(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 031 577 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
15.06.2016 Bulletin 2016/24

(21) Application number: **14834968.1**

(22) Date of filing: **06.08.2014**

(51) Int Cl.:
B24B 9/00 *(2006.01)* ***B24B 37/11*** *(2012.01)*
B24D 13/12 *(2006.01)* ***H01L 21/304*** *(2006.01)*

(86) International application number:
PCT/JP2014/070712

(87) International publication number:
WO 2015/020082 (12.02.2015 Gazette 2015/06)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **09.08.2013 JP 2013167116**

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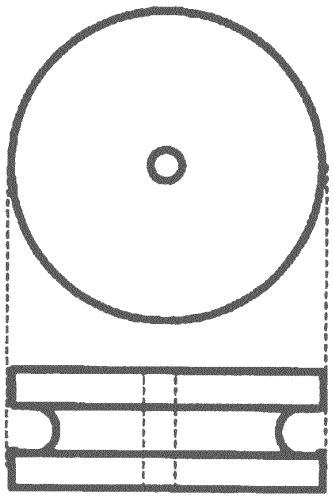
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(54) POLISHING TOOL AND PROCESSING METHOD FOR MEMBER

(57) The present invention relates to a method for polishing an object having a certain shape and, more particularly, to a polishing method using a polishing tool provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to efficiently and uniformly polish the curved surface of the object. A polishing tool of the present invention is provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object. The polishing pad preferably has a Shore A hardness of 5 or greater and a surface formed by at least one of a cloth, a non-woven fabric, a resin processed non-woven fabric, synthetic leather, synthetic resin foam, and a composite thereof. A polishing method of the present invention uses a polishing tool including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object and polish the curved surface of the object.

Fig.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a method for polishing an object having a certain edge shape and, more particularly, to a polishing method using a rotating polishing tool that holds a polishing pad shaped to efficiently and uniformly polish a curved edge of an object to be polished.

BACKGROUND ART

[0002] Generally, a polishing method using a rotating polishing tool that holds a polishing pad includes pressing the rotating polishing tool against the edge of an object to be polished in contact with the object to polish the surface of contact. For example, the edge of a silicon wafer is polished by pressing the silicon wafer at a certain angle to form a chamfered portion (refer to, for example, patent documents 1 and 2).

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, to polish the edge of an object to be polished, the position and angle of contact with the polishing tool needs to be adjusted in conformance with the shape of the object. In particular, when polishing the edge into a curved surface, the position and angle of the object to be polished needs to be adjusted and entirely be finished as a curved surface. Thus, the polishing requires skill, and the polishing time is longer compared to normal planar polishing.

[0005] Further, the number of objects that can be polished at the same time is limited in the conventional method. This lengthens the polishing time, which is not constant, and causes the polishing to be inefficient.

[0006] Thus, there is a demand for a rotating polishing tool and method that uniformly and efficiently polishes a curved edge of an object to be polished.

MEANS FOR SOLVING THE PROBLEM

[0007] The inventors of the present invention have studied the above problem and completed the present invention. More specifically, the present invention relates to a polishing method including pressing a polishing tool, which is provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object, against the curved surface of the object and polishing the curved surface of the object by feeding a polishing liquid to the pressed portion and moving the polishing pad relative to the object. This allows the curved surface of the object to be uniformly polished.

[0008] To achieve the above objective, one aspect of the present invention provides a polishing tool provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object.

[0009] It is preferred that the polishing tool be disk-shaped and have a diameter of 20 mm or larger, and that the polishing pad have a Shore A hardness of 5 or greater.

[0010] A further aspect of the present invention provides a processing method including, by using a polishing tool provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object, pressing the polishing pad against the curved surface of the object;, and polishing the curved surface of the object by rotating the polishing tool while feeding a polishing liquid to a portion of contact between the polishing pad and the object. It is preferred that the polishing tool be disk-shaped and have a diameter of 20 mm or larger, and that the method further include controlling a rotation speed of the polishing tool and reducing centrifugal force acting on the polishing surface to reduce dispersion of the polishing liquid.

[0011] A further aspect of the present invention provides a method for polishing an object with a polishing device that includes a pressure controller. The method includes measuring a contact pressure at a portion of contact between a curved surface of the object and a surface of a polishing tool, and controlling a polishing pressure and a shape of a polishing portion in the polishing tool so that the contact pressure is uniform.

EFFECTS OF THE INVENTION

[0012] The present invention succeeds in efficiently and uniformly polishing a curved surface of an object to be polished with a polishing tool that includes a polishing pad.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a diagram showing one example of the shape of a polishing pad.
Fig. 2 is a diagram showing one example of the

shape of a polishing pad. Grooves are formed to feed a polishing liquid from the center of the pad. Two identically shaped pads are prepared, and the two pads are combined for use.

Fig. 3 is a diagram showing one example of a polishing pad. Bores are formed in the central portion of the pad to feed a polishing liquid.

Fig. 4 is a diagram showing one example of the shape of a polishing pad. The pad of Fig. 2 is combined with the pad of Fig. 3.

Fig. 5 is a diagram showing one example of a polishing device.

Fig. 6 is a diagram showing one example of a polishing device.

Fig. 7 is a diagram showing one example of a polishing device. This example is provided with a polishing liquid feeding unit.

Fig. & is a diagram showing one example of a polishing device. This example is provided with a pressure sensor or a device that functions in the same manner as the pressure sensor.

Fig. 9 is a partial side view showing a modified example of a polishing tool, which includes a polishing pad, and an object to be polished.

Fig. 10 is a partial side view showing a modified example of a polishing tool, which includes a polishing pad, and an object to be polished.

Fig. 11 is a partial side view showing a modified example of a polishing tool, which includes a polishing pad, and an object to be polished.

Fig. 12 is a partial side view showing a modified example of a polishing tool, which includes a polishing pad, and an object to be polished.

Fig. 13 is a partial side view showing one example of a polishing tool that is modified in shape

Fig. 14 is a partial side view showing one example of a polishing tool that is modified in shape.

MODES FOR CARRYING OUT THE INVENTION

[0014] One embodiment of the present invention will now be described

[0015] A polishing tool of the present embodiment has a feature in that the polishing tool is provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished (workpiece to be polished) to uniformly contact the curved surface of the object (refer to Fig. 1). The polishing tool of the present embodiment has a feature in that the polishing tool is shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object.

[0016] An object to be polished used in the present embodiment includes a curved surface. The curved surface of the object shows a curved line in a cross-section orthogonal to a surface to be polished of the object. Further, the shape of the curved line is identical or similar in the cross-section at a number of locations on the surface to be polished. A polishing tool including a polishing surface shaped in conformance with a curved surface of an object to be polished may be used to polish the object. This results in uniform contact of the curved surface of the object with the polishing surface of the polishing tool and allows for uniform polishing The curved line in the cross-section of the surface to be polished of the object may have any shape The curved line may be an arc or a combination of arcs and partially include a straight portion. For example, the curved surface of the object to be polished may be bulged toward the outer side of the object (refer to example shown in Fig. 9) or recessed toward the inner side of the object (refer to example shown in Fig. 10). Further, the object to be polished may include a surface to be polished having a generally triangular cross-section with a rounded peak (refer to example shown in Fig. 11) or a generally stepped shape with rounded corners (refer to example shown in Fig. 12). Even when the surface to be polished of the object to be polished is a curved surface having one of the above shapes, the use of a polishing tool including a polishing surface shaped in conformance with the curved surface of the object to polish the object results in uniform contact of the curved surface of the object with the polishing surface of the polishing tool and allows for uniform polishing.

[0017] The polishing tool of the present embodiment has a feature in that the polishing tool is provided with a polishing pad that includes a polishing surface shaped in conformance with a curved surface of an object to be polished. The polishing pad of the present embodiment need only be located on the edge or the periphery of the polishing tool The polishing pad may be adhered to the periphery of the polishing tool, coupled to the periphery of the polishing tool, or molded in any manner on the periphery of the polishing tool. Alternatively, the polishing tool may be molded as the polishing pad. There is no particular restriction to the material of the polishing tool except for the polishing portion (polishing pad), and a resin, a metal, or a ceramic may be used. Alternatively, a mixture of a plurality of materials may be used. For example, when a resin is used as the material of the polishing tool, any synthetic resin may be used. Examples of such a synthetic resin include a thermosetting resin (such as phenol resin, epoxy resin, urethane resin, and polyimide) and a thermoplastic resin (such as polyethylene, polypropylene, acrylic resin, polyamide, and polycarbonate). When a metal is used as the material of the polishing tool, 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. When a ceramic is used as the material of the polishing tool, 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.

[0018] Further, any material may be used for the object to be polished. For example, when using a resin, any

synthetic resin may be used. Examples of such a synthetic resin include a thermosetting resin (such as phenol resin, epoxy resin, urethane resin, and polyimide) and a thermoplastic resin (such as polyethylene, polypropylene, acrylic resin, polyamide, and polycarbonate). When a ceramic is used as the material of the object to be polished, 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. When a metal is used as the material of the object to be polished, 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. The object to be polished may be used for any purpose. For example, the object to be polished 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

[0019] It is preferred that the polishing tool be disk-shaped and have a diameter of 20 mm or larger. When the polishing tool has a large size, a high linear velocity is obtained even when the rotation speed is the same. Thus, there is no need for the rotation speed of the polishing tool to be high when performing polishing. Further, the centrifugal force applied to the polishing surface by the rotation can be reduced. This limits the dispersion of the polishing liquid. The size of the polishing tool is preferably 30 mm or larger in diameter, and more preferably 50 mm or larger in diameter.

[0020] Further, the size of the polishing tool is preferably 1,000 mm in diameter or smaller, and more preferably 400 mm or smaller. When the diameter of the polishing tool is 1,000 mm and the rotation speed is 80 rpm, a linear velocity of 300 m/min is obtained. A polishing tool having a larger diameter obtains a higher linear velocity with a small rotation speed, further reduces the centrifugal force acting on the polishing surface, and limits the dispersion of the polishing liquid. When the size of the polishing tool is too large, the polishing device is enlarged and becomes noneconomic Thus, from an economic viewpoint, it is preferred that the size of the polishing tool be 1,000 mm or smaller in diameter.

[0021] Depending on the polishing method or the specification of the polishing device, the polishing tool may be larger when, for example, the device polishes a plurality of objects with a single polishing tool. When a plurality of objects are polished at the same time, the processing efficiency increases, and the number of polishing devices required for polishing can be decreased.

[0022] The polishing pad in the polishing tool of the present embodiment has a Shore A hardness of 5 or greater. When a polishing pad 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 pad 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 of the polishing pad is 5 or greater, the surface of the object to be polished can be polished in a preferred manner. Further, deformation of the surface of the polishing pad can be reduced that would be caused by polishing performed within a short period of time.

[0023] The polishing tool of the present embodiment has a feature in that the material of the polishing pad is at least one of a cloth, a non-woven fabric, a resin processed non-woven fabric, synthetic leather, synthetic resin foam, and a composite thereof. The polishing pad may include abrasive grains. When using a pad including abrasive grains, the type 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.

[0024] The polishing method of the present embodiment is performed by using a polishing tool provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object, pressing the polishing pad against the curved surface of the object, and polishing the curved surface of the object by rotating the polishing tool while feeding a polishing liquid to a portion of contact between the polishing pad and the object.

[0025] The polishing method of the present embodiment has a feature in that a polishing liquid is fed to the portion of contact between the polishing pad and the object to be polished. The polishing liquid may be fed by directly feeding the polishing liquid to the portion of contact from the outer side. Depending on the structure of the polishing device, for example, a polishing liquid feeding mechanism such as a rotary joint may be arranged at a connection portion of the polishing tool to directly feed a polishing liquid (processing liquid) to the polishing portion from the inside of the polishing tool (refer to Figs. 2 to 4 and 7). The feeding efficiency of the polishing liquid can be further increased by feeding the polishing liquid from the inside.

[0026] To efficiently use the polishing liquid, it is further preferable that a cover be arranged around the rotating polishing tool and that a recovery device be provided to increase the recovery efficiency of the polishing liquid.

[0027] The polishing liquid may have a known composition used for polishing, lapping, or machining. The polishing liquid may be aqueous based, oil based, or ether based. Further, when necessary, an additive such as a pH adjuster, an etching agent, an oxidant, a complexing agent, a surfactant, an emulsifier, an antioxidant, an anticorrosive, a protective film forming agent, a thickener, a stabilizing agent, a dispersant, an antiseptic, and a fungicide may be used. Abrasive grains may further be added to the polishing liquid. The type of abrasive grains used for the polishing liquid 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. Further, organic particles using, for example, thermoplastic resin may be used.

[0028] It is preferred that the linear velocity during the polishing be 10 m/min or higher. When the linear velocity is 10m/min or higher, the edge of the object to be polished may be efficiently polished

[0029] The rotation speed of the polishing tool during the polishing is preferably 5,000 rpm or lower, and more preferably 2,000 rpm or lower. When the polishing tool is rotated at a high speed of 5,000 rpm or higher, the centrifugal force acting on the polishing surface disperses the polishing liquid. Thus, to continue polishing, the polishing liquid needs to be replenished to make up for the dispersed amount. Thus, to hold the polishing liquid in the polishing tool in a suitable manner and perform stably polishing, the preferred rotation speed is 5,000 rpm or lower.

[0030] The processing method of the present embodiment attaches a polishing tool to a certain polishing device to use the polishing tool. As long as the polishing device includes a mechanism that can hold and rotate the polishing tool, the polishing device is not particularly limited and may be, for example, a known polishing device. Examples of the polishing device include grinding devices such as a cylindrical grinder, a bench grinder, and a grinder. The relative positions of the polishing tool and the object to be polished need to be set so that the curved surface of the object can be polished. However, there may be any positional relationship. For example, the polishing tool may be supported horizontally (refer to Fig. 6) or vertically (refer to Fig. 5) and be pressed from any direction against the object to be polished to perform polishing In the polishing method of the present embodiment, a jig is used to fix the object to be polished at a certain angle and position. The jig is preferably movable and preferably able to sequentially perform polishing while moving the edge of the object to be polished.

[0031] The polishing method of the present embodiment is performed by attaching a polishing tool and/or an object to be polished to a polishing device that includes a pressure controller when polishing the object with the polishing tool, measuring the contact pressure at a portion of contact between a curved surface of the object and a surface of the polishing tool, and controlling the polishing pressure and the shape of the polishing portion in the polishing tool so that the contact pressure is uniform. To perform further uniform and accurate polishing, a pressure sensor or a device that functions in the same manner as the pressure sensor, namely, a pressure controller, is attached to the rotation shaft of the object to be polished, the rotation shaft of the polishing tool, or the polishing tool. The pressure at the portion of contact between the curved surface of the object to be polished and the polishing tool surface is measured and the distribution and change of the contact pressure are measured to control the polishing pressure and the shape of the polishing portion in the polishing tool during polishing. This keeps the polishing accuracy and the polishing efficiency constant and allows the timing for replacing the polishing tool to be checked (refer to Fig. 8).

[0032] Figs. 13 and 14 show a modified example of the present embodiment. In the modified example shown in Fig. 13, the polishing tool 10 includes a polishing pad formed from the material described above, more specifically, a material that elastically deforms and has a certain degree of elasticity. A polishing surface 11 has a width H1 in a direction parallel to the rotation axis of the polishing tool 10 (direction of arrow Y in Fig. 13) that is smaller by a predetermined amount a than the thickness T1 of the object to be polished K (i.e., distance between upper surface KU and lower surface KD of object to be polished K) prior to polishing. In this manner, the polishing pad is formed from an elastic body, and the polishing surface 11 of the polishing pad is shaped to be smaller than the shape of the portion to be polished in the object K. This example has the advantages described below.

[0033] As shown in Fig. 14, in this modified example, when the polishing tool 10 is rotated and the object to be polished K is pressed against the polishing surface 11, the polishing pad, which is elastically deformed by the predetermined amount α, applies a pressing force F to the upper surface KU and the lower surface KD of the object to be polished K. This is advantageous in that when polishing the object to be polished K, in addition to the edge KE, which has a curved surface, the upper surface KU and the lower surface KD are simultaneously polished. When the predetermined amount α is increased, the elastic deformation amount of the polishing pad increases when polishing the object to be polished K. Thus, the pressing force F applied to the upper surface KU and the lower surface KD of the object to be polished K may be optimized by optimizing the predetermined amount α.

[0034] The force for pressing the edge KE of the object to be polished K against the polishing surface 11 and the pressing force F applied to the upper surface KU and the lower surface KD of the object to be polished K may be adjusted when necessary to properly polish the object K.

[0035] As described above, when molding the polishing tool as the polishing pad, the polishing tool 10 is formed of a material like a resin that elastically deforms and has a certain degree of elasticity. Further, in the same manner as the modified example shown in Fig. 13, the width H1 of the polishing surface 11 in the polishing tool 10 is smaller by a predetermined amount α than the thickness T1 of the object to be polished K prior to polishing. In this manner, when the polishing tool 10, which functions as a polishing pad, is formed by an elastic body, and the polishing surface 11 of the polishing tool 10 is shaped to be smaller than the portion to be polished in the object to be polished K, advantages similar to those of the modified example shown in Fig. 13 can be obtained.

INDUSTRIAL APPLICABILITY

[0036] As described above, the present invention is effective as a polishing tool and a polishing method for accurately polishing a curved surface of an object to be polished. In particular, the present invention allows a curved surface of an object to be polished with high accuracy. Further, the present invention is more efficient than the conventional method.

DESCRIPTION OF THE REFERENCE CHARACTERS

[0037] 10: polishing tool, 11: polishing surface, K: object to be polished, KE: edge (of object to be polished), KU: upper surface (of object to be polished), KD: lower surface (of object to be polished)

Claims

1. A polishing tool comprising a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object.

2. The polishing tool according to claim 1, wherein the polishing tool is disk-shaped and has a diameter of 20 mm or larger.

3. The polishing tool according to claim 1 or 2, wherein the polishing pad has a Shore A hardness of 5 or greater

4. A processing method comprising:

   by using a polishing tool provided with a polishing pad including a polishing surface shaped in conformance with a curved surface of an object to be polished to uniformly contact the curved surface of the object pressing the polishing pad against the curved surface of the object; and
   polishing the curved surface of the object by rotating the polishing tool while feeding a polishing liquid to a portion of contact between the polishing pad and the object

5. The processing method according to claim 4, wherein the polishing tool is disk-shaped and has a diameter of 20 mm or larger, the method further comprising controlling a rotation speed of the polishing tool and reducing centrifugal force acting on the polishing surface to reduce dispersion of the polishing liquid.

6. The processing method according to claim 4 or 5, wherein the polishing pad has a surface including abrasive grains

7. A method for polishing an object with a polishing tool, the method comprising:

   attaching the polishing tool and/or the object to be polished to a polishing device that includes a pressure controller;
   measuring a contact pressure at a portion of contact between a curved surface of the object and a surface of the polishing tool; and
   controlling a polishing pressure and a shape of a polishing portion in the polishing tool so that the contact pressure is uniform.

Fig.1

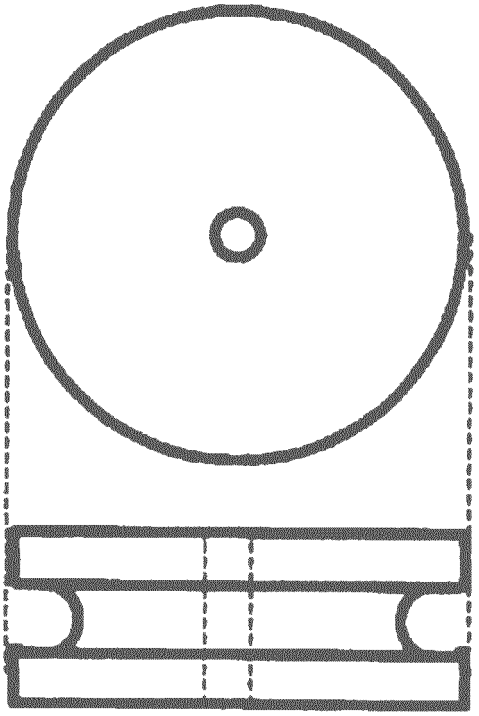


Fig.2

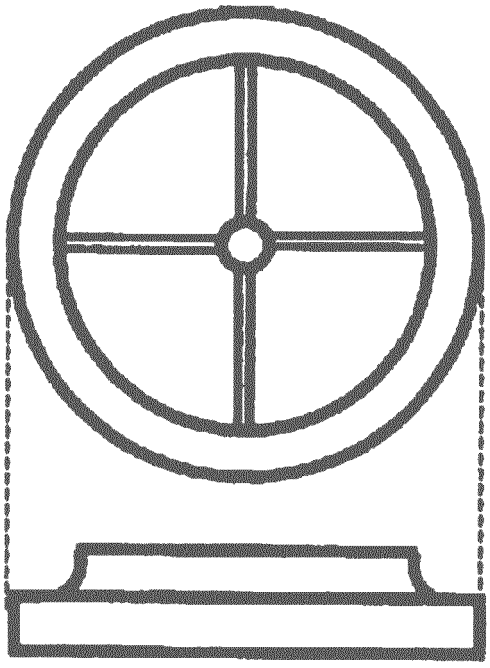


Fig.3

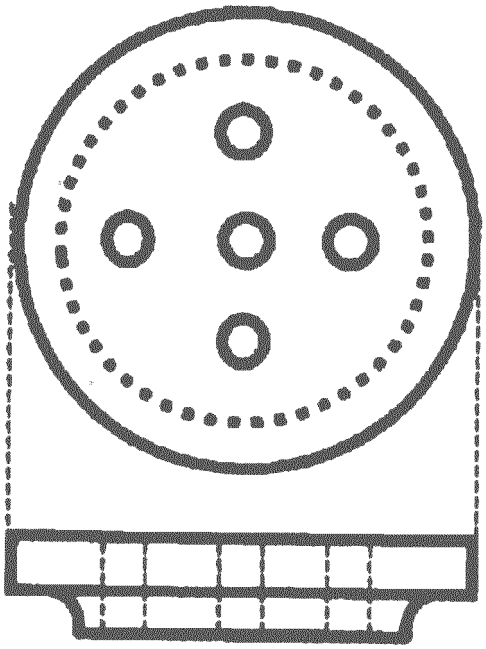


Fig.4

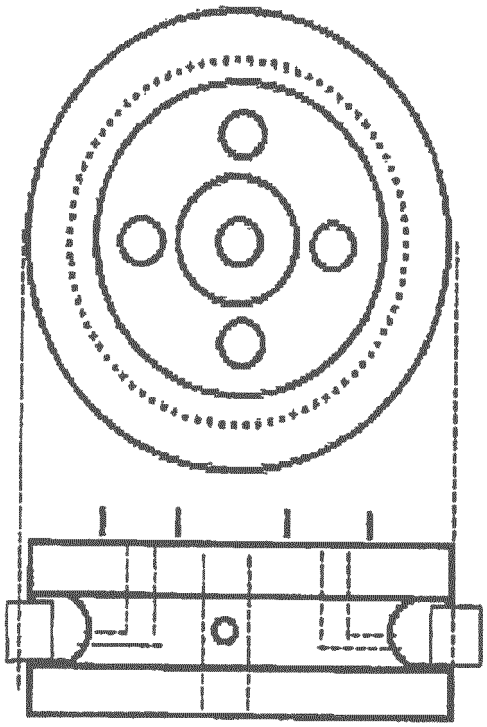


Fig.5

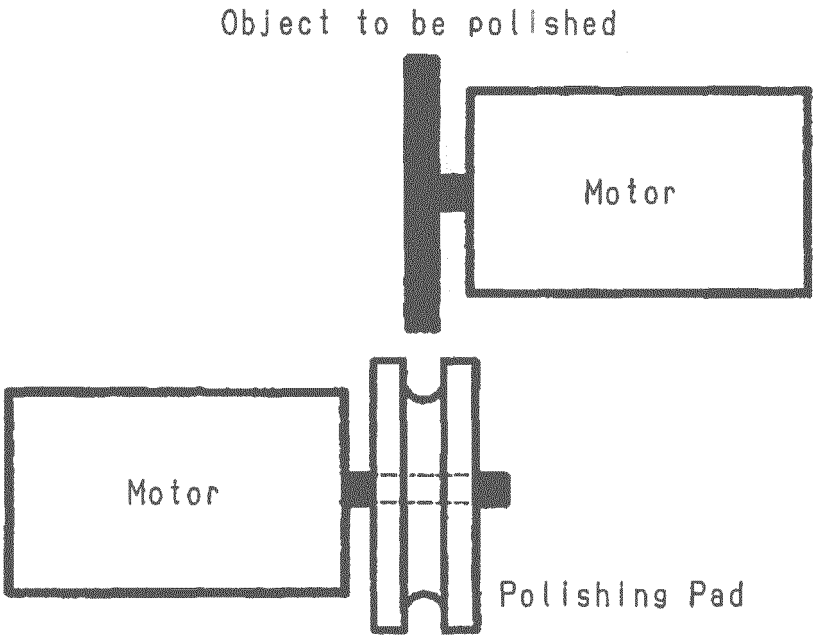

Object to be polished
Motor
Motor
Polishing Pad

Fig.6

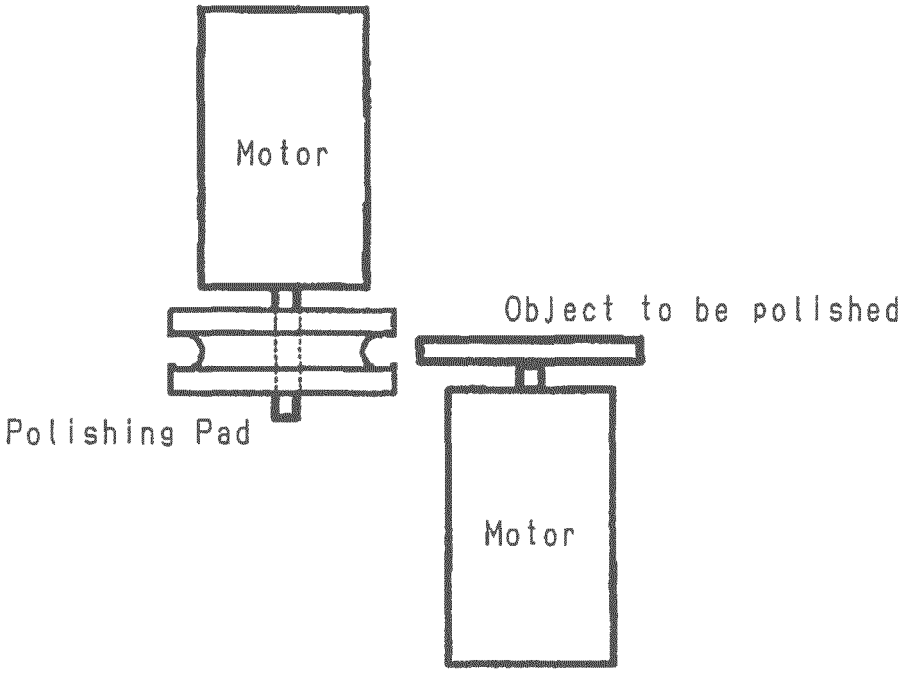

Motor
Object to be polished
Polishing Pad
Motor

Fig.7

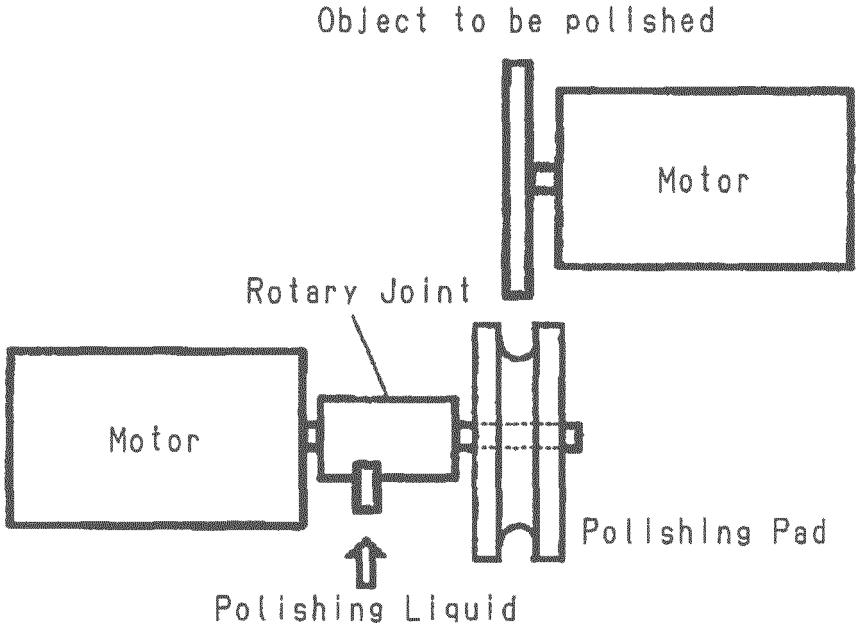

Object to be polished
Motor
Rotary Joint
Motor
Polishing Pad
Polishing Liquid

Fig.8

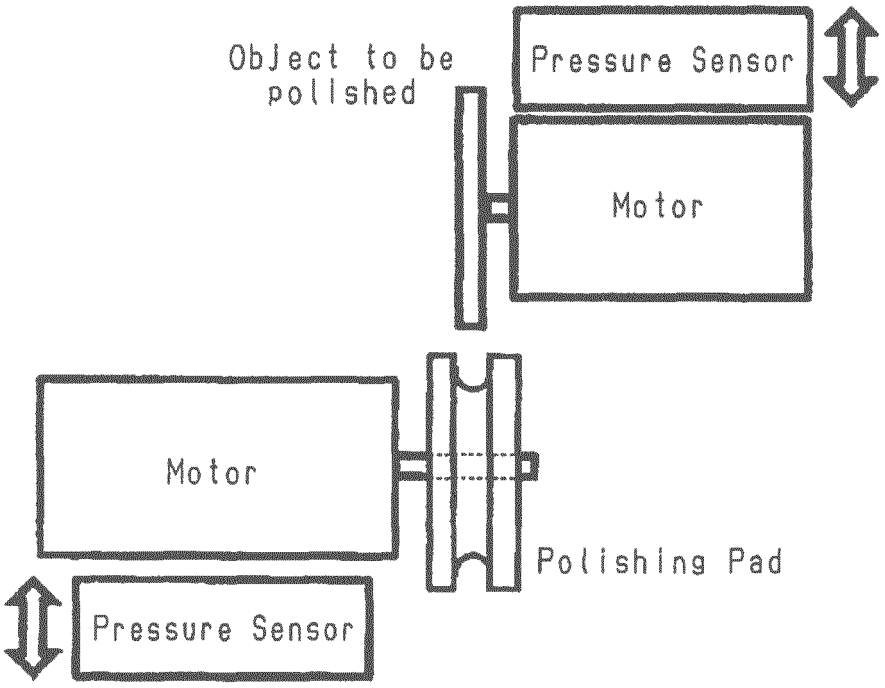

Object to be polished
Pressure Sensor
Motor
Motor
Polishing Pad
Pressure Sensor

Fig.9

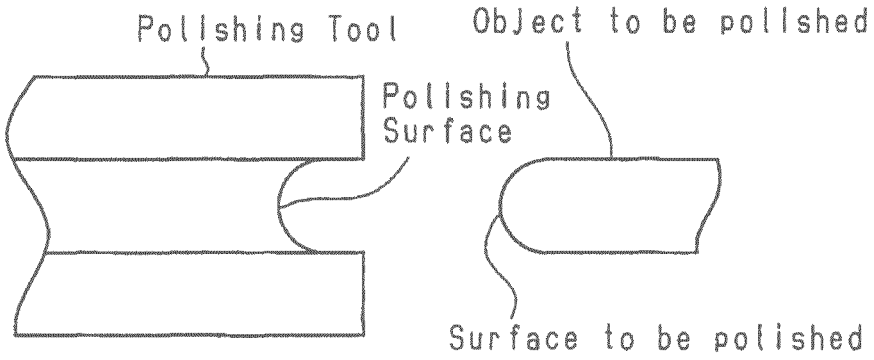

Polishing Tool
Object to be polished
Polishing Surface
Surface to be polished

Fig.10

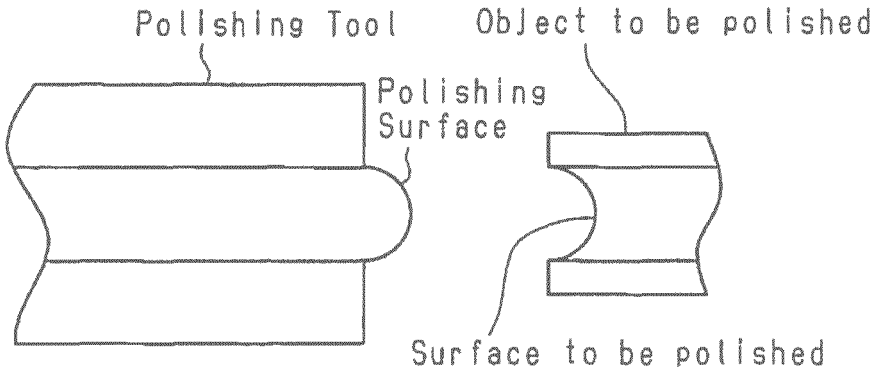

Polishing Tool
Object to be polished
Polishing Surface
Surface to be polished

Fig.11

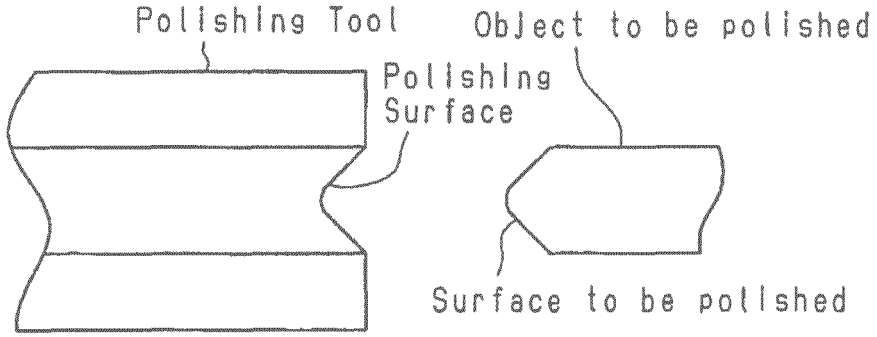

Polishing Tool
Object to be polished
Polishing Surface
Surface to be polished

Fig.12

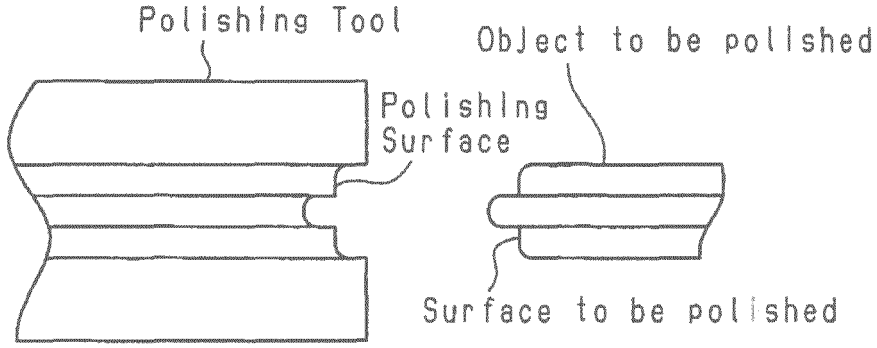

Polishing Tool
Object to be polished
Polishing Surface
Surface to be polished

Fig.13

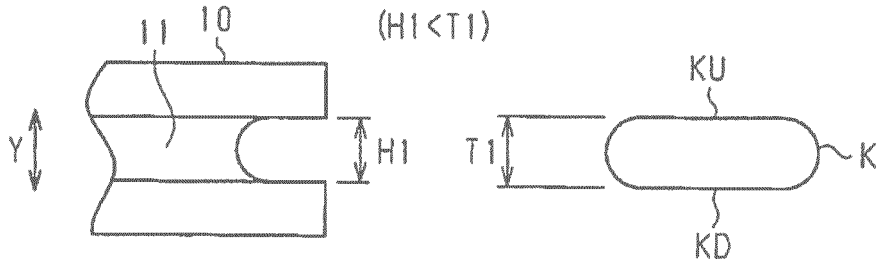
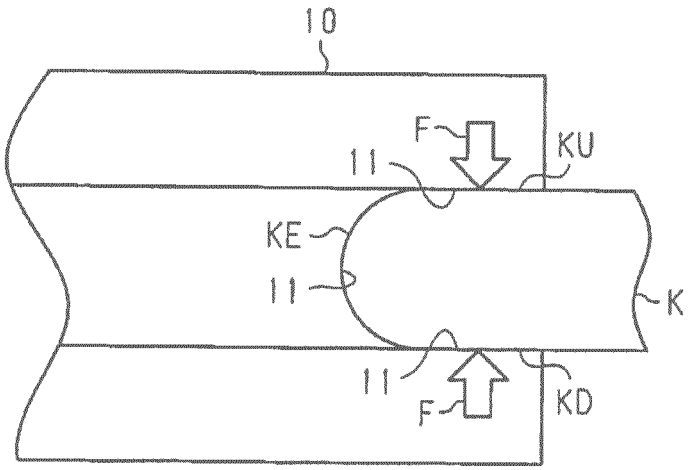


Fig.14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/070712

A. CLASSIFICATION OF SUBJECT MATTER
B24B9/00(2006.01)i, *B24B37/11*(2012.01)i, *B24D13/12*(2006.01)i, *H01L21/304*(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)
B24B9/00, B24B37/11, B24D13/12, H01L21/304

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)
WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 5-152260 A (Shin-Etsu Handotai Co., Ltd.), 18 June 1993 (18.06.1993), paragraph [0004]; fig. 6 & US 5317836 A & EP 549143 A1	1-5 6
Y	JP 2012-9550 A (Disco Inc.), 12 January 2012 (12.01.2012), paragraphs [0018] to [0024] (Family: none)	6

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

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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 October, 2014 (16.10.14)	28 October, 2014 (28.10.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/070712

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. 175567/1980(Laid-open No. 100456/1982) (Showa Soki Kabushiki Kaisha), 21 June 1982 (21.06.1982), specification, page 2, line 5 to page 3, line 17; fig. 1 (Family: none)	1-6
X	US 2010/0190416 A1 (SCHWARZENBACH Walter), 29 July 2010 (29.07.2010), paragraphs [0042] to [0046]; fig. 2 to 3 & JP 2010-177664 A & EP 2213415 A1 & CN 101791780 A & KR 10-2010-0088064 A	1
X	JP 2007-88143 A (Elpida Memory, Inc.), 05 April 2007 (05.04.2007), paragraphs [0014] to [0021]; fig. 1 to 3 & US 2007/0066192 A1	7
A	JP 2004-58186 A (Hitachi Zosen Corp.), 26 February 2004 (26.02.2004), paragraphs [0017] to [0025]; fig. 1 to 2 (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11188590 A **[0003]**
- JP 2001205549 A **[0003]**