United States Patent

[11] 3,589,071

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[54] **SURFACE POLISHING APPARATUS AND METHOD THEREFOR**
6 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **51/7,** 51/284, 51/317
[51] **Int. Cl.** **B24b 19/00**
[50] **Field of Search** 51/7, 17, 59, 284, 317, 318, 283, 281

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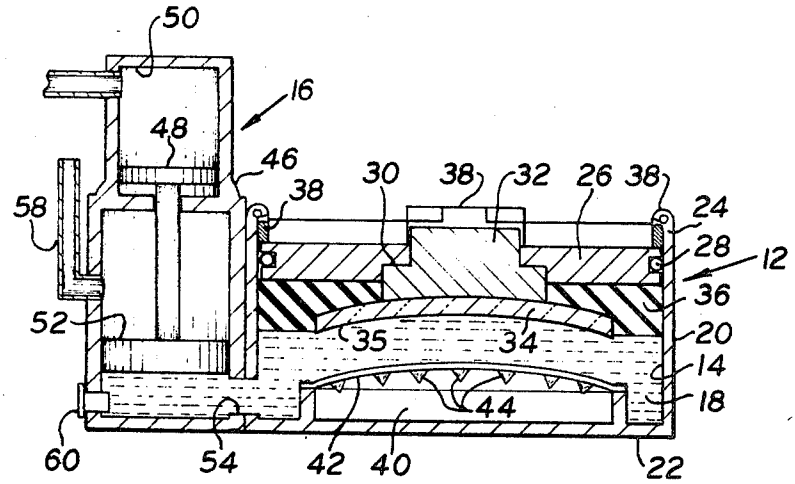
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ABSTRACT: An apparatus and method utilizing a polishing slurry for fine polishing of articles as lenses or the like, in the operation of which the slurry, with its abrasive or polishing particles suspended therein, is initially confined under pressure against the article surface to be polished and then subjected to vibratory movement which causes polishing movement of the slurry polishing particles over this article surface and thus uniform polishing thereof.



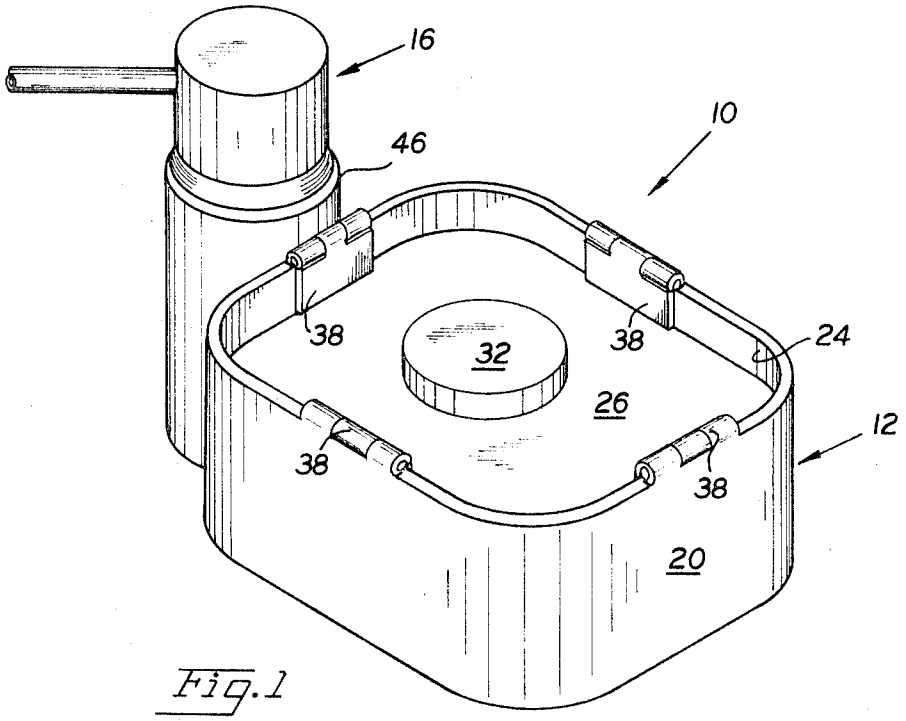


Fig. 1

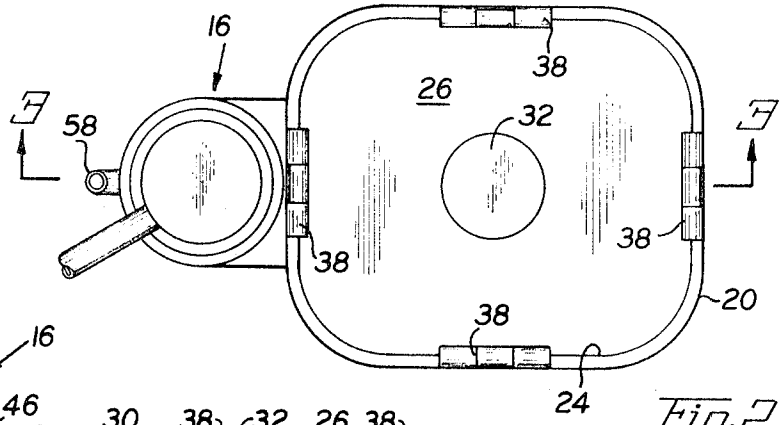


Fig. 2

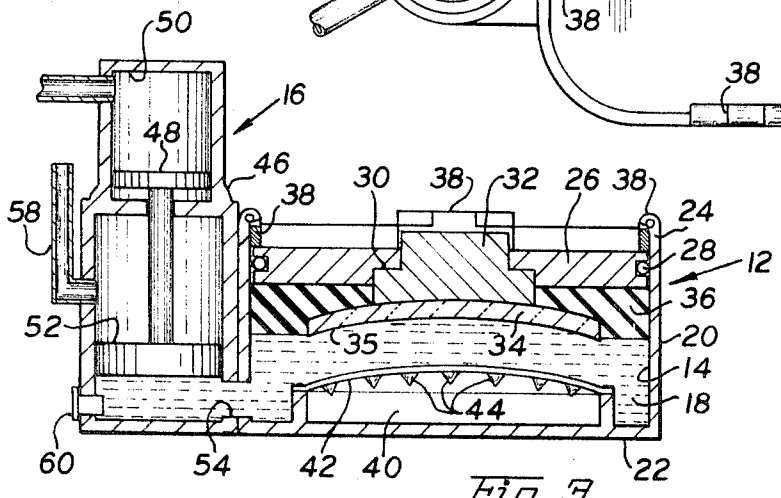


Fig. 3

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SURFACE POLISHING APPARATUS AND METHOD THEREFOR

The present invention relates generally to ultrasonic polishing techniques, and more particularly to improvements in apparatus and method utilizing ultrasonic vibration and a polishing slurry for fine polishing of articles as lenses and other accurately generated surfaces.

It is already well known, according to U.S. Pat. No. 3,154,890 issued to J. H. Lemelson and similar patents, how to achieve a polishing function utilizing vibration and a polishing slurry. Generally, the polishing slurry, which contains abrasive or polishing particles, is flowed into contact with and thus against and progressively along the surface to be polished and consequently causes polishing thereof. To intensify this polishing action, which otherwise would be too time consuming to be commercially practicable, ultrasonic vibrators or transducers are used to cause vibration in the flowing slurry and have been found to effectively accelerate the polishing. The adaption of the foregoing for fine polishing of articles, as lenses or other accurately generated ophthalmic surfaces, is not entirely satisfactory, however, since uniform polishing is not always achieved. Specifically, it is believed that the area of the surface against which the slurry initially impinges is subjected to a more vigorous polishing action than other areas, and that this contributes to nonuniform polishing. Another contributing factor is the existence of air bubbles in the flowing slurry which, in an obvious manner, interferes with the polishing action of the slurry and results in the production of aberrations in the finished surface.

Broadly, it is an object of the present invention to provide an improved surface polishing apparatus and method overcoming the foregoing and other shortcomings of the prior art. Specifically, it is an object to provide a vibratory apparatus utilizing a polishing slurry in the mode of operation of which the slurry has an effective polishing action.

A surface polishing apparatus demonstrating objects and advantages of the present invention includes means defining a polishing chamber about a surface to be polished and means for admitting and nonflowingly confining under pressure, a polishing slurry in such chamber to thereby establish void free contact against the surface. Thereafter, vibratory devices such as transducers, are operated to cause impingement of the abrasive or polishing particles of the slurry against the surface which results in polishing thereof. By avoiding flow of the slurry during the polishing operation and relaying on void free pressurized impingement, it has been found that effective, uniform polishing results.

The above brief description, as well as further objects, features and advantages of the present invention, will be more fully appreciated by reference to the following detailed description of a presently preferred, but nonetheless illustrative embodiment in accordance with the present invention, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a surface polishing apparatus in accordance with the present invention;

FIG. 2 is a plan view illustrating additional structural features thereof; and

FIG. 3 is a side elevational view, in section taken on line 3–3 of FIG. 2, illustrating internal structural features thereof.

Reference is now made to the drawings wherein there is shown a surface polishing apparatus, generally designated **10**, demonstrating objects and advantages of the present invention. Apparatus **10** includes two major components. The first is a housing structure generally identified **12** which, as best shown in FIG. 3, defines an internal chamber **14**. The second is a pressure applying device or cylinder generally identified by numeral **16** effective to apply pressure to a fluid medium which is caused to flow, preparatory to operation of the surface polishing apparatus **10**, from the pressure applying device **16** into the chamber **14**. MOre specifically, the referred to medium will be understood to be a conventional polishing slurry consisting of a fluid body and abrasive or polishing particles suspended in such body, the fluid body and said particles being individually and collectively designated **18**.

As generally understood, the polishing slurry **18** is a material well known for its polishing action during movement relative to a surface to be polished. Also, as is generally well understood, the referred to polishing function is limited to the smoothing and, as in the case of ophthalmic media, the creating of transparency in a lens surface or the like article which has previously been produced by a fine grinding or other such operation. Thus, the polishing slurry **18** heretofore and in the present application is not intended to nor is it used to generate the lens or a similar surface but rather only to produce a fine polishing thereof. As will be explained in greater detail herein, apparatus **10** is effective in achieving this fine polishing of lenses or other such accurately produced surfaces in a uniform manner and without causing undesirable excessive reduction in any localized area of the surface.

Turning now more specifically to the construction of the apparatus **10**, in a preferred form as illustrated, the housing structure **12** includes a generally cylindrical upstanding wall **20**, a bottom wall **22** and a top opening **24** of a size which accommodates, in a snug or force fit, a cover member **26** having an annular sealing ring **28** rendering the chamber **14** fluid tight. Cover member **26** has a central counterbore **30** which accommodates a holding member **32** which, in turn, is appropriately attached either adhesively or by suction to an article such as a lens **34** whose surface is to be fine polished. An elastomeric member **36** is advantageously placed between the article, here shown as a lens **34** and the cover **26** to absorb an excessive vibrational shock as may be transmitted during operation of the apparatus **10**. After the lens **34** is positioned and supported in the manner illustrated in which it, in effect, constitutes the upper wall bounding the chamber **14**, inadvertent removal of the cover **26** is prevented by dropping down the hinged holding elements **38** spaced circumferentially and located about an upper lip formed about the cylindrical wall **20**.

Located opposite the lens **34**, in its operative position as just described and in a slightly elevated position from the bottom wall **22**, is a housing including an upper wall **42** in which there is appropriately operatively arranged plural transducers, individually and collectively designated **44**. As is generally understood, the transducers **44**, in response to electrical energization, are effective in producing vibrations in a range and at a frequency which could be ultrasonic.

The pressure applying device **16** includes an outer housing **46** conveniently shown to be formed as a cylinder for a piston **48** which, in response to pressure fluid injected in any well known manner into an upper chamber **50**, has a lower piston head **52** which forces the polishing slurry **18** through a port **54** into the space or chamber **14** adjacent the lens surface **35**. Specifically, the extent of pressure applied by the piston **48** is such that the polishing slurry **18** completely fills the chamber **14** such that the upper surface of the slurry, in response to the applied pressure, is forced into intimate overall full surface contact with and against the downwardly facing adjacent surface **35** of lens **34** it being understood that this is the surface requiring fine polishing. It has been found that by confining the slurry under pressure within the space defining the chamber **14** adjacent the surface **35**, the slurry is nonflowing and in pressurized void free contact with the surface. Thus, the pressurized slurry **18** is free of any air bubbles or other voids throughout its contact with the lens surface **35**. The presence of bubbles or voids results in uneven polishing. The void free contact between the slurry and lens surface obviates unequal polishing and undesired aberrations. The result is a full, even and uniform fine polishing of the lens surface **35**. Completing the construction of the pressure applying device **16** is a feed tube **58** for supplying and/or increasing the volume of the bubble free polishing slurry **18** and also a plug **60** for draining the apparatus **10**.

After attaining the condition of the apparatus **10** as depicted in FIG. **3**, it is contemplated that the polishing operation will be commenced with the electrical energization of the transducers **44**. The ultrasonic vibrations of the transducers are transmitted directly to the confined slurry toward which the same are directed and whose polishing particles are pressurized into voidless contact with the lens surface. In response to this vibratory motion, the abrasive or polishing particles of the slurry come into direct physical abrading contact with the lens surface **35** and produce a fine, even and uniform polishing of this surface.

This is in contrast to the prior art use of a polishing slurry which is caused to flow against and along a surface to be polished and relies on this relative movement of the abrasive portion of the slurry to achieve the necessary polishing function. In accordance with the present invention, the polishing slurry **18** does not flow dynamically relative to the lens surface **35** but the vibratory motion induced in such slurry has nevertheless been found to be effective in causing the abrasive particles suspended in the polishing slurry **18** to impinge upon and thereby cause even and uniform polishing of the lens surface **35**.

Thus the present invention discloses a unique apparatus and method of fine polishing the surface of an article. Although the apparatus here shown has been disclosed for use in connection with a concavely shaped lens surface of simple or compound contour, the invention is not to be so limited. It will be recognized that the surface **35** could be convex, of a simple or compound contour, or it could be flat or substantially planar. Thus the arrangement of structure of the apparatus may need to be varied in simple details in order to enable its use and operation with articles whose shapes differ from that of the article **34** here enclosed. It is to be recognized, therefore, that the apparatus shown and the article **34** treated in this disclosure, are merely for illustrative and explanatory purposes only.

It is to be understood that an apparatus having different structural details may be utilized provided the same supports the article whose surface is to be polished in such manner that the surface is exposed adjacent to a space within which the polishing slurry is confined and with which it is in a nonflowing, void free contact, whereby the slurry is able to be placed under pressure to assure the even, uniform, fine polishing of the surface.

A latitude of modification, change and substitution is intended in the foregoing disclosure and in some instances some features of the invention will be employed without a corresponding use of other features.

What I claim is:

1. An apparatus for polishing a surface of an article comprising

a substantially closed chamber,

means in said chamber to support an article in fixed position in said chamber exposing the surface of the article to be polished,

a polishing slurry in said chamber, said slurry completely filling said chamber and being confined in nonflowing relation with the defines of said chamber and in polishing contact with the fixed surface to be polished,

means connected with said chamber to place the polishing slurry therein under pressure to cause the polishing slurry to contact the fixed surface void free and under pressure,

and means for vibrating the polishing slurry in said chamber to move the same relative to said fixed surface.

2. A surface polishing apparatus as defined in claim **1**

wherein said vibrating means are transducers located at least opposite said surface to be polished and with said polishing slurry therebetween to induce ultrasonic vibrations to said polishing slurry.

3. A polishing apparatus for polishing the surface of an article comprising

a polishing chamber including means therein to support the article with the surface thereof to be polished fixedly exposed in said chamber,

a polishing slurry including polishing particles completely filling and confined in and in nonflowing relation with said chamber and in contact against said surface to be polished,

and means for vibrating said slurry such that said polishing particles are caused to have polishing movement against said exposed surface to be polished and thereby result in polishing thereof,

and means exerting a pressure on said polishing slurry while the same is confined in and in nonflowing relation to said chamber to provide intimate pressurized contact between said polishing slurry and said fixed exposed surface to be polished.

4. A surface polishing apparatus as defined in claim **3**

wherein said pressure exerting means is variable and includes a cylinder having a supply of polishing slurry in fluid communication with said polishing chamber,

a piston operating in said cylinder effective to cause charging of said polishing slurry under pressure from said cylinder into said polishing chamber,

and means for maintaining said pressure of said polishing slurry during polishing operation of said surface polishing apparatus.

5. A surface polishing apparatus as defined in claim **4**

including transducers operatively arranged in said one of the walls bounding said polishing slurry chamber which is opposite said surface to be polished.

6. In the method of fine polishing a surface of an article utilizing a polishing slurry,

fixedly supporting the article whose surface is to be polished and exposing the surface to be polished by providing a spaced adjacent the surface,

confining the polishing slurry in and completely filling the space so that the slurry is in nonflowing, full surface contact with the surface to be polished and the defining walls of the space,

placing the confined nonflowing slurry under pressure to cause the slurry to contact the surface void free and under pressure,

and subjecting the slurry to ultrasonic vibrations to vibrate the same relative to the fixed article.