United States Patent

Giardini

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[54] ARRANGEMENT FOR INTERNAL FORM GRINDING PORTIONS OF SPHERICAL SURFACES

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[52] **U.S. Cl.** .....**51/73 R,** 51/105 R, 51/204, 51/267, 51/289 R, 51/356

[51] **Int. Cl.** **B24b 7/00**

[58] **Field of Search** .....51/105 R, 73 R, 356, 289 S, 51/289 R, 267, 204

[56] **References Cited**

UNITED STATES PATENTS

3,353,303	11/1967	Stern	51/105 R
3,200,540	8/1965	Lavallee	51/73 R
2,380,332	7/1945	Scheer	51/267
3,110,993	11/1963	Grage	51/267

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[57] **ABSTRACT**

An arrangement for high speed lap grinding ball rod ends and the like including an annular grinding wheel having an internal semicircular groove extending about its inner periphery, while the workpiece is mounted for rotation at a skewed angle to the axis of the grinding wheel and extends into the peripheral groove so as to create a form grinding action with cross grinding. Lubricant is supplied to the internal groove to provide lubricating fluid under pressure in the grind zone, trapped by an external housing surrounding the wheel, which also serves as a safety retainer therefor.

6 Claims, 2 Drawing Figures

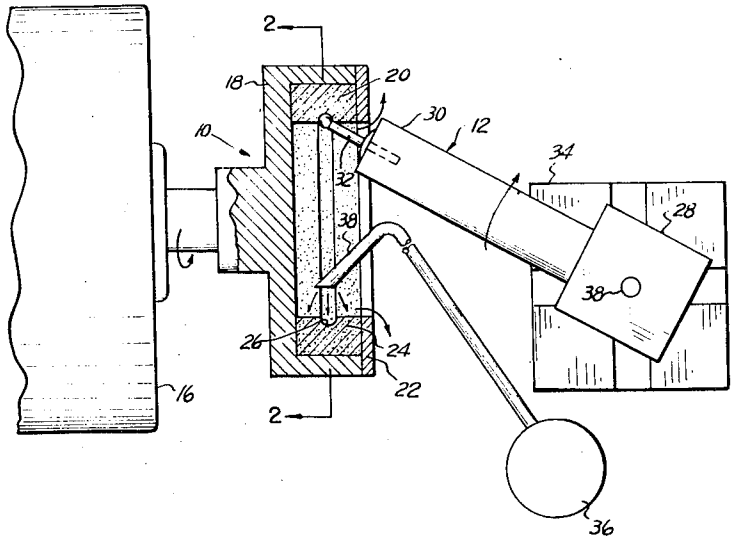
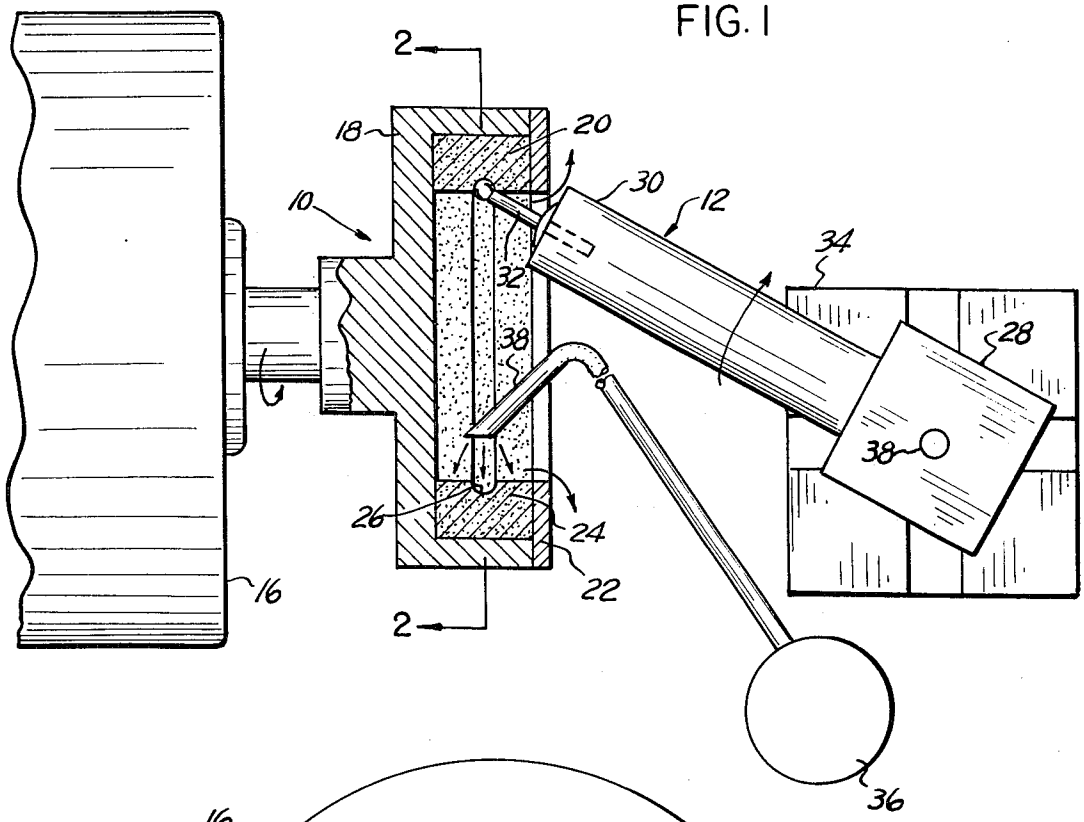


FIG. 1



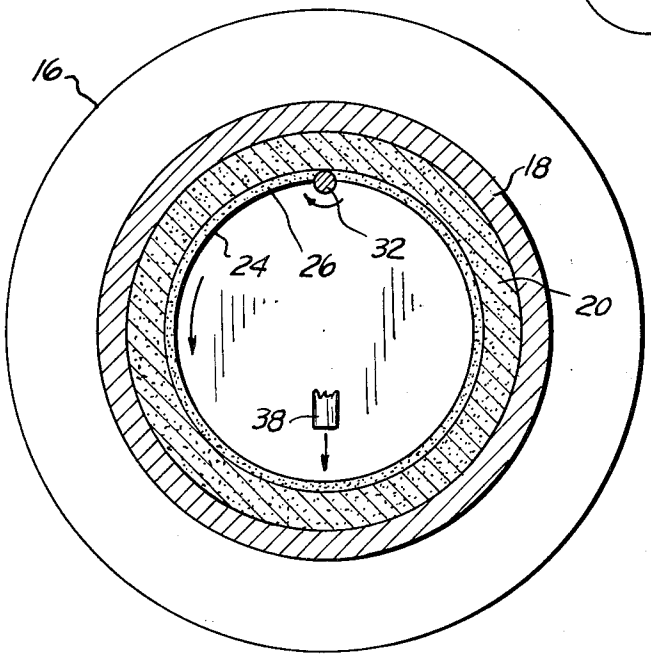


FIG. 2

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ARRANGEMENT FOR INTERNAL FORM GRINDING PORTIONS OF SPHERICAL SURFACES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention concerns grinding and more specifically form lap grinding of partial spherical surfaces.

2. Description of the Prior Art

Grinding portions of spherical surfaces, particularly on workpieces such as piston swivel rod ends for pumps, etc., has in the past been limited to arrangements involving point contact between the abrading member and the workpiece, with some means for generating a portion of a spherical surface by relative rotation therebetween. An example of this arrangement being shown in U.S. Pat. No. 2,982,057. This approach has not been successful in finish grinding, however, due to the nature of the grinding action, and a lapping step is usually required subsequent to the grinding operation to obtain highly finished surfaces. In addition, the grinding operation itself is relatively time consuming since the surface must be generated and requires relatively complex apparatus.

Form grinding of ball rod ends in which a semicircularly shaped groove in the grinding wheel is used while potentially shortening the grinding operation has been considered impractical since the large contact area between the grinding wheel and the workpiece creates problems of lubricant starvation and consequent burning of the part surface. In addition, variations in the ground surface are normally encountered due to variations in the grinding action around the periphery of the form shape, as the grind pressure necessarily varies, in turn leading to the need for a finish grinding or lapping operation subsequent to the grinding operation.

Hence, it is an object of the present invention to provide a method and apparatus for form grinding portions of spherical surfaces without surface burning and to surface finishes as fine as 4 rms or better in one operation.

SUMMARY OF THE INVENTION

This object and others which will become apparent upon a reading of the following specification and claims is accomplished by skewing the axis of rotation of the workpiece with respect to the axis of rotation of the grinding wheel, and providing the grinding wheel with a semicircular groove formed in an internal surface thereof to receive the portion of the workpiece to be ground. The grinding wheel is encased about its periphery with a housing so that lubricant supplied to the internal surface is trapped by the centrifugal action of the wheel to insure high pressure lubrication in the grind zone. The housing also prevents centrifugal disintegration of the wheel to provide an added safety feature.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevational view in partial section of the grinding arrangement according to the present invention.

FIG. **2** is a view of the section taken along line **2—2** of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following detailed description, certain specific terminology will be utilized for the sake of clarity and a specific embodiment described in order to provide a complete understanding of the invention, but the invention is not so limited and may be practiced in a variety of forms and embodiments.

Referring to the drawings, and particularly FIG. **1**, the wheel head assembly **10** is shown as well as the workhead assembly **12** and the lubricant supply stream **14**.

The wheel head assembly **10** includes a drive motor **16** drivingly connected to a housing **18**, which contains a grinding wheel **20**, retained therein by an end plate **22** secured to the housing **18**.

The grinding wheel **20** has formed therein an internal surface **24**, a semicircular groove **26**, of the particular appropriate dimensions to produce the part to be ground. In order to true this surface periodically after successive grinding cycles, a complementary crush roller and appropriate support and drive arrangements (not shown) may be provided in the manner well known in the art.

The work head assembly **12** includes a work drive motor **28** and attached workholder **30**, supported so that the axis of rotation thereof is skewed with respect to the axis of rotation of the grinding wheel **20**. The work holder **30** is adapted to receive a workpiece **32** to be ground and hold it in registry with the groove **26** during the grinding operation.

In connection with this, a feed traversing support **34** and pivot **35** for the work head assembly **12** is provided to allow the workpiece **32** to be aligned and fed into contact with the semicircular groove **26**, in a manner well known in the art in other form grinding arrangements.

The lubricant supply **14** includes a source of filtered lubricant **36** supplying a nozzle **38** which is situated to direct lubricant into the surface **24** and groove **26**. Both the cooling and lubricating needs may be supplied by the lubricant system **14**, and the volume and characteristic of the fluid supplied may be selected to be suitable for both these purposes.

In operation, the drive motor **16** is operated at 10–15,000 rpm, and the rotating workpiece **32** is advanced into the grinding wheel **20**. Since the respective axes are skewed with respect to each other, it can be seen that a cross grinding action occurs and each point on the ground surface is ground by each portion about the groove **26** in a rapidly shifting pattern due to the high speed of the drive motor, so that the net effect is a uniformly finished workpiece of a very fine surface finish — on the order of 4 rms obtainable.

The lubricant is absorbed by the grinding wheel voids and distributed therethrough by centrifugal force until the voids are saturated and further penetration thereof is precluded by the housing **18**. At this point, the excess lubricant spills over the edge as indicated to be collected for return to the source **36**.

The centrifugal force maintains the lubricant in the grind zone at a considerable pressure, since the groove **26** acts as a lubricant channel to tend to retain the lubricant therein, hence insuring that the lubricant will be present throughout the grind zone and eliminating the surface burn and chatter problems normally occurring in this situation due to lubricant starvation.

In addition, as discussed at length in copending application Ser. No. 48,355, entitled, "Method and Apparatus for Internal Plunge Grinding" substantial occlusion of the grinding wheel voids results in exclusion of atmospheric oxygen, lessening the wheel fouling problem occurring as a result of chemical bonding between the grinding wheel base material and the workpiece material.

Hence, the portion of the spherical surface may be ground from rough to finish in one operation, with a very fine surface finish obtainable without the need for complex or precision apparatus.

What is claimed is:

1. Apparatus for grinding partially spherical surfaces on a workpiece comprising:

a grinding wheel having formed therein a circular internal surface extending about the axis of rotation of said grinding wheel;

a form contoured into said internal surface extending about said axis of rotation and being at least partially circular in cross section;

means for rotating said grinding wheel about said axis;

workholder means for positioning a workpiece in said form;

means rotating said workpiece about an axis skewed from said grinding wheel axis while said workpiece is positioned in said form and during rotation of said grinding wheel, whereby continual cross grinding of the workpiece to said form is accomplished.

2. The apparatus of claim 1 wherein said form comprises a channel extending about said internal surface and further including means for directing lubricant into said channel.

3. The apparatus of claim 2 further including a housing member surrounding said grinding wheel member about its periphery.

4. The apparatus of claim 3 wherein said housing extends about the sides of said grinding wheel extending radially inward at least to level of said inner surface.

5. The apparatus of claim 4 further including means for directing a liquid into said channel, whereby after saturation of said grinding wheel voids with said liquid said housing prevents further migration of said liquid away from said channel to provide high pressure lubrication in the zone of grinding activity.

6. Apparatus for form grinding a workpiece comprising:

a grinding wheel mounted for rotation about an axis and having a form contoured on an inner surface and shaped to tend to retain fluid therein during rotation of said grinding wheel;

housing means encasing said grinding wheel periphery extending radially inward to said inner surface;

means for directing lubricant into said form;

means for advancing a workpiece into said form, whereby said workpiece is ground to said form by said grinding wheel contour.

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