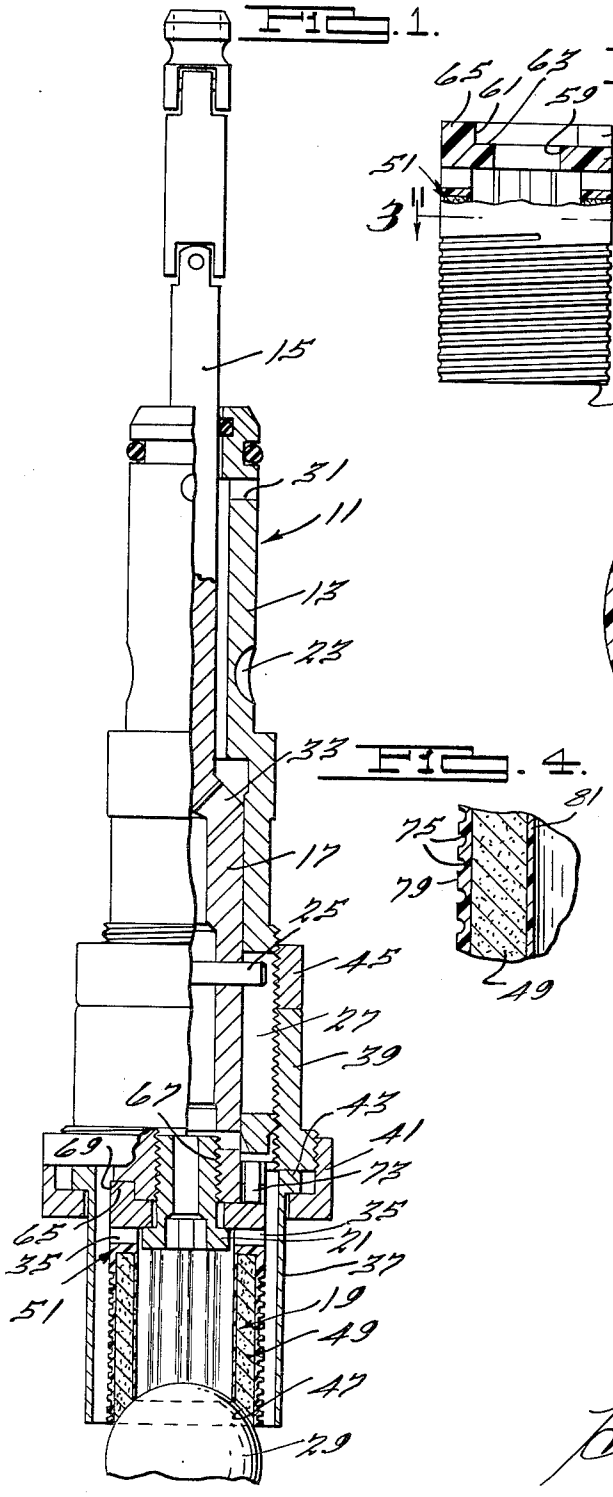


Fig. 2.

Fig. 3.

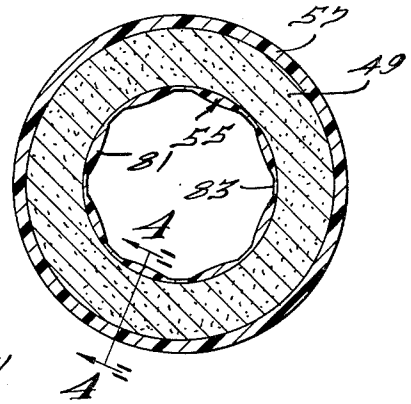
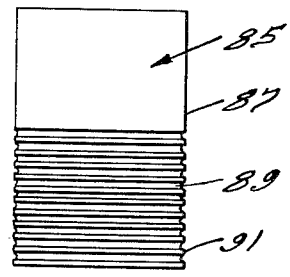


Fig. 4.

Fig. 5.



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BALL HONING TOOL

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This invention relates to grinding or honing tools and more particularly to a honing element for honing spherical surfaces on workpieces.

It is an object of the present invention to provide a honing element for the honing of spherical surfaces in which a tubular abrasive stone is provided with a non-abrasive supporting shell intimately engaged therewith which is of sufficient strength and thickness to fully support the stone against cracking, yet which will evenly abrade or peel away with the abrasive material at the working surface thereof during the course of the honing operation.

It is another object of the present invention to provide a honing element of the above character which may be easily and positively positioned in a honing tool and which permits substantially complete use of the abrasive material in the honing element.

It is a further object of the present invention to provide a honing element of the above character which is relatively inexpensive to manufacture, economical to use, and rugged in construction.

It is still another object of the present invention to provide an abrasive element having a tubular abrasive core reinforced by non-abrasive inner and outer supporting shells which may be manufactured in a manner assuring perfect concentricity of the supporting walls with the tubular abrasive core.

These and other objects of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a view partly in section and partly in elevation of a honing tool and honing element embodying the principles of the present invention;

FIG. 2 is an enlarged elevational view, partly in section, of the honing element illustrated in FIG. 1;

FIG. 3 is a sectional view of the structure illustrated in FIG. 2 taken along the line 3—3 thereof;

FIG. 4 is a fragmentary sectional view of the structure illustrated in FIG. 2 taken along the line 4—4 thereof; and

FIG. 5 is an elevational view of structure similarly illustrated in FIG. 2 showing another form of the invention.

Referring now to the drawings, FIGURE 1 illustrates a typical honing tool 11 on which the honing element of the present invention may be used. The honing tool includes a hollow rotatable drive shaft 13 within which an actuating rod 15 is positioned for axial movement. The actuating rod 15 has a hollow lower portion 17 to which the honing element of the present invention, identified by the number 19, is secured by a hollow screw 21. The honing tool is supported and driven by a honing machine (not shown) and the drive shaft 11 is provided with a plurality of spherical sockets 23 about its periphery which are engaged by suitable driving balls (not shown) of the honing machine for the purpose of transmitting rotary power to the honing tool. A driving connection is provided between the drive shaft 13 and the actuating rod 15 by means of a torque pin 25 extending through the lower actuating rod portion 17 and into diametrically opposed slots 27 formed in the drive shaft 13. During the rotation of the honing tool the actuating rod

15 is advanced axially toward the workpiece 29 to compensate for the material abraded away from the honing element 19 and in order to maintain constant abrading pressure. During the axial advancement of the drive shaft 13 the pins 25 are free to move downwardly in the slots 27.

In the course of the honing operation coolant is admitted into the honing tool through a plurality of inlet ports 31 in the drive shaft 13 and flows downwardly in the tool through an annular cavity formed between the drive shaft 13 and the actuating rod 15. The coolant then flows into the hollow lower portion 17 of the actuating rod through a plurality of apertures 33 formed therein, through the hollow screw 21, and thence into the hollow honing element where it comes in contact with the workpiece 29. Inasmuch as the coolant is under pressure, a pair of diametrically opposed ports 35 are formed in the honing element to relieve the fluid pressure and permit the outward flow of coolant. To prevent the random spraying of the coolant out of the outlet ports 35 a shield or shroud 37 is spacedly positioned around the honing element 19 and is supported in that position by an internally threaded sleeve 39 threaded onto the lower end of the drive shaft 13. A collar 41 is threaded onto the lower end of the drive sleeve 39 and holds an outturned flange 43 formed on the upper end of the shield 37 to the sleeve 39. The shield 37 may be axially adjusted by rotation of the sleeve 39 which may be secured in place by a lock nut 45. During the course of the honing operation, not only is the honing tool rotated but the workpiece 29 is also rotated in a manner assuring uniform abrasive contact of the honing element 19 over the entire spherical surface to be honed. A typical workpiece consists of a stud having a segmentally spherical head and the shank of the stud may be easily fixtured and rotated for this purpose.

The honing element 19 is of generally hollow cylindrical or tubular construction and is consumed in the honing operation by being abraded or worn away from its concave lower end 47 which forms the working surface of the element. The honing element is composed of a hollow cylindrical stone 49 of bonded abrasive material disposed within a molded supporting body 51 of rigid, non-abrasive material. The abrasive material may be of any suitable commercially available type such as silicon carbide grit bonded in a vitrified matrix. Another type of abrasive material which has been found particularly successful is one consisting of grains of silicon carbide, aluminum oxide or other suitable grit dispersed in a carbon-graphite matrix. The body 51 may be molded from any suitable, rigid non-abrasive material. A variety of synthetic resins, such as alkids or phenolics, having fiber glass fillers have been found to be satisfactory for this purpose.

The detailed construction of the body 51 may be clearly seen in FIGS. 2, 3 and 4, wherein the body is shown as being provided with a base portion 53 from which an integral inner annular supporting wall 55 and a concentric outer supporting wall 57 extend in intimate engagement with the stone 49. The base portion 53 is provided with a central bore 59 which is counterbored at 61 to form a flat annular shoulder 63 and an upstanding annular wall 65. As may be seen in FIG. 1, the screw 21 passes through the bore 59 and is threaded into the hollow lower end of the actuating rod portion 17 at 67, holding the annular wall 65 securely against a peripheral shoulder 69 formed on the lower end of the actuating rod portion 17. In order to drivably connect the honing element to the actuating rod for co-rotation a radial slot 71 is formed in the wall 65 to receive a pin 73 carried by the actuating rod portion 17.

The concentric annular inner and outer supporting wall

portions 55 and 57, respectively, serve to reinforce and support the stone 49 against the pressures created by the honing element being forced against the workpiece. Particularly strong pressures are developed laterally outwardly of the stone which might crack the wall of the stone if it were unsupported. For this reason the outer wall 57 must be of substantial thickness and strength to resist such forces. On the other hand, the outer wall must be of such a character as to abrade or peel away with the stone 49 during the honing operation. As is well known in the honing art, the dulled pieces of grit on the working face of the stone wear away during the honing operation, thereby continuously reducing the length of the stone. If that portion of the non-abrasive outer supporting wall 57 in engagement with the workpiece were not also continuously reduced in length, the supporting wall 57 would soon extend beyond the working surface of the stone and tend to hold the stone away from the workpiece. To assure the continuous wearing away of the thick outer wall 57, a plurality of closely spaced grooves 75 are formed in the periphery of the outer wall 57 from the lower end 77 thereof up to just short of the upper end of the stone 49. In the form of the invention illustrated in FIG. 2, the grooves 75 are of continuous thread or helical form. The spaces between the grooves 75 are the normal thickness of the wall and by comparison to the grooves 75 may be described as ridges 79. The thread form of the grooves 75 assures that some part of the groove will always be in engagement with the workpiece. The outer wall being thinner at the groove will more easily abrade or break away at that location. During the honing operation this groove location continuously moves around the circumference of the working surface of the stone in engagement with the workpiece. Yet the thicker portion of the outer wall 57 represented by the ridges 79 remains in sufficiently close proximity to the working surface of the stone to fully reinforce it against breakage. While the overall dimensions of the wall 57 and the groove 75 may be altered within substantial limits depending upon the character of the honing operation, the strength of the material used in the body member 51 and the type of abrasive material in the stone 49, it has been found that for most uses an outer wall 57 of forty-thousandths of an inch thickness having a groove 75 of twenty-thousandths of an inch in depth will produce the desired results and assure that the outer wall 57 will progressively peel or break away around the circumference thereof in engagement with the workpiece.

Inasmuch as the downward pressure of the honing element on the spherical workpiece creates radially outwardly directed forces, most of the pressure is received by the outer wall 57 and the inner wall 55 need not be as thick. Thus, the inner wall 55 need be no greater than the thickness of the outer wall 57 at the bottom of the grooves 75; e.g. twenty-thousandths of an inch in the example given. In order to facilitate the breakdown of the inner wall at the working surface and also to enhance the molding of the honing element, the inner wall 55 is made polygonal in shape, such as by having the eight sides 81 as illustrated in FIG. 3. Portions 83 of extreme thinness, as for example of only several thousandths of an inch, are formed between each of the sides 81. By this means the die core which is used to form the inner wall 81 will serve to center the abrasive cylindrical stone 49 in the die and assure concentricity of the walls 55 and 57 with the stone 49.

Another form of the invention is illustrated in FIG. 5, wherein a honing element 85 is provided with a non-abrasive body 87 identical to the body 51 illustrated in FIG. 2, except that it has a plurality of closely spaced separate and parallel annular grooves 89 formed around its periphery. Thus, a series of separate ridges 91 are formed between the grooves 89, which are of sufficient strength to reinforce the stone against breakage, while the grooves provide locations at which the outer wall

may easily abrade and break away. As the working surface of the stone wears down, tending to place greater working pressure on the lowermost of the ridges 91, the lowermost ridge 91 will eventually break away by breaking of the wall in the groove 89 immediately thereabove. However, the next ridge remaining on the outer wall is in sufficient proximity to the working surface of the honing element to support and reinforce the abrasive material against cracking.

The honing element of the present invention is preferably made by first bonding or molding the stone 49 into its cylindrical form. The formed stone is then placed around a cylindrical core of polygonal cross-section in a die cavity. The longitudinally extending corners between the sides of the core are in such close proximity to the inner surface of the stone as to correctly position the stone within the dies and assure the concentricity of the inner and outer supporting walls thereto. The plastic material is then injected into the dies and the molding is carried out in usual manner. While the grooves 75 or 89 may be directly molded in the outer wall, it has been found commercially expedient to mold the body member with a smooth outer supporting wall and thereafter machine the grooves therein. However, the grooves may be formed in the outer supporting wall in any commercially satisfactory manner.

While it will be apparent that the preferred embodiments herein demonstrated are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. A honing element comprising a hollow cylindrical abrasive stone, a reinforcing wall in intimate engagement with the outer periphery of said stone leaving at least one end of stone exposed, said stone having an inner reinforcing wall portion in engagement with the inner periphery of said stone, said outer wall having a plurality of closely spaced grooves disposed adjacent to the exposed end of the stone.

2. A honing element comprising a hollow cylindrical abrasive stone mounted in an integral rigid synthetic resin base supporting body having a base portion provided with means for securing the honing element to a honing tool, an annular outer supporting wall portion surrounding said stone in intimate engagement therewith, and an inner supporting wall portion in engagement with the inner periphery of said stone, said outer supporting wall portion having a plurality of spaced grooves formed therein disposed substantially laterally of the cylindrical length of said stone.

3. A honing element comprising a hollow cylindrical abrasive stone mounted in a rigid non-abrasive supporting body, said supporting body having an annular outer supporting wall portion intimately engaging the outer periphery of said stone and a hollow cylindrical inner supporting wall portion, said outer supporting wall portion having a plurality of closely spaced grooves formed around the periphery thereof and said inner supporting wall portion having a cross-sectional shape which is polygonal at its inner diameter.

4. A honing apparatus including a honing tool having an axially feedable member provided with a hollow end portion, a honing element secured to the terminus of said hollow end portion, means for supplying rotary power to said axially feedable member, said honing element having a tubular abrasive stone mounted in a rigid non-abrasive supporting body provided with an apertured base portion and an annular outer supporting wall portion in intimate engagement with the periphery of said stone, said outer supporting wall portion having a plurality of closely spaced grooves formed therearound, and an apertured fastener extending through the aperture of said base portion operable to secure said honing element to said axially

feedable member and to provide a fluid passage for honing coolant from within the hollow end portion of said axially feedable member to the interior of said honing element.

5. The method of honing a spherical workpiece surface which includes; rotating the concave end of a tubular abrasive stone over the substantially spherical surface of a workpiece as it is rotated, the outwardly directed wedging pressure at the working end of the stone being resisted by an outer wall which wears slower than the stone wears but which progressively breaks away as wear within the stone end occurs.

6. A honing element including a tubular abrasive stone, a reinforcing outer wall of resin material disposed about said stone in intimate engagement with the outer periphery thereof leaving one end exposed, said reinforcing outer wall being provided on the outer surface with alternately thin and thick annular sections adjacent to the exposed end of the stone.

7. A honing element comprising a hollow cylindrical abrasive stone, a reinforcing wall in intimate engagement with the outer periphery of said stone leaving at least one end of the stone exposed, said stone having an inner reinforcing wall portion in engagement with the inner periphery of said stone, the reinforcing inner and outer wall portions and the stone therebetween being substantially of concave spherical section.

8. A honing element comprising a hollow cylindrical abrasive stone mounted in a body of rupturable material, said stone having a recess at one end of truncated spherical shape for abrading a spherical section of a workpiece, said supporting body having an annular outer supporting wall portion extending into said exposed end and surrounding said abrasive stone in intimate engagement therewith, said outer supporting wall portion having a plurality of ring sections separated by annular grooves which extend part way into the material of the wall portion and cause the fracture of the lowermost ring section as abrading occurs.

9. The structure as set forth in claim 8 wherein said grooves are separate and annular in form to provide ring sections with weakened wall portions therebetween.

10. The structure as set forth in claim 8 wherein said grooves are continuous to provide a thread with a weakened wall portion between the turns thereof.

11. The structure as set forth in claim 8 wherein said grooves are of a depth of substantially one-half the thickness of the material of said outer supporting wall portion.

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