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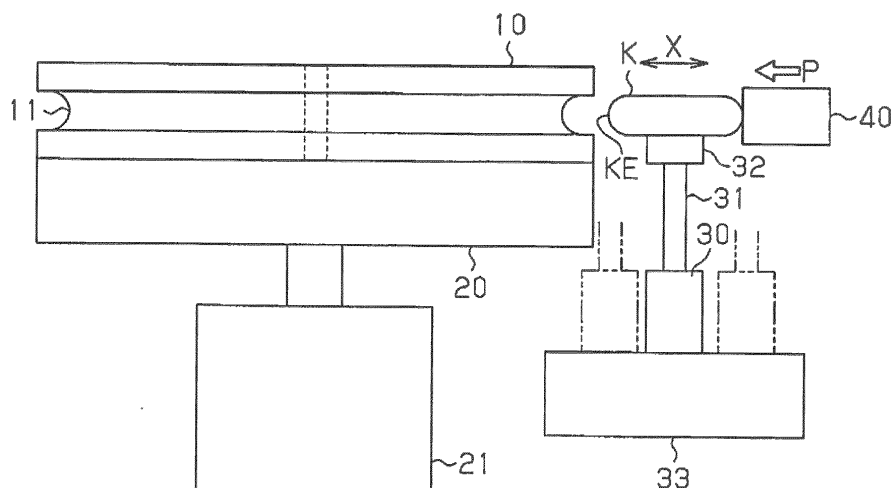
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(54) **POLISHING DEVICE AND POLISHING METHOD**

(57) It is an objective of the present invention to provide a polishing device and a polishing method that allows for polishing of workpieces having various contours. The polishing device includes a motor movement mechanism (33) and a second motor (30) that rotates a workpiece

(K). The motor movement mechanism (33) moves the workpiece (K) in a direction tangential to a radially outer circumferential surface of a polishing member (10) and moves the workpiece (K) in a direction orthogonal to a rotational axis of the polishing member (10).

Fig.2



Description

TECHNICAL FIELD

[0001] The present invention relates to a polishing device and a polishing method.

BACKGROUND ART

[0002] Patent document 1 and patent document 2 each describe a polishing device that polishes a periphery of a workpiece by rotating the workpiece (object to be polished) in contact with a polishing member.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0003]

Patent Document 1: Japanese Laid-Open Patent Publication No. 11-188590

Patent Document 2: Japanese Laid-Open Patent Publication No. 2001-205549

SUMMARY OF THE INVENTION

PROBLEMS THAT ARE TO BE SOLVED BY THE INVENTION

[0004] However, in the conventional polishing device described above, the polishing member contacts the periphery of the rotating workpiece. Thus, the workpiece is limited to a workpiece having a truly round contour, such as a disk-shaped or cylindrical workpiece. This imposes limitations on the polishing of workpieces having contours with other shapes.

[0005] The term "truly round" refers to the shape of a curve traced along points that are at an equal distance from a given point. The term "contour" refers to the shape in a projected view on a plane orthogonal to a side surface to be polished of the workpiece.

[0006] The present invention is made in view of such circumstances, and its objective is to provide a polishing device and a polishing method that allow for polishing of workpieces having various contours.

MEANS FOR SOLVING THE PROBLEM

[0007] To solve the above problem, a polishing device that polishes a workpiece includes a polishing member and a movement mechanism. The polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece. The movement mechanism moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member.

[0008] To solve the above problem, another polishing device that polishes a workpiece includes a polishing member, a first movement mechanism, and a second movement mechanism. The polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece. The first movement mechanism moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member. The second movement mechanism moves at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0009] To solve the above problem, another polishing device that polishes a workpiece includes a polishing member and a rotation mechanism. The polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece. The rotation mechanism rotates at least one of the workpiece and the polishing member.

[0010] To solve the above problem, another polishing device that polishes a workpiece includes a polishing member and a pressing mechanism. The polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece. The pressing mechanism presses at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0011] To solve the above problem, another polishing device that polishes a workpiece includes a polishing member, a movement mechanism, and a rotation mechanism. The polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece. The movement mechanism moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member. The rotation mechanism rotates at least one of the workpiece and the polishing member.

[0012] To solve the above problem, another polishing device that polishes a workpiece includes a polishing member, a movement mechanism, and a pressing mechanism. The polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece. The movement mechanism moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member. The pressing mechanism presses at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0013] To solve the above problem, another polishing device that polishes a workpiece includes a polishing member, a movement mechanism, a rotation mechanism, and a pressing mechanism. The polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the

workpiece. The movement mechanism moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member. The rotation mechanism rotates at least one of the workpiece and the polishing member. The pressing mechanism presses at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0014] The above polishing devices preferably include a motor that rotates the polishing member from below. The above polishing devices preferably include a base that is rotated integrally with the polishing member when the polishing member is located on an upper surface of the base.

[0015] To solve the above problem, a polishing method for polishing a workpiece with a polishing member that includes a polishing surface shaped in conformance with the shape of a portion to be polished of the workpiece includes moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member when polishing the workpiece.

[0016] To solve the above problem, another polishing method for polishing a workpiece with a polishing member that includes a polishing surface shaped in conformance with the shape of a portion to be polished of the workpiece includes moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member when polishing the workpiece, and moving at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0017] To solve the above problem, another polishing method for polishing a workpiece with a polishing member that includes a polishing surface shaped in conformance with the shape of a portion to be polished of the workpiece includes rotating at least one of the workpiece and the polishing member.

[0018] To solve the above problem, another polishing method for polishing a workpiece with a polishing member that includes a polishing surface shaped in conformance with the shape of a portion to be polished of the workpiece includes pressing at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0019] To solve the above problem, another polishing method for polishing a workpiece with a polishing member that includes a polishing surface shaped in conformance with the shape of a portion to be polished of the workpiece includes moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member and rotating at least one of the workpiece and the polishing member.

[0020] To solve the above problem, another polishing method for polishing a workpiece with a polishing member that includes a polishing surface shaped in conform-

ance with the shape of a portion to be polished of the workpiece includes moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member and pressing at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0021] To solve the above problem, another polishing method for polishing a workpiece with a polishing member that includes a polishing surface shaped in conformance with the shape of a portion to be polished of the workpiece includes moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member, rotating at least one of the workpiece and the polishing member, and pressing at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

[0022] The polishing methods preferably include rotating the polishing member from below. The polishing methods preferably include when the polishing member is located on an upper surface of a base, rotating the polishing member integrally with the base.

[0023] In the above devices and methods, the polishing member includes a polishing surface that is shaped in conformance with the shape of the portion to be polished of the workpiece. Thus, even when the portion to be polished of the workpiece has a non-planar shape, for example, a curved surface or a triangular shape, the workpiece can be polished.

[0024] In the above devices and methods, when at least one of the workpiece and the polishing member is moved in the direction tangential to the radially outer circumferential surface of the polishing member, the workpiece linearly moves relative to the polishing member. Thus, the workpiece having a linear contour can be polished.

[0025] In the above devices and methods, when at least one of the workpiece and the polishing member is moved in the direction tangential to the radially outer circumferential surface of the polishing member and at least one of the workpiece and the polishing member is rotated in a direction orthogonal to the rotation axis of the polishing member, the workpiece and the polishing member can be shifted to any positional relationship. This maintains the contact of polishing member and the workpiece while following the contour shape of various workpieces. Thus, the workpieces having various contours can be polished.

[0026] In the above devices and methods, when at least one of the workpiece and the polishing member is rotated, a surface to be polished of the workpiece may be changed. Thus, for example, the entire periphery or a portion of each of the workpieces having various contours can be appropriately polished.

[0027] In the above devices and methods, when at least one of the workpiece and the polishing member is pressed in a direction orthogonal to the rotation axis of

the polishing member, the polishing of the workpiece can be advanced. Additionally, uniform contact (i.e., touch) of the workpiece and the polishing surface can be enhanced.

[0028] In the above devices and methods, when the polishing member is rotated from below or when the polishing member, which is located on the upper surface of the base, is rotated integrally with the base, stable rotation of the polishing member can be obtained with a small axial run-out. This allows for a process with higher accuracy.

EFFECT OF THE INVENTION

[0029] The present invention succeeds in polishing of workpieces having various contours.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Fig. 1 is a schematic plan view showing the structure of a polishing device according to one embodiment.

Fig. 2 is a schematic side view showing the structure of the polishing device of the embodiment.

Fig. 3 is a schematic plan view showing the structure of a polishing device according to a modified example of the embodiment.

Fig. 4 is a plan view showing one example of a workpiece that is polished using the polishing device of the modified example shown in Fig. 3.

Fig. 5 is a partial side view showing a workpiece and a polishing member according to another modified example of the embodiment.

Fig. 6 is a partial side view showing a workpiece and a polishing member according to another modified example of the embodiment.

Fig. 7 is a partial side view showing a workpiece and a polishing member according to another modified example of the embodiment.

Fig. 8 is a partial side view showing a workpiece and a polishing member according to another modified example of the embodiment.

Fig. 9 is a partial side view showing a workpiece and a polishing member according to another modified example of the embodiment.

Fig. 10 is a schematic view showing a workpiece that is processed with a polishing device according to another modified example of the embodiment.

Fig. 11 is a schematic view showing a workpiece that is processed with a polishing device according to another modified example of the embodiment.

Fig. 12 is a schematic view showing the structure of a pressure application mechanism according to another modified example of the embodiment.

MODES FOR CARRYING OUT THE INVENTION

[0031] A polishing device, a polishing method, and a workpiece according to one embodiment of the present invention will now be described with reference to Figs. 1 and 2.

[0032] As shown in Fig. 1, the polishing device includes a discoid polishing member 10. The polishing member 10 includes a radially outer circumferential surface that is used to polish an end of a workpiece K, which is a portion to be polished.

[0033] The workpiece K has a tetragonal contour, or a tetragonal projected shape on a plane orthogonal to a side surface to be polished of the workpiece K (shape of workpiece K shown in Fig. 1). More specifically, the corners of the tetragon are not right-angled but round. Instead, the corners of the tetragon may be right-angled.

[0034] As shown in Fig. 2, the workpiece K includes an end KE the shape of which (shape of portion to be polished) is processed in advance to have a curved surface. The end KE having the processed curved surface is polished with the polishing member 10.

[0035] Any optimal material for polishing the end KE may be used for the polishing member 10. For example, when a resin is used as the material of the polishing member 10, any synthetic resin may be used. Examples of such a synthetic resin include a thermosetting resin (phenol resin, epoxy resin, urethane resin, polyimide, etc.) and a thermoplastic resin (polyethylene, polypropylene, acrylic resin, polyamide, polycarbonate, etc.). Alternatively, a cloth, a non-woven fabric, a resin processed non-woven fabric, synthetic leather, or a composite thereof may be used. The polishing surface of the polishing member 10 preferably has a Shore A hardness of 5 or greater. When a polishing member 10 having a shore A hardness of 5 or greater, which is subject to hardness measurement, is left for 60 minutes or longer in a dry condition where the humidity is 20% to 60% under room temperature, the hardness of the polishing surface of the polishing member is then measured with a durometer (type A) that is compliance with JIS K6253, and the measured value is 5 or greater. When the Shore A hardness is 5 or greater, the surface of the workpiece K can be polished in a preferred manner. Further, deformation of the polishing surface of the polishing member 10 can be reduced that would be caused by polishing performed within a short period of time.

[0036] The Shore A hardness of the polishing surface of the polishing member 10 is preferably 40 or greater, more preferably 70 to 95, and particularly preferably 70 to 85.

[0037] When a metal is used as the material of the polishing member 10, magnesium, aluminum, titanium, iron, nickel, cobalt copper, zinc, manganese, or an alloy of which the main component is any of these metals may be used.

[0038] When a resin or a metal is used as the material of the polishing member 10, the polishing member 10

may include abrasive grains. The kind of the used abrasive grains is not particularly limited and may be metal oxide particles of silicon oxide, aluminum oxide, zirconium oxide, cerium oxide, magnesium oxide, calcium oxide, titanium oxide, manganese oxide, iron oxide, or chromium oxide; a carbide such as silicon carbide; a nitride; a boride; or a diamond.

[0039] When a ceramic is used as the material of the polishing member 10, any of ceramics and glass; any of an oxide, nitride, boride, and carbide of silicon, aluminum, zirconium, calcium, and barium; or any of aluminum oxide, zirconium oxide, silicon oxide, silicon carbide, silicon nitride, and boron nitride may be used.

[0040] Further, any material may be used for the workpiece K. For example, when a resin is used as the material of the workpiece K, any synthetic resin may be used. Examples of such a synthetic resin include a thermosetting resin (phenol resin, epoxy resin, urethane resin, polyimide, etc.) and a thermoplastic resin (polyethylene, polypropylene, acrylic resin, polyamide, polycarbonate, etc.).

[0041] When a ceramic is used as the material of the workpiece K, any of ceramics, glass, and fine ceramics; any of an oxide, carbide, nitride, and boride of silicon, aluminum, zirconium, calcium, and barium may be used.

[0042] When a metal is used as the material of the workpiece K, magnesium, aluminum, titanium, iron, nickel, cobalt, copper, zinc, manganese, or an alloy of which the main component is any of these metals may be used.

[0043] The workpiece K may be used for any purpose. For example, the workpiece K may be used as a wheel, a shaft, a container, a casing (for example, case and housing), a frame, a ball, a wire, an ornament, or the like.

[0044] The polishing member 10 is fixed to the upper surface of a discoid base 20 in a removable manner. The lower surface of the base 20 includes a center portion that is fixed to a rotation shaft of a first motor 21. When the first motor 21 is driven to be rotated, the base 20 and the polishing member 10 rotate. The first motor 21 is located below the polishing member 10 and the base 20. The polishing member 10, which is located on the upper surface of the base 20, is rotated together with the base 20 from below. This obtains stable rotation of the polishing member 10 with a small axial run-out and allows for a process with higher accuracy.

[0045] The radially outer circumferential surface of the polishing member 10 includes a polishing surface 11, which is a curved grooved surface that circumferentially extends. The curvature of the polishing surface 11 is shaped in conformance with the shape of the end KE of the workpiece K (shape of portion to be polished). More specifically, the polishing surface 11 and the end KE have the same curvature.

[0046] When the diameter of the polishing member 10 is maximized within a range in which the polishing accuracy is appropriately maintained, ends KE of workpieces K may be simultaneously polished with the circumferential surface of the polishing member 10. This improves the productivity. Additionally, the maximum diameter of

the polishing member 10 increases the linear velocity of polishing member 10 at the outer circumference even when the rotation speed of the polishing member 10 is the same. This obtains the sufficient linear velocity for the polishing even when the rotation speed of the polishing member 10 is relatively decreased. Thus, for example, dispersion of the processing liquid, which will be described later, may be reduced.

[0047] The workpiece K is held by a fixing seat 32 in a removable manner. The fixing seat 32 is fixed to a rotation shaft 31 of a second motor 30. When the second motor 30 is driven, the workpiece K is rotated about the rotation shaft 31 (in arrow R direction or arrow L direction shown in Fig. 1). The second motor 30 forms the rotation mechanism.

[0048] The second motor 30 is coupled to a motor movement mechanism 33. The motor movement mechanism 33 includes a mechanism that reciprocates the second motor 30 in directions orthogonal to a rotation axis of the polishing member 10. Hereafter, the directions orthogonal to the rotation axis of the polishing member 10 are referred to as the "arrow X directions" (shown in Fig. 2).

[0049] The motor movement mechanism 33 also includes a mechanism that reciprocates the second motor 30 in directions tangential to the radially outer circumferential surface of the polishing member 10. Hereafter, the directions tangential to the radially outer circumferential surface of the polishing member 10 are referred to as the "arrow Y directions" (shown in Fig. 1).

[0050] When the second motor 30 is moved by the motor movement mechanism 33, the second motor 30, the rotation shaft 31, the fixing seat 32, and the workpiece K are integrally moved in the directions orthogonal to the rotation axis of the polishing member 10 and in the directions tangential to the radially outer circumferential surface of the polishing member 10. The motor movement mechanism 33 forms the first movement mechanism and the second movement mechanism.

[0051] The polishing device further includes a pressing mechanism 40 that presses the workpiece K in a direction orthogonal to the rotation axis of the polishing member 10. The pressing mechanism 40 presses the workpiece K against the polishing surface 11 of the polishing member 10 with pressure P. The pressure P of the pressing mechanism 40 may be adjusted in any manner. For example, contact pressure of a portion that contacts the end KE of the workpiece K and the polishing surface 11 is measured with, for example, a load cell. Then, the pressure P is adjusted so that the contact pressure is constant at a predetermined value. Alternatively, the pressure P may be adjusted in accordance with the area of the contact portion (e.g., the pressure P is increased where the area of the contact portion is large and decreased where the area of the contact portion is small).

[0052] The contact pressure tends to be higher on a corner than on a flat portion. Thus, appropriate polishing control may be performed in accordance with the shape

of the workpiece K, for example, by shorting time for polishing a portion of the workpiece having high contact pressure, for example, a corner, and extending time for polishing a portion of the workpiece having high contact pressure, for example, a flat portion. Alternatively, the process time may be adjusted together with the adjustment of the pressure P to perform constant polishing.

[0053] An appropriate drive source, such as electric power, hydraulic pressure, air pressure, or gas pressure, may be used as the drive source of the motor movement mechanism 33 and the pressing mechanism 40. The motor movement mechanism 33 and the pressing mechanism 40 may be automatically driven by a controller including, for example, a CPU, a RAM, and a ROM or may be driven, for example, when the operator of the polishing device operates a switch.

[0054] When the motor movement mechanism 33 moves the second motor 30 and the pressing mechanism 40 presses the workpiece K, the end KE of the workpiece K is pressed against the polishing surface 11. Then, a contact portion of the end KE and the polishing surface 11 is supplied with, for example, a processing liquid in an appropriate manner. The processing liquid may be directly supplied to the contact portion of the end KE and the polishing surface 11 from the outer side. Alternatively, a processing liquid supply mechanism such as a rotary joint may be arranged in a portion that connects the polishing member 10 (more specifically, base 20 to which polishing member 10 is fixed) and the first motor 21. When the processing liquid supply mechanism supplies the processing liquid into the polishing member 10, the processing liquid may be supplied from the polishing member 10 to the contact portion through a supply passage formed in the polishing member 10. When supplied from the inside of the polishing member 10 toward the contact portion, the processing liquid may be further efficiently supplied. Additionally, to efficiently use the processing liquid, it is further preferable that a cover be arranged around the polishing member 10 and that a collection device be provided to increase the efficiency for collecting the processing liquid.

[0055] An appropriate kind of the processing liquid may be used in accordance with the material of the workpiece K to be polished and the polishing member 10. Specifically, a cutting liquid, grinding liquid, a lapping material, a polishing agent, or a chemical mechanical polishing liquid may be used. The processing liquid may include abrasive grains. The kind of the used abrasive grains is not particularly limited and may be metal oxide particles of silicon oxide, aluminum oxide, zirconium oxide, cerium oxide, magnesium oxide, calcium oxide, titanium oxide, manganese oxide, iron oxide, or chromium oxide; a carbide, such as silicon carbide; a nitride; a boride; or a diamond.

[0056] The amount of the abrasive grains contained in the processing liquid is preferably 1 mass percent or greater, and more preferably 2 mass percent or greater. The amount of the abrasive grains contained in the

processing liquid is also preferably 50 mass percent or less, and more preferably 40 mass percent or less.

[0057] The abrasive grains in the processing liquid have an average secondary particle diameter of preferably 0.1 μm or greater, and more preferably 0.3 μm or greater. As the average secondary particle diameter of the abrasive grains increases, the processing liquid improves the processing speed.

[0058] Additionally, the average secondary particle diameter of the abrasive grains in the processing liquid is preferably 20 μm or less, and more preferably 5 μm or less. As the average secondary particle diameter of the abrasive grains decreases in the processing liquid, the surface of the workpiece K can be further uniformly polished. The average secondary particle diameter of the abrasive grains is a volume average particle diameter that is measured with a laser diffraction/scattering particle size distribution measurement instrument, such as "LA-950" manufactured by HORIBA, Ltd.

[0059] When necessary, the processing liquid may further include another component such as a pH adjuster, an etching agent, an oxidant, a water-soluble polymer, a copolymer and a salt and derivative thereof, an anticorrosive, a chelating agent, a dispersant aid, an antiseptic, or a fungicide.

[0060] For example, a known acid, base, or a salt of them may be used as the pH adjuster. Examples of such an acid that can be used as the pH adjuster include an inorganic acid, such as hydrochloric acid, sulfuric acid, nitric acid, hydrofluoric acid, boric acid, carbonic acid, hypophosphorous acid, phosphorous acid, or phosphoric acid; and an organic acid, such as formic acid, acetic acid, propionic acid, butyric acid, valeric acid, 2-methylbutyric acid, n-hexanoic acid, 3,3-dimethylbutyric acid, 2-ethylbutyric acid, 4-methylpentanoic acid, n-heptanoic acid, 2-methylhexanoic acid, n-octanoic acid, 2-ethylhexanoic acid, benzoic acid, glycolic acid, salicylic acid, glyceric acid, oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, maleic acid, phthalic acid, malic acid, tartaric acid, citric acid, lactic acid, diglycolic acid, 2-furancarboxylic acid, 2,5-furandicarboxylic acid, 3-furancarboxylic acid, 2-tetrahydrofurancarboxylic acid, methoxyacetic acid, methoxyphenylacetic acid, or phenoxyacetic acid.

[0061] Examples of such a base that can be used as the pH adjuster include an amine, such as aliphatic amine or aromatic amine; an organic base, such as quaternary ammonium hydroxide; an alkali metal hydroxide, such as potassium hydroxide; an alkaline earth metal hydroxide; and ammonia.

[0062] Instead of the above acid or in combination with the above acid, a salt of the above acid, such as an ammonium salt or an alkali metal salt, may be used as the pH adjuster. Such a pH adjuster is used to adjust the pH value of the processing liquid to the optimal value, which differs in accordance with the kind of the workpiece K to be polished.

[0063] Examples of the etching agent include an inor-

ganic acid, such as nitric acid, sulfuric acid, or phosphoric acid; an organic acid, such as acetic acid, citric acid, tartaric acid, or methanesulfonic acid; an inorganic alkali, such as potassium hydroxide or sodium hydroxide; and an organic alkali, such as ammonia, amine, or quaternary ammonium hydroxide.

[0064] Examples of the oxidant include hydrogen peroxide, peracetic acid, a percarbonate, urea peroxide, a perchlorate, a persulfate, an oxoacid, such as sulfuric acid, nitric acid, or phosphoric acid, and a salt of the oxoacid.

[0065] Examples of the water-soluble polymer, the copolymer and the salt and derivative thereof include a polycarboxylic acid, such as a polyacrylate; a polysulfonic acid, such as polyphosphonic acid or polystyrenesulfonic acid; a polysaccharide, such as xanthan gum or sodium alginate; a cellulose derivative such as hydroxyethyl cellulose or carboxymethyl cellulose; polyethylene glycol; polyvinyl alcohol; polyvinylpyrrolidone; sorbitan monooleate; an oxyalkylene-based polymer having one or more kinds of oxyalkylene unit; a non-ionic surfactant; and an anionic surfactant. Examples of the non-ionic surfactant include polyoxyethylene alkylether, polyoxyethylene alkylphenylether, sorbitan monooleate, and an oxyalkylene-based polymer having one or more kinds of oxyalkylene unit. Examples of the anionic surfactant include an alkylsulfonic acid-based compound, an alkylbenzenesulfonic acid-based compound, an alkyl-naphthalenesulfonic acid-based compound, a methyltaurine acid-based compound, an alkyl-diphenyletherdisulfonic acid-based compound, an α -olefinsulfonic acid-based compound, a naphthalenesulfonic acid condensate, and a sulfosuccinic acid diester-based compound.

[0066] Examples of the anticorrosive include a monocyclic compound, a polycyclic compound having a condensed ring, and heterocyclic compound, such as an amine, a pyridine, a tetraphenylphosphonium salt, a benzotriazole, a triazole, a tetrazole, or benzoic acid.

[0067] Examples of the chelating agent include a carboxylic acid-based chelating agent, such as gluconic acid; an amine-based chelating agent, such as ethylenediamine, diethylenetriamine, or trimethyltetraamine; polyaminopolycarbon-based chelating agent, such as ethylenediaminetetraacetic acid, nitrilotriacetic acid, hydroxyethylethylenediaminetriacetic acid, triethylenetetraminehexaacetic acid, or diethylenetriaminepentaacetic acid; an organic phosphonic acid-based chelating agent, such as 2-aminoethylphosphonic acid, 1-hydroxyethyliden-1,1-diphosphonic acid, aminotri(methylenephosphonic acid), ethylenediaminetetrakis(methylenephosphonic acid), diethylenetriaminepenta(methylenephosphonic acid), ethane-1,1-diphosphonic acid, ethane-1,1,2-triphosphonic acid, methanedi-hydroxyphosphonic acid, or 1-phosphonobutan-2,3,4-tricarboxylic acid; a phenol derivative; and 1,3-diketone.

[0068] Examples of the dispersant aid include a condensed phosphate, such as pyrophosphate or hexamet-

aphosphate.

[0069] Examples of the antiseptic include sodium hypochlorite.

[0070] Examples of the fungicide include an oxazoline, such as oxazolidine-2,5-dione.

[0071] When the processing liquid is supplied and the rotation speed of the first motor 21 is adjusted, the end KE having a curved surface is polished. The end KE may be polished, for example, through the following steps.

Step 1: The motor movement mechanism 33 moves the workpiece K toward the rotation center of the polishing member 10 in an arrow X direction, so that the end KE contacts the polishing surface 11.

Step 2: While the pressing mechanism 40 is driven and the end KE and the polishing surface 11 are in contact, the motor movement mechanism 33 moves the workpiece K in the arrow Y directions. This shifts portions that contact the end KE and the polishing surface 11. Consequently, the polishing of one side of the workpiece K progresses.

Step 3: When the polishing of one side of the workpiece K is finished, the pressing mechanism 40 is separated from the end KE. Then, as the motor movement mechanism 33 moves the workpiece K in an arrow X direction, the second motor 30 rotates the workpiece K. When the workpiece K is rotated while maintaining contact of the workpiece K and the polishing surface 11, a side adjacent to the side that has been polished is opposed toward the polishing surface 11. This switches the side that is polished.

[0072] Repetition of step 2 and step 3 polishes the entire four sides of the workpiece K. The polishing steps described above are one example. Thus, the driving modes of the motor movement mechanism 33 and the pressing mechanism 40 may be changed taking into consideration, for example, the process time.

[0073] The present embodiment has the advantages described below.

(1) The motor movement mechanism 33 moves the workpiece K in the directions (arrow Y directions) tangential to the radially outer circumferential surface of the polishing member 10. Thus, the workpiece K linearly moves relative to the polishing member 10. This allows for polishing of the end KE of the tetragonal workpiece K having a linear side.

(2) The second motor 30 rotates the workpiece K to change the surface (side) of the workpiece K that is polished. Thus, the entire periphery of the workpiece K having a tetragonal contour can be polished.

(3) When polishing the workpiece K, the workpiece K is pressed against the polishing member 10. This

advances the polishing of the workpiece K and enhances uniform contact, or touch, of the workpiece K and the polishing surface 11.

(4) The polishing device includes a polishing member 10 having a polishing surface 11 that is shaped in conformance with the shape of the end KE of the workpiece K to be polished. Thus, even when the end KE of the workpiece K has a curved surface, which differs from a flat surface, the end KE can be polished.

(5) In the polishing method, the polishing device is used to polish the workpiece K. Thus, even when the shape of the portion to be polished (shape of end KE) has a curved surface, which differs from a flat surface, and the workpiece K is tetragonal, the periphery of the workpiece K can be polished.

[0074] The embodiment may be modified as follows.

- The workpiece K is rotated to polish the entire periphery of the workpiece K. Instead, a portion of the periphery of the workpiece K, for example, only one, two, or three sides of the workpiece K may be polished.
- In step 3, the workpiece K is rotated as moving in an arrow X direction away from the rotation center of the polishing member 10. Instead, after the workpiece K is moved in an arrow Y direction until the end KE that has been polished is separated away from the polishing surface 11, the workpiece K may be rotated. Then, the workpiece K may be moved in an arrow Y direction so that the side of the workpiece K that is next to be polished approaches the polishing surface 11. When the side that is polished is switched in this manner, each side of the workpiece K may be polished. In this modified example, the function for moving the workpiece K in the arrow X directions may be omitted from the motor movement mechanism 33.
- When polishing only one of the four sides of the workpiece K, the motor movement mechanism 33 may only have the function for moving the workpiece K in the arrow Y directions, and the rotation mechanism (second motor 30 and the like) may be omitted. Even in this case, the motor movement mechanism 33 linearly moves the workpiece K relative to the polishing member 10. Thus, one side of the end KE of the tetragonal workpiece K having linear sides can be polished.
- In the embodiment, the workpiece K is movable in the arrow X directions and the arrow Y directions. Additionally, a mechanism that moves the rotation center of the polishing member 10 may be provided.

While the workpiece K is moved in the arrow X directions, the polishing member 10 may be moved in the arrow Y directions. Alternatively, while the workpiece K is moved in the arrow Y directions, the polishing member 10 may be moved in the arrow X directions.

[0075] Alternatively, the workpiece K and the polishing member 10 may both be moved in the arrow X directions. Alternatively, the workpiece K and the polishing member 10 may both be moved in the arrow Y directions.

- In the embodiment, the workpiece K is movable. Instead, the polishing member 10 may be configured to be movable. Fig.3 is a schematic view showing such a modified example.

[0076] As shown in Fig. 3, the tetragonal workpiece K is clamped by a polishing device in an appropriate manner. The rotation center of the polishing member 10, which is driven to be rotated, includes a movement mechanism 50 that moves the polishing member. The movement mechanism 50 functions as a first movement mechanism that moves the polishing member 10 in the directions (arrow Y directions shown in Fig. 3) tangential to the radially outer circumferential surface of the polishing member 10 and as a second movement mechanism that moves the polishing member 10 in the directions (arrow X directions in Fig. 3) orthogonal to the rotation axis of the polishing member 10. An appropriate mechanism may be used as the movement mechanism 50. For example, a link mechanism or a mechanism similar to the motor movement mechanism 33 may be used.

[0077] In this modified example of the polishing device, the movement mechanism 50 shifts the polishing member 10 to any position relative to the workpiece K. This maintains the contact of the workpiece K and the polishing member 10 while following the contour shape of the workpiece K. More specifically, as indicated by the double-dashed lines in Fig. 3, the polishing member 10 may be moved along the periphery (end KE) of the workpiece K. Thus, in such a modified example, the entire periphery of the workpiece K having the tetragonal contour can be polished. Additionally, in such a modified example, even when the polishing member 10 is relatively small in size, the entire periphery of the workpiece K can be polished compared to the above embodiment. Instead of the movement mechanism 50 of the modified example shown in Fig. 3, a movement mechanism that moves the polishing member 10 in the arrow Y directions shown in Fig. 3 may be arranged separately from a movement mechanism that moves the polishing member 10 in the arrow X directions shown in Fig. 3. Additionally, in the modified example shown in Fig. 3, a portion of the periphery of the workpiece K, for example, only one, two, or three sides of the workpiece K, may be polished.

[0078] - The polishing member 10 is arranged on the upper surface of the base 20. Instead, the base 20 may

be omitted, and the rotation shaft of the first motor 21 may be directly fixed to the center of the polishing member 10.

- The pressing mechanism 40 is driven to press the end KE against the polishing surface 11. However, the pressing mechanism 40 may be omitted as long as the end KE can be pressed against the polishing surface 11 when the motor movement mechanism 33 moves the second motor 30 in an arrow X direction.
- The motor movement mechanism 33 reciprocates the second motor 30 in the directions (arrow X directions shown in Fig. 2) orthogonal to the rotation axis of the polishing member 10 and the directions (arrow Y directions shown in Fig. 1) tangential to the radially outer circumferential surface of the polishing member 10. Instead, a mechanism that moves the second motor 30 in the directions (arrow X directions shown in Fig. 2) orthogonal to the rotation axis of the polishing member 10 may be arranged separately from a mechanism that moves the second motor 30 in the directions (arrow Y directions shown in Fig. 1) tangential to the radially outer circumferential surface of the polishing member 10.
- The second motor 30 is moved to move the workpiece K. Instead, the workpiece K may be moved using a different means.
- The end KE of the workpiece K is polished. However, the portion to be polished is not limited to such an end and may be a different portion.
- The end KE of the workpiece K to be polished may have a non-planar shape other than a curved surface. For example, as shown in Fig. 5, the shape may be a triangle. Alternatively, as shown in Fig. 6, the shape may be a triangle with a round peak. Additionally, the end KE of the workpiece K to be polished may have the form of steps as shown in Fig. 7 or the form of steps with round corners as shown in Fig. 8. Additionally, as shown in Fig. 9, the end KE may be recessed inward in the workpiece K. Further, a curve surface may have a number of curvatures or partially have a straight portion. In such modified examples, when the polishing surface 11 of the polishing member 10 is shaped in conformance with the shape of the end KE of the workpiece K (shape of portion to be polished), the end KE can be polished.
- The contour of the workpiece K may have any of a variety of shapes other than a tetragonal shape. For example, the shape may have a plurality of planar or curved surfaces or may be triangular or elliptical. More specifically, in the embodiment and modified examples, workpieces K having various contours

can be polished. For example, the circumferential surface of a tubular workpiece K having a circular contour can be polished.

[0079] In the modified example shown in Fig. 3, the polishing member 10 can be shifted to any position relative to the workpiece K. Thus, as shown in Fig. 4, even when the contour of the workpiece K is shaped to have a number of curvatures, the periphery of the workpiece K can be polished.

[0080] In the embodiment, the workpiece K is moved in the arrow X directions to bring the end KE of the workpiece K into contact with the polishing surface 11 and also separate the end KE that has been polished from the polishing surface 11. The motor movement mechanism 33, which is capable of moving the workpiece K in the arrow X directions and the arrow Y directions, can shift the workpiece K to any position relative to the polishing member 10. This maintains the contact of the workpiece K and the polishing member 10 while following the contour shape of the workpiece K. Additionally, the polishing device of the above embodiment includes the rotation mechanism that rotates the workpiece K. Thus, in the above embodiment, when the movement of the workpiece K in the arrow X directions and the arrow Y directions is combined with the rotation of the workpiece K, the periphery of the workpiece K can be polished even when the workpiece K has a shape such as that shown in Fig. 4, that is, the shape of the contour of the workpiece K have a number of curvatures.

- When feature (A) is adopted that includes movement of at least one of the workpiece K and the polishing member 10 in the directions (arrow Y directions) tangential to the radially outer circumferential surface of the polishing member 10, one side of the workpiece K can be polished. When feature (B) is adopted that includes movement of at least one of the workpiece K and the polishing member 10 in the directions (arrow X directions) orthogonal to the rotation axis of the polishing member 10 and movement of at least one of the workpiece K and the polishing member 10 in the directions (arrow Y directions) tangential to the radially outer circumferential surface of the polishing member 10, the workpiece K and the polishing member 10 may be shifted to any positional relationship. When feature (C) is adopted that includes rotation of at least one of the workpiece K and the polishing member 10, a surface to be polished of the workpiece K may be changed. When feature (D) is adopted that includes the pressing of at least one of the workpiece K and the polishing member 10 in the directions orthogonal to the rotation axis of the polishing member 10, the polishing of the workpiece may be advanced, and the uniform contact (i.e., touch) of the workpiece and the polishing surface may be enhanced. Features (A) to (D) may be adopted in combination or solely in accordance with the

shape of the workpiece K and the processing purpose. In such a case, the advantages may be obtained in accordance with the adopted features (A) to (D).

- When the polishing member 10 or the workpiece K is rotated to polish the workpiece K, polishing marks may remain in the polished surface of the workpiece K in the rotation direction. To limit such polishing marks, a reciprocation mechanism that reciprocates at least one of the polishing member 10 and the workpiece K in directions intersecting the rotation direction may be further included in addition to the above various mechanisms. Figs. 10 and 11 show two examples in which such a reciprocation mechanism is included in the polishing device of the above embodiment shown, for example, in Fig. 2.

[0081] The modified example of the polishing device shown in Fig. 10 includes a pivot mechanism 60 that pivots the workpiece K in directions orthogonal to the rotation direction of the polishing member 10. An appropriate mechanism, for example, a link mechanism, may be used as the pivot mechanism 60.

[0082] In this modified example, when the polishing member 10 is rotated to polish the end KE of the workpiece K, the pivot mechanism 60 is activated. The activation of the pivot mechanism 60 pivots the workpiece K in directions (arrow RO directions shown in Fig. 10) orthogonal to the rotation direction of the polishing member 10. The pivotal motion of the workpiece K pivots the end KE of the workpiece K, which is being rotationally polished, along the curved surface of the polishing surface 11. Such pivoting of the end KE results in intersecting polishing marks of the end KE and reduces the polishing marks compared to those resulted from the polishing only by rotation. This limits the polishing marks caused by the rotational polishing.

[0083] The pivot directions of the workpiece K are not necessarily limited to the directions orthogonal to the rotation direction of the polishing member 10. When the workpiece K is pivoted in directions at least intersecting the rotation direction of the polishing member 10, the polishing marks intersect one another. This limits the polishing marks caused by the rotational polishing. Alternatively, instead of the workpiece K, the polishing member 10 may pivot. Further, the workpiece K and the polishing member 10 may both pivot.

[0084] The modified example of the polishing device shown in Fig. 11 includes an oscillation mechanism 70 that slightly oscillates the workpiece K in directions orthogonal to the rotation direction of the polishing member 10. An appropriate mechanism, for example, a mechanism using ultrasonic oscillations, may be used as the oscillation mechanism 70.

[0085] In this modified example, when the polishing member 10 is rotated to polish the end KE of the workpiece K, the oscillation mechanism 70 is activated. The

activation of the oscillation mechanism 70 slightly oscillates the workpiece K in directions (arrow UD directions shown in Fig. 11) orthogonal to the rotation direction of the polishing member 10. The oscillation of the workpiece K slightly reciprocates the end KE of the workpiece K, which is being rotationally polished, in the arrow UD directions in contact with the curved surface of the polishing surface 11. Such reciprocation of the end KE results in intersecting polishing marks of the end KE and reduces the polishing marks compared to those formed when polishing only with rotation. Thus, in this modified example, the polishing marks caused by the rotational polishing may be limited.

[0086] The oscillation directions of the workpiece K are not necessarily limited to the directions orthogonal to the rotation direction of the polishing member 10. When the workpiece K is oscillated in directions at least intersecting the rotation direction of the polishing member 10, the polishing marks intersect one another. This limits the polishing marks caused by the rotational polishing. Alternatively, instead of the workpiece K, the polishing member 10 may oscillate. Further, the workpiece K and the polishing member 10 may both oscillate.

[0087] In the same manner, the reciprocation mechanism may be applied to the polishing device (e.g., polishing device shown, for example, in Fig. 3) in the modified examples of the embodiment. Also, in this case, polishing marks caused by the rotational polishing may be limited.

- As shown, for example, in Fig. 2, in the above embodiment, when the workpiece K is pressed against the polishing surface 11 in a direction (arrow X direction shown, for example, in Fig. 2) orthogonal to the rotation axis of the polishing member 10, the end KE of the workpiece K is polished. In this case, the pressed end KE is polished. However, the upper and lower surfaces of the workpiece K, that is, two surfaces of the workpiece K that are parallel to the planar orthogonal to the rotation axis of the polishing member 10, do not receive much pressure when being polished and may fail to be sufficiently polished. In this regard, a pressure application mechanism that applies perpendicular pressure to the two surfaces of the workpiece K may be further included in addition to the above various mechanisms.

[0088] Fig. 12 schematically shows the structure of one example of such a pressure application mechanism. As shown in Fig. 12, the pressure application mechanism includes a roller 80 and an actuator 82. The roller 80, which is discoid, rotates about a rotation shaft 81. The roller 80 includes a circumferential surface that is in contact with a circumferential portion of an upper surface 10U of the polishing member 10. Rotation of the upper surface 10U rotates the roller 80. The roller 80 and the upper surface 10U only need to be in contact at least while polishing the workpiece K. Thus, the roller 80 and

the upper surface 10U may be in constant contact with each other or in contact with each other only when polishing the workpiece K.

[0089] The actuator 82 includes an appropriate mechanism that presses the roller 80 against the upper surface 10U and is of, for example, a motor-driven type or a hydraulic pressure-driven type. While polishing the workpiece K, the actuator 82 is activated to press the roller 80 against the upper surface 10U (in arrow VT direction shown in Fig. 12).

[0090] In this manner, when the roller 80 is pressed against the upper surface 10U, pressing force F that presses the polishing surface 11 of the polishing member 10 is applied to an upper surface KU of the workpiece K. When the pressing force F is applied to the upper surface KU, a lower surface KD of the workpiece K, which is in contact with the polishing surface 11 of the polishing member 10, is pressed against the polishing surface 11 of the polishing member 10. Consequently, the same pressing force F as that applied to the upper surface KU of the workpiece K is also applied to the lower surface KD of the workpiece K. When the pressing force F is applied to the upper surface KU and the lower surface KD of the workpiece K, not only the end KE but the upper surface KU and the lower surface KD are also polished at the same time while polishing the workpiece K. In the modified example shown in Fig. 12, when the pressure application mechanism presses one surface (upper surface U) of the polishing member 10, the pressing force F is applied to the upper surface KU and the lower surface KD of the workpiece K. This decreases the number of the pressure application mechanisms compared to when the pressure application mechanisms are arranged on the two surfaces of the polishing member 10.

[0091] In the modified example shown in Fig. 12, the actuator 82 is used to press the roller 80. However, when the mass of the roller 80 is large enough to apply sufficient pressing force only with the weight of the roller 80, the actuator 82 may be omitted. In this modified example, one surface of the polishing member 10 is pressed. Instead, two surfaces may be pressed, for example, by sandwiching the two surfaces of the polishing member 10. When the two surfaces are pressed in this manner, distortion of the polishing member 10 may be limited compared to when one surface is pressed. When the polishing member 10 is fixed and the workpiece K is rotated to be polished, the roller 80 does not need to be configured to be rotational. In this case, the roller 80 may be changed to a simple weight.

DESCRIPTION OF REFERENCE CHARACTERS

[0092]

10: polishing member, 10U: upper surface (of polishing member), 11: polishing surface, 20: base, 21: first motor, 30: second motor, 31: rotation shaft, 32: fixing seat, 33: motor movement mechanism, 40:

pressing mechanism, 50: movement mechanism, K: workpiece to be polished, KE: end (of workpiece), KU: upper surface (of workpiece), KD: lower surface (of workpiece), 60: pivot mechanism, 70: oscillation mechanism, 80: roller, 81: rotation shaft, 82: actuator.

Claims

1. A device that polishes a workpiece, the polishing device comprising:

a polishing member including a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece; and
a movement mechanism that moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member.

2. A device that polishes a workpiece, the polishing device comprising:

a polishing member including a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece;
a first movement mechanism that moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member; and
a second movement mechanism that moves at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.

3. A device that polishes a workpiece, the polishing device comprising:

a polishing member including a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece; and
a rotation mechanism that rotates at least one of the workpiece and the polishing member.

4. A device that polishes a workpiece, the polishing device comprising:

a polishing member including a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece; and
a pressing mechanism that presses at least one of the workpiece and the polishing member in a

- direction orthogonal to a rotation axis of the polishing member.
5. A device that polishes a workpiece, the polishing device comprising:
 - 5 a polishing member including a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece;
 - 10 a movement mechanism that moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member; and
 - 15 a rotation mechanism that rotates at least one of the workpiece and the polishing member.
 6. A device that polishes a workpiece, the polishing device comprising:
 - 20 a polishing member including a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece;
 - 25 a movement mechanism that moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member; and
 - 30 a pressing mechanism that presses at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.
 7. A device that polishes a workpiece, the polishing device comprising:
 - 35 a polishing member including a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece;
 - 40 a movement mechanism that moves at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member;
 - 45 a rotation mechanism that rotates at least one of the workpiece and the polishing member; and
 - 50 a pressing mechanism that presses at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.
 8. The polishing device according to any one of claims 1 to 7, further comprising:
 - 55 a motor that rotates the polishing member from below.
 9. The polishing device according to any one of claims
- 1 to 8, further comprising:
- a base including an upper surface, wherein when the polishing member is located on the upper surface, the base is rotated integrally with the polishing member.
 10. A method for polishing a workpiece with a polishing member, wherein the polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece, the polishing method comprising:
 - when polishing the workpiece, moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member.
 11. A method for polishing a workpiece with a polishing member, wherein the polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece, the polishing method comprising:
 - when polishing the workpiece, moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member; and
 - moving at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.
 12. A method for polishing a workpiece with a polishing member, wherein the polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece, the polishing method comprising:
 - rotating at least one of the workpiece and the polishing member.
 13. A method for polishing a workpiece with a polishing member, wherein the polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece, the polishing method comprising:
 - pressing at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member.
 14. A method for polishing a workpiece with a polishing member, wherein the polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece, the polishing method comprising:

moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member; and
 rotating at least one of the workpiece and the polishing member. 5

15. A method for polishing a workpiece with a polishing member, wherein the polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece, the polishing method comprising: 10

moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member; and 15
 pressing at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member. 20

16. A method for polishing a workpiece with a polishing member, wherein the polishing member includes a polishing surface that is shaped in conformance with the shape of a portion to be polished of the workpiece, the polishing method comprising: 25

moving at least one of the workpiece and the polishing member in a direction tangential to a radially outer circumferential surface of the polishing member; 30
 rotating at least one of the workpiece and the polishing member; and
 pressing at least one of the workpiece and the polishing member in a direction orthogonal to a rotation axis of the polishing member. 35

17. The polishing method according to any one of claims 10 to 16, further comprising: 40
 rotating the polishing member from below.

18. The polishing method according to any one of claims 10 to 17, further comprising: 45
 when the polishing member is located on an upper surface of a base, rotating the polishing member integrally with the base. 50

55

Fig.1

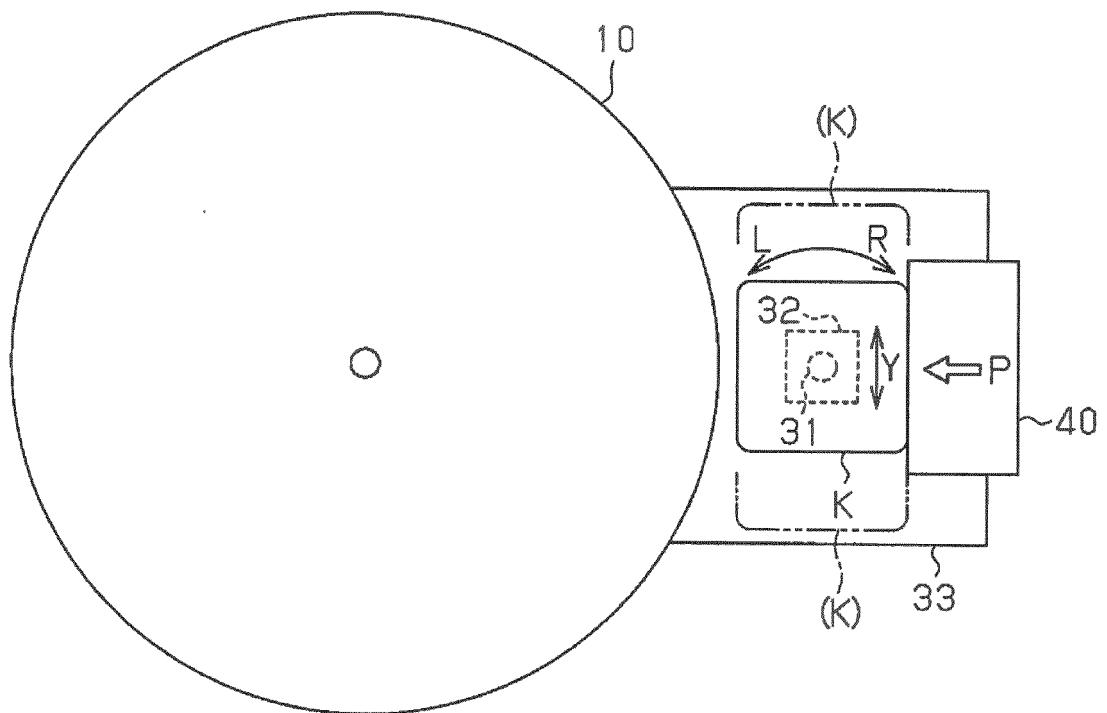


Fig.2

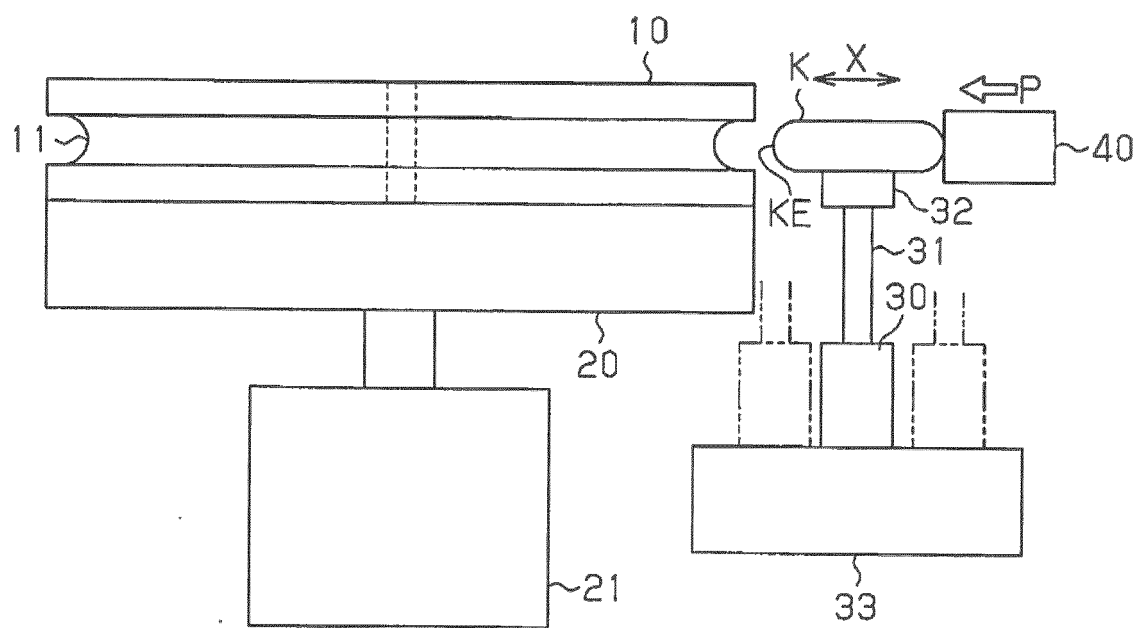


Fig.3

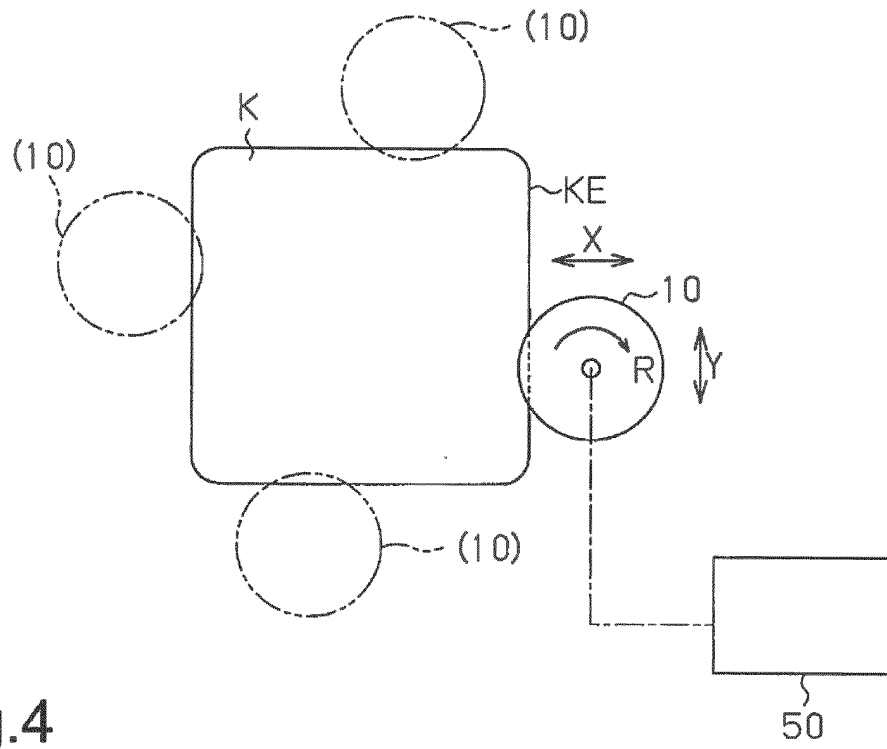


Fig.4

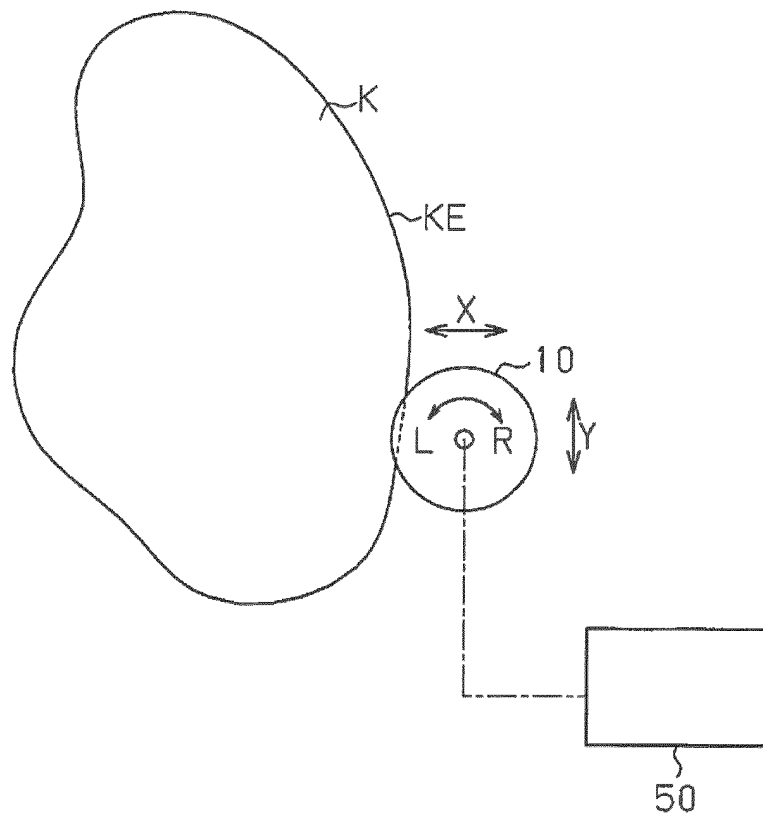


Fig.5

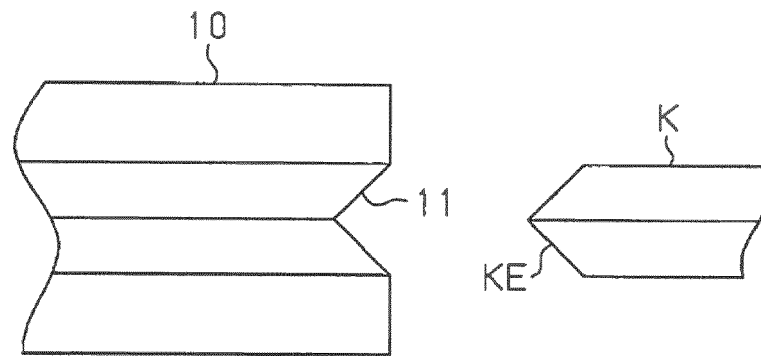


Fig.6

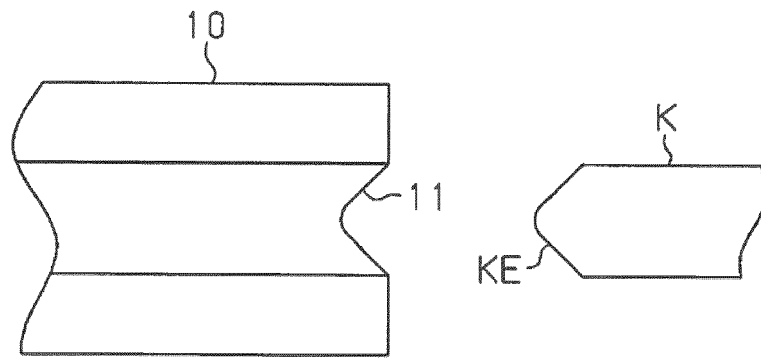


Fig.7

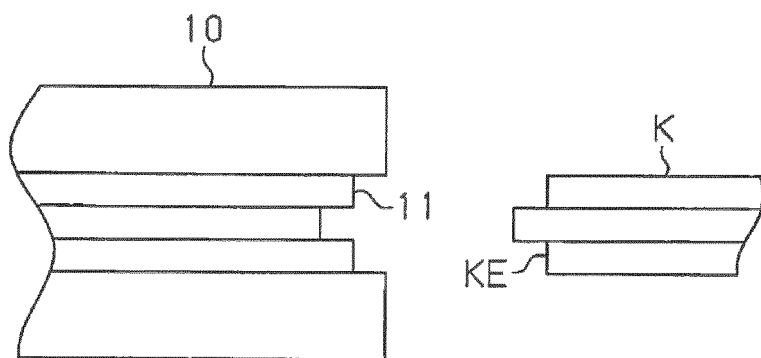


Fig.8

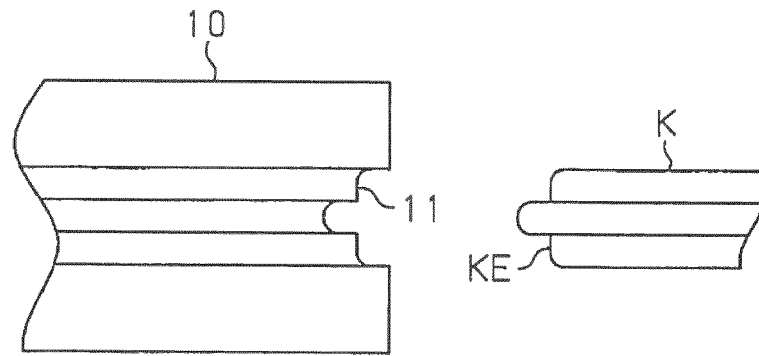


Fig.9

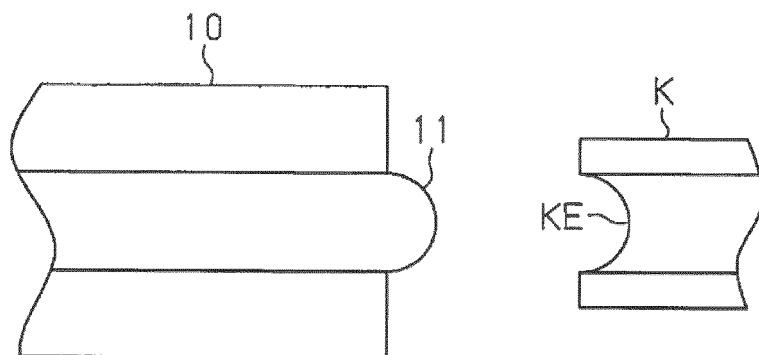


Fig.10

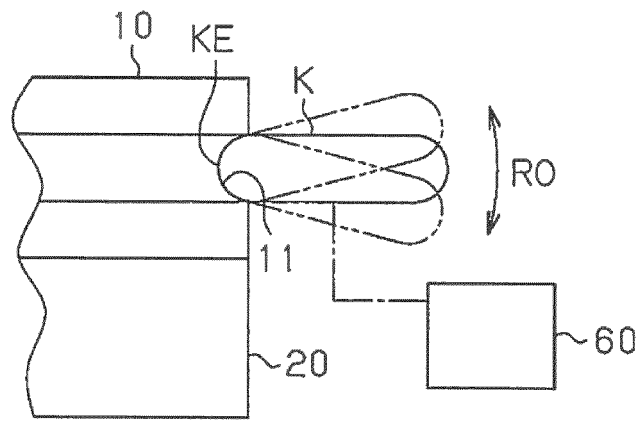


Fig.11

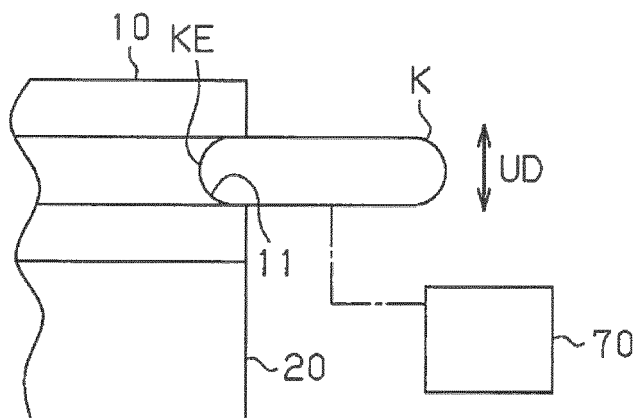
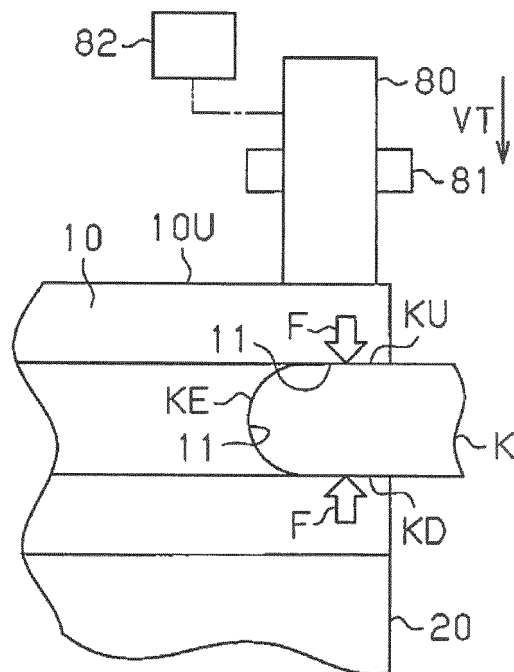


Fig.12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/076360

A. CLASSIFICATION OF SUBJECT MATTER

B24B19/08(2006.01)i, B24B9/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B24B19/08, B24B9/00, B24B7/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 61-65763 A (Nippon Sheet Glass Co., Ltd.), 04 April 1986 (04.04.1986), page 2, lower left column, line 13 to page 3, lower left column, line 7; fig. 1 to 5 (Family: none)	1-2, 4-11, 13-18
Y	JP 53-88291 A (Kabushiki Kaisha Fukuyama Tekkosho), 03 August 1978 (03.08.1978), fig. 5 to 6 (Family: none)	1-2, 4-11, 13-18
Y	JP 2001-38589 A (Speedfam Co., Ltd.), 13 February 2001 (13.02.2001), paragraph [0031] (Family: none)	1-2, 4-11, 13-18

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
03 December, 2014 (03.12.14)Date of mailing of the international search report
16 December, 2014 (16.12.14)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/076360

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 31140/1984 (Laid-open No. 143646/1985) (Toyoda Machine Works, Ltd.), 24 September 1985 (24.09.1985), specification, page 7, line 15 to page 8, line 7; fig. 1 (Family: none)	3, 12
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 96768/1982 (Laid-open No. 1548/1984) (Ken KOIDE), 07 January 1984 (07.01.1984), entire text; all drawings (Family: none)	1
A	JP 11-70471 A (Asahi Glass Co., Ltd.), 16 March 1999 (16.03.1999), entire text; all drawings (Family: none)	1
A	JP 4-360772 A (Toto Ltd.), 14 December 1992 (14.12.1992), entire text; all drawings (Family: none)	1
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 68118/1988 (Laid-open No. 170558/1989) (Showa Electric Wire & Cable Co., Ltd.), 01 December 1989 (01.12.1989), entire text; all drawings (Family: none)	1

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2001205549 A [0003]