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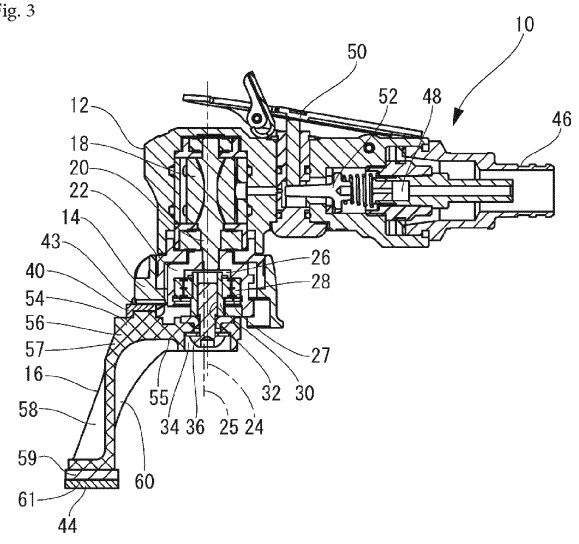
(54) POLISHING MACHINE

(57) [Technical Problem] An object is to provide a polishing machine capable of reducing vibration.

[Solution to Problem] A polishing machine (10) has an abrasive holding member (16) mounted to a drive shaft (22) rotationally driven by a vane air motor (18) such that the abrasive holding member (16) is rotatable about an eccentric axis (25) relative to a rotational drive center axis (24) of the drive shaft (22). The abrasive holding member (16) has a movement restricting part (40) provided at a position away from the eccentric axis in the direction of a radial axis (38) that is radial to the eccentric axis. A pair of guide rollers (42) and (43) provided in a body part (12) are disposed so that a first engagement position where one guide roller (42) and the movement restricting part engage each other and a second engagement position where the other guide member (43) and the movement restricting part engage with each other are located on the laterally opposite sides of the radial axis (38), facing each other across the radial axis, to restrict movement of the abrasive holding member (16) so that, when the drive shaft (22) is rotationally driven, the abrasive holding member (16) is displaced in the direction of the radial axis (38), while pivoting about a point between the first engagement position and the second engagement position.

Fig. 3



EP 3 115 150 A1

Description

Technical Field:

[0001] The present invention relates to polishing machines. More particularly, the present invention relates to a polishing machine in which an abrasive holding member fitted with an abrasive material is driven to rotate eccentrically.

Background Art:

[0002] There is a polishing machine in which an abrasive holding member fitted with an abrasive material is mounted to a drive shaft such that the abrasive holding member is rotatable about an eccentric axis extending parallel to a rotational drive center axis of the drive shaft at a position away from the rotational drive center axis, and in which the abrasive holding member is supported in such a manner as to restrict the lateral movement of the abrasive holding member in directions lateral to a radial axis that is radial to the eccentric axis, thereby moving the abrasive material in an elliptical motion which is a combination of a back-and-forth motion and an oscillating motion. In such a polishing machine, in order to restrict the lateral movement of the abrasive holding member, a guide roller mounted in the polishing machine body is rotatably engaged with the lateral side surfaces of a groove provided in the abrasive holding member (Patent Literature 1).

Citation List:

Patent Literature:

[0003] Patent Literature 1: Japanese Patent No. 5,363,870

Summary of Invention:

Technical Problem:

[0004] In the above-described conventional polishing machine, the guide roller alternately engages the lateral side surfaces of the groove to thereby restrict the lateral movement of the abrasive holding member at a position where the groove is formed. In order for the guide roller to engage the groove while rotating smoothly, the guide roller has to always engage only one of the lateral side surfaces of the groove without engaging the two side surfaces simultaneously. Accordingly, the diameter of the guide roller is set smaller than the breadth of the groove so that a clearance is formed between the guide roller and one side surface of the groove. Consequently, when the guide roller moves from a position of engagement with one side surface to a position of engagement with the other side surface while the abrasive holding member is being driven, a collision occurs between the guide roller and the side surface. Since the abrasive holding member is driven at high speed, the collision occurs continuously, which may result in the polishing machine vibrating considerably.

[0005] An object of the present invention is to provide a polishing machine capable of reducing vibration as occurring in the conventional polishing machine.

Solution to Problem:

[0006] The present invention provides a polishing machine comprising: a body part; a motor mounted in the body part; a drive shaft rotationally driven by the motor; an abrasive holding member to be fitted with an abrasive material and mounted to the drive shaft such that the abrasive holding member is rotatable about an eccentric axis extending parallel to a rotational drive center axis of the drive shaft at a position away from the rotational drive center axis, the abrasive holding member having a movement restricting part provided at a position away from the eccentric axis in a direction of a radial axis that is radial to the eccentric axis; and a pair of guide members mounted in the body part at respective positions away from the rotational drive center axis to engage the movement restricting part, the pair of guide members being disposed so that a first engagement position where one of the pair of guide members and the movement restricting part engage each other and a second engagement position where the other of the pair of guide members and the movement restricting part engage each other are located on laterally opposite sides of the radial axis, facing each other across the radial axis, to restrict movement of the abrasive holding member so that, when the drive shaft is rotationally driven, the abrasive holding member is displaced in the direction of the radial axis, while pivoting about a point between the first engagement position and the second engagement position.

[0007] In the polishing machine, a pair of guide members are disposed so that the position of engagement between one of the guide members and the movement restricting part and the position of engagement between the other guide member and the movement restricting part are located on laterally opposite sides across the radial axis. Therefore, it is possible to restrict the movement of the abrasive holding member in a state where each guide member and the movement restricting part are kept in contact with each other at all times. Accordingly, it is possible to reduce vibration attributed to a clearance between the guide member and the movement restricting part, as experienced with the prior art.

[0008] Preferably, the pair of guide members may comprise guide rollers, respectively, which are rotatable relative to the body part.

[0009] With the above-described structure, the movement restricting part is smoothly rotationally engaged with the guide members; therefore, it is possible to reduce friction between the movement restricting part and the guide members and also possible to further reduce vi-

bration.

[0010] Preferably, the guide rollers may have respective rotation center axes inclined in opposite directions to each other with respect to the rotational drive center axis.

[0011] More preferably, the movement restricting part may have engagement surfaces engaging the pair of guide members, respectively, the engagement surfaces being inclined with respect to the eccentric axis so as to face in a direction away from a position at which the abrasive material is fitted to the abrasive holding member.

[0012] With the above-described structure, a load that the abrasive holding member receives when the abrasive material is pressed against a material to be polished can be borne not only by a portion of the abrasive holding member that is mounted to the drive shaft but also by a portion of the abrasive holding member that is in engagement with each guide member. Accordingly, deflection of the abrasive holding member due to the load is reduced, and stress applied to the abrasive holding member is dispersed. Consequently, it becomes possible to prevent breakage of the abrasive holding member.

[0013] Preferably, the movement restricting part may have a projection shape so as to be held between the pair of guide members.

[0014] Preferably, the pair of guide members may each be formed of an elastic member at at least a part thereof that engages the movement restricting part.

[0015] Also preferably, the movement restricting part of the abrasive holding member may be formed of an elastic member.

[0016] If the mutually engaging portions of the guide members and the movement restricting part are formed of elastic members, as stated above, vibration is absorbed by the elastic members, so that it becomes possible to further reduce the transmission of vibration to the body part.

[0017] Specifically, the abrasive holding member may comprise a first part having a drive shaft mounting portion mounted to the drive shaft, an upper surface facing the body part and provided with the movement restricting part, and a lower surface facing away from the upper surface, and a second part extending from the lower surface of the first part. The second part may be provided at a distal end thereof with an abrasive mounting portion to which an abrasive material is attached. The movement restricting part may be located between the drive shaft mounting portion and the abrasive mounting portion in the direction of the radial axis.

[0018] Embodiments of a polishing machine according to the present invention will be explained below on the basis of the accompanying drawings.

Brief Description of Drawings:

[0019]

Fig. 1 is a left side view of a polishing machine according to one embodiment of the present invention.

Fig. 2 is a front view of the polishing machine shown in Fig. 1.

Fig. 3 is a sectional view taken along the line III-III in Fig. 2.

Fig. 4 is a top view showing an abrasive holding member and a pair of guide rollers.

Fig. 5 is a schematic view showing the relationship between a pair of guide rollers and a movement restricting part in a second embodiment.

Fig. 6 is a schematic view showing the relationship between a pair of guide rollers and a movement restricting part in a third embodiment.

Fig. 7 is a left side view of a polishing machine with a flat plate-shaped abrasive holding member attached thereto.

Fig. 8 is a left side view of a polishing machine with a disk-shaped abrasive holding member attached thereto.

Description of Embodiments:

[0020] A polishing machine 10 according to one embodiment of the present invention has, as shown in Figs. 1 and 2, a body part 12 and an abrasive holding member 16 attached to a holding member mounting portion 14 located at the lower end of the body part 12. As shown in Fig. 3, the body part 12 is provided therein with a vane air motor 18, and a cup-shaped drive shaft 22 is secured to the lower end of an output shaft 20 of the vane air motor 18. The drive shaft 22 is driven to rotate about a rotational drive center axis 24 which is coincident with the axis of the output shaft 20. The drive shaft 22 is provided with a recess 26 with a circular cross-section centered on an eccentric axis 25 extending parallel to the rotational drive center axis 24 at a position away from the rotational drive center axis 24. The recess 26 has a tubular member 30 rotatably mounted therein through a radial bearing 28 attached to a circular inner peripheral surface 27 of the recess 26. The tubular member 30 constitutes an inner raceway of the radial bearing 28 and has an inner peripheral surface forming a threaded hole 32. The threaded hole 32 is threadedly engaged with a bolt 36 through a stepped hole 34 in the abrasive holding member 16, thereby allowing the abrasive holding member 16 to be secured to the tubular member 30. In this way, the abrasive holding member 16 is mounted to the drive shaft 22, which is driven to rotate about the rotational drive center axis 24, such that the abrasive holding member 16 is rotatable about the eccentric axis 25. The abrasive holding member 16 has a movement restricting part 40 extending along a radial axis 38 extending in a predetermined radial direction (direction of radius) from the eccentric axis 25, as will be explained below. The movement restricting part 40 is engaged from both sides by a pair of guide rollers 42 and 43 provided in the holding member mounting portion 14 of the body part 12, thereby restricting the lateral movement of the movement restrict-

ing part 40. Thus, an abrasive material 44 attached to the distal end of the abrasive holding member 16 is moved in a reciprocating elliptical motion. The polishing machine 10 is a device that polishes a material to be polished by pressing the abrasive material 44, which moves in a reciprocating elliptical motion as stated above, against the material to be polished.

[0021] The body part 12 is provided at its rear end (right end as seen in Fig. 3) with an air tube joint 46 for connecting an air tube extending from an air pump (not shown), thereby introducing compressed air supplied through the connected air tube into the body part 12. A compressed air flow path 48 extends from the air tube joint 46 to the vane air motor 18. The compressed air flow path 48 is provided therein with a switching valve mechanism 52 which is actuated to open or close with an operating lever 50 pivotably attached to the body part 12. By actuating the operating lever 50, the supply of compressed air to the vane air motor 18 is controlled to thereby control the drive and stop of the vane air motor 18. The vane air motor 18 and the switching valve mechanism 52 in the polishing machine 10 are well-known to those skilled in the art; therefore, a detailed explanation thereof is omitted.

[0022] The abrasive holding member 16 has a horizontal portion 56 extending forward (leftward as seen in Figs. 3 and 4) and having an upper surface 54 facing the body part 12 and a lower surface 55 facing away from the upper surface 54, a vertical portion 58 extending downward from a front end portion 57 of the lower surface 55 of the horizontal portion 56, and an abrasive mounting portion 59 extending forward from the lower end of the vertical portion 58. The abrasive material 44 is attached to a lower surface 61 of the abrasive mounting portion 59 by using a pressure-sensitive adhesive seal. Both of the side portions of the horizontal portion 56, the vertical portion 58, and the abrasive mounting portion 59 are provided with ribs 60 to impart sufficient strength to the abrasive holding member 16.

[0023] The above-described pair of guide rollers 42 and 43 are, as shown in Fig. 4, disposed on the laterally opposite sides of a predetermined radial axis 38 extending from the eccentric axis 25 at respective positions facing each other across the radial axis 38. The guide rollers 42 and 43 have rotation center axes 62 and 63, respectively, which are, as will be clear from Fig. 2, inclined in opposite directions to each other with respect to the rotational drive center axis 24 of the drive shaft 22 so as to come closer to each other toward the upper side as seen from the front side of the polishing machine 10. Consequently, rotational engagement surfaces 64 and 65 of the guide rollers 42 and 43 are also inclined with respect to the rotational drive center axis 24 in the same way as the rotation center axes 62 and 63 of the guide rollers 42 and 43. It should be noted that the term "directions lateral to the radial axis 38" as used herein means directions perpendicularly intersecting both the eccentric axis 25 and the radial axis 38. It should be noted that the left side as seen in Fig. 2 corresponds to the right side of the radial axis 38, and the right side as seen in Fig. 2 corresponds to the left side of the radial axis 38. Further, the upper side as seen in Fig. 4 corresponds to the right side of the eccentric axis 25, and the lower side as seen in Fig. 4 corresponds to the left side of the eccentric axis 25.

[0024] The upper surface 54 of the abrasive holding member 16 is provided with an movement restricting part 40 of a rubber material at a position away from the eccentric axis 25 in the direction of the radial axis 38, which is radial to the eccentric axis 25. The movement restricting part 40 has stabilizing engagement surfaces 68 and 69 engaging the pair of guide rollers 42 and 43, respectively. The stabilizing engagement surfaces 68 and 69 are, as will be clear from Fig. 2, located on the laterally opposite sides of the radial axis 38 and inclined in opposite directions to each other with respect to the eccentric axis 25 (superimposed on the rotational drive center axis 24 in Fig. 2) as seen from the front side of the polishing machine 10 so as to face away from the abrasive mounting portion 59 (upward as seen in Fig. 2). The inclination angles of the stabilizing engagement surfaces 68 and 69 are set to be the same as the inclination angles of the rotation center axes 62 and 63 of the corresponding guide rollers 42 and 43. The movement restricting part 40 has a projection shape projecting upward so as to be held between the pair of guide rollers 42 and 43. Accordingly, the position of engagement between the left guide roller 42 and the left stabilizing engagement surface 68 of the movement restricting part 40 and the position of engagement between the right guide roller 43 and the right stabilizing engagement surface 69 of the movement restricting part 40 are located on the laterally opposite sides of the radial axis 38 at respective positions facing each other across the radial axis 38.

[0025] When the vane air motor 18 is rotationally driven, the abrasive holding member 16 performs an eccentric circular motion with respect to the rotational drive center axis 24 at the position of the stepped hole 34. At the position where the movement restricting part 40 is provided, however, the abrasive holding member 16 is restricted from moving in the directions lateral to the radial axis 38 by the pair of guide rollers 42 and 43. Consequently, the abrasive holding member 16 moves in such a manner that the abrasive holding member 16 is displaced along the direction of the radial axis 38, which is radial to the eccentric axis 25, while pivoting about a point between the positions of engagement between the stabilizing engagement surfaces 68 and 69 of the movement restricting part 40 and the associated guide rollers 42 and 43. Thus, the abrasive mounting portion 59, which is located further forward of the movement restricting part 40 as seen in the direction of the eccentric axis 25, performs a reciprocating elliptical motion which is a combination of an oscillating motion and a rectilinear motion. It should be noted that the locus of the abrasive mounting portion 59 changes depending on the positional relation-

ship between the eccentric axis 25, the movement restricting part 40, and the abrasive mounting portion 59. That is, when the movement restricting part 40 is located at the midpoint between the eccentric axis 25 and the abrasive mounting portion 59, the locus of the abrasive mounting portion 59 is circular. In this regard, however, motions of the abrasive mounting portion 59, including a motion describing such a circular locus, are herein referred to as "elliptical motion". Precisely, the locus of the abrasive mounting portion 59 is not elliptical or circular but a slightly distorted elliptical or circular shape.

[0026] Thus, in the polishing machine 10, the movement restricting part 40 is engagingly supported by two distinct guide rollers 42 and 43 at positions on the laterally opposite sides of the radial axis 38, which is radial to the eccentric axis 25. Therefore, the movement restricting part 40 and the guide rollers 42 and 43 can be kept in contact with each other at all times. Consequently, there will be no collision between the movement restricting part 40 and either of the guide rollers 42 and 43, and it is possible to reduce vibration considerably.

[0027] In this embodiment, the movement restricting part 40 of the abrasive holding member 16 is formed of a rubber material, which is an elastic member, as has been stated above. Therefore, when the abrasive holding member 16 is moved, the movement restricting part 40, which is held between the pair of guide rollers 42 and 43, always keeps in contact with the guide rollers 42 and 43 while being elastically deformed at the positions of engagement with the guide rollers 42 and 43. Further, since the movement restricting part 40 is formed of a rubber material, vibration of the abrasive holding member 16 is absorbed by the rubber material, so that the transmission of vibration to the body part 12 is further reduced. It should be noted that although in this embodiment the movement restricting part 40 is formed of an elastic member, the rotational engagement surfaces 64 and 65 of the guide rollers 42 and 43 may each be formed of an elastic member instead.

[0028] As has been stated above, the stabilizing engagement surfaces 68 and 69 of the movement restricting part 40 face obliquely upward, and the rotational engagement surfaces 64 and 65 of the guide rollers 42 and 43 face obliquely downward; therefore, the pair of guide rollers 42 and 43 can receive not only lateral force but also upward force from the abrasive holding member 16. Consequently, upward force that the abrasive holding member 16 is subjected to when the abrasive material 44 is pressed against a material to be polished during a polishing operation can be borne not only by the joint between the abrasive holding member 16 and the drive shaft 22 but also by the movement restricting part 40. Accordingly, stress applied to the abrasive holding member 16 is dispersed, so that the abrasive holding member 16 becomes less likely to break. In addition, vertical deflection at the abrasive mounting portion 59 is reduced, which results in a reduction in the change of the contact angle between the abrasive material 44 and the material to be polished when the abrasive material 44 is pressed against the material to be polished. Consequently, the polishing operation can be conducted in a state where the contact between the abrasive material and the material to be polished is even more stable.

[0029] In the above-described embodiment, the pair of guide rollers 42 and 43 are installed so that the rotation center axes 62 and 63 extend obliquely, thereby making the inclination angles of the rotational engagement surfaces 64 and 65 substantially the same as the inclination angles of the stabilizing engagement surfaces 68 and 69 of the movement restricting part 40. In another embodiment, it is possible to use guide rollers 142 and 143, as shown in Fig. 5, whose rotation center axes 162 and 163 are parallel to the rotational drive center axis 24 of the drive shaft 22 and whose rotational engagement surfaces 164 and 165 are conical surfaces inclined with respect to the rotation center axes 162 and 163. In still another embodiment, the movement restricting part 40, which has a projection shape, may be replaced with a movement restricting part 240, as shown in Fig. 6, which is shaped with a recess whose lateral side surfaces are defined as stabilizing engagement surfaces 268 and 269 engageable with guide rollers 242 and 243, respectively. In this case, the stabilizing engagement surfaces 268 and 269 are formed to oppose each other in the lateral direction and to face upward. Further, the guide rollers 242 and 243 are installed so that their rotation center axes 262 and 263 are inclined in opposite directions to each other with respect to the rotational drive center axis 24 of the drive shaft 22 so as to come closer to each other toward the lower side.

[0030] The abrasive holding member 16 of the polishing machine 10 can be easily detached by removing the bolt 36 and can also be replaced with another abrasive holding member, if necessary. For example, as shown in Fig. 7, the abrasive holding member 16 may be replaced with a flat plate-shaped abrasive holding member 116. The abrasive holding member 116 is rotatably mounted to the drive shaft 22 in the same way as the abrasive holding member 16 shown in Figs. 1 to 4 and has a movement restricting part 140 held between the pair of guide rollers 42 and 43. Accordingly, an abrasive material 144 stuck on a lower surface 161 of the abrasive holding member 116 performs a reciprocating elliptical motion. Alternatively, as shown in Fig. 8, the abrasive holding member 16 may be replaced with a disk-shaped abrasive holding member 216. The abrasive holding member 216 does not have either of the movement restricting parts 40 or 140, which are engaged with the pair of guide rollers 42 and 43. The abrasive holding member 216 is free to rotate about the eccentric axis 25 without being restricted. The abrasive holding member 216 has an abrasive material 244 attached to a lower surface 261 thereof. When the vane air motor 18 is driven with the abrasive material 244 pressed against a material to be polished, the abrasive holding member 216 revolves around the rotational drive center axis 24 of the drive

shaft 22, and while doing so, the abrasive holding member 216 rotates about the eccentric axis 25 by friction that the abrasive material 244 receives from the material to be polished and by its own centrifugal force.

[0031] In the relevant embodiments, the guide rollers 42 and 43 are used as guide members that guide the movement restricting part 40 (140) of the abrasive holding member 16(116), thereby rotationally supporting the movement restricting part 40 (140) and thus reducing sliding friction between each guide member and the movement restricting part 40

[0032] (140). However, the guide rollers 42 and 43 need not necessarily be used as guide members. For example, members made of a material having low frictional properties may be used to slidably support the movement restricting part 40 (140). The movement restricting part 40 (140) may also be supported with members that are flexibly elastically deformable in response to movement of the movement restricting part 40 (140).

List of Reference Signs:

[0033] Polishing machine 10; body part 12; holding member mounting part 14; abrasive holding member 16; vane air motor 18; output shaft 20; drive shaft 22; rotational drive center axis 24; eccentric axis 25; circular inner peripheral surface 27; radial bearing 28; tubular member 30; threaded hole 32; stepped hole 34; bolt 36; radial axis 38; movement restricting part 40; guide rollers 42 and 43; abrasive material 44; air tube joint 46; compressed air flow path 48; operating lever 50; switching valve mechanism 52; upper surface 54; lower surface 55; horizontal portion 56; front end portion 57; vertical portion 58; abrasive mounting portion 59; ribs 60; lower surface 61; rotation center axes 62 and 63; rotational engagement surfaces 64 and 65; stabilizing engagement surfaces 68 and 69; (flat plate-shaped) abrasive holding member 116; movement restricting part 140; guide rollers 142 and 143; abrasive material 144; lower surface 161; rotation center axes 162 and 163; rotational engagement surfaces 164 and 165; (disk-shaped) abrasive holding member 216; movement restricting part 240; guide rollers 242 and 243; abrasive material 244; lower surface 261; rotation center axes 262 and 263; stabilizing engagement surfaces 268 and 269.

Claims

1. A polishing machine comprising:

a body part;
a motor mounted in the body part;
a drive shaft rotationally driven by the motor;
an abrasive holding member to be fitted with an abrasive material and mounted to the drive shaft such that the abrasive holding member is rotatable about an eccentric axis extending parallel to a rotational drive center axis of the drive shaft at a position away from the rotational drive center axis, the abrasive holding member having a movement restricting part provided at a position away from the eccentric axis in a direction of a radial axis that is radial to the eccentric axis; and
a pair of guide members mounted in the body part at respective positions away from the rotational drive center axis to engage the movement restricting part, the pair of guide members being disposed so that a first engagement position where one of the pair of guide members and the movement restricting part engage each other and a second engagement position where the other of the pair of guide members and the movement restricting part engage each other are located on laterally opposite sides of the radial axis, facing each other across the radial axis, to restrict movement of the abrasive holding member so that, when the drive shaft is rotationally driven, the abrasive holding member is displaced in the direction of the radial axis, while pivoting about a point between the first engagement position and the second engagement position.

2. The polishing machine of claim 1, wherein the pair of guide members comprise guide rollers, respectively, which are rotatable relative to the body part.

3. The polishing machine of claim 2, wherein the guide rollers have respective rotation center axes inclined in opposite directions to each other with respect to the rotational drive center axis.

4. The polishing machine of any one of claims 1 to 3, wherein the movement restricting part has engagement surfaces engaging the pair of guide members, respectively, the engagement surfaces being inclined with respect to the eccentric axis so as to face in a direction away from a position at which the abrasive material is fitted to the abrasive holding member.

5. The polishing machine of any one of claims 1 to 4, wherein the movement restricting part has a projection shape so as to be held between the pair of guide members.

6. The polishing machine of any one of claims 1 to 5, wherein the pair of guide members are each formed of an elastic member at at least a part thereof that engages the movement restricting part.

7. The polishing machine of any one of claims 1 to 6, wherein the movement restricting part of the abrasive holding member is formed of an elastic member.

8. The polishing machine of any one of claims 1 to 7,

wherein the abrasive holding member comprises a first part having a drive shaft mounting portion mounted to the drive shaft, an upper surface facing the body part and provided with the movement restricting part, and a lower surface facing away from the upper surface, and a second part extending from the lower surface of the first part, the second part being provided at a distal end thereof with an abrasive mounting portion to which an abrasive material is attached, the movement restricting part being located between the drive shaft mounting portion and the abrasive mounting portion in the direction of the radial axis.

Fig. 1

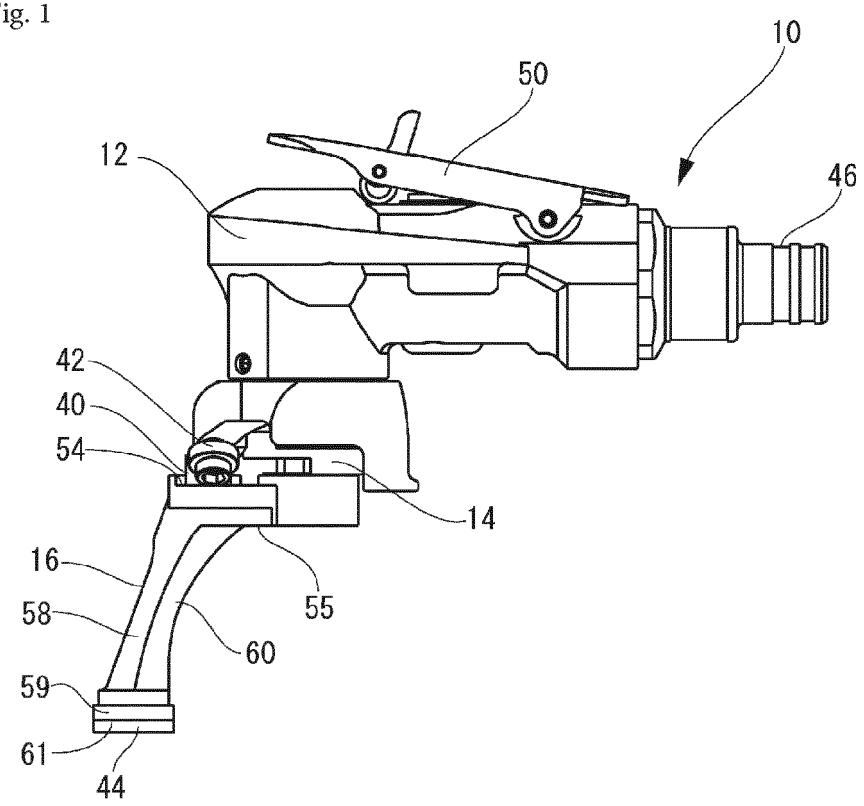

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Fig. 2

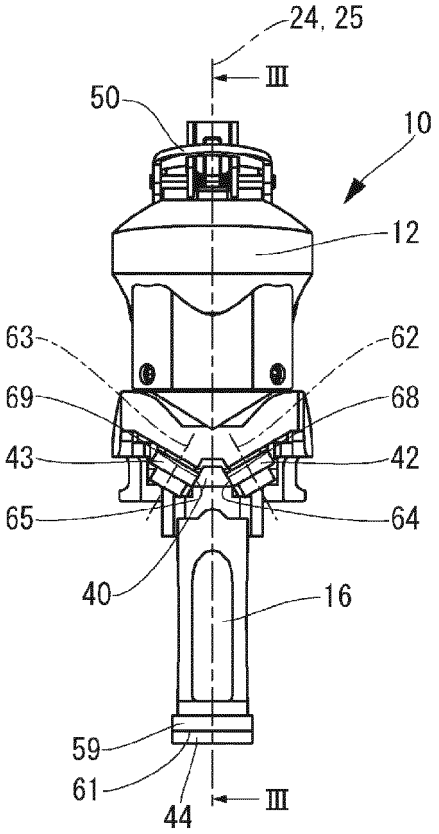
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Fig. 3

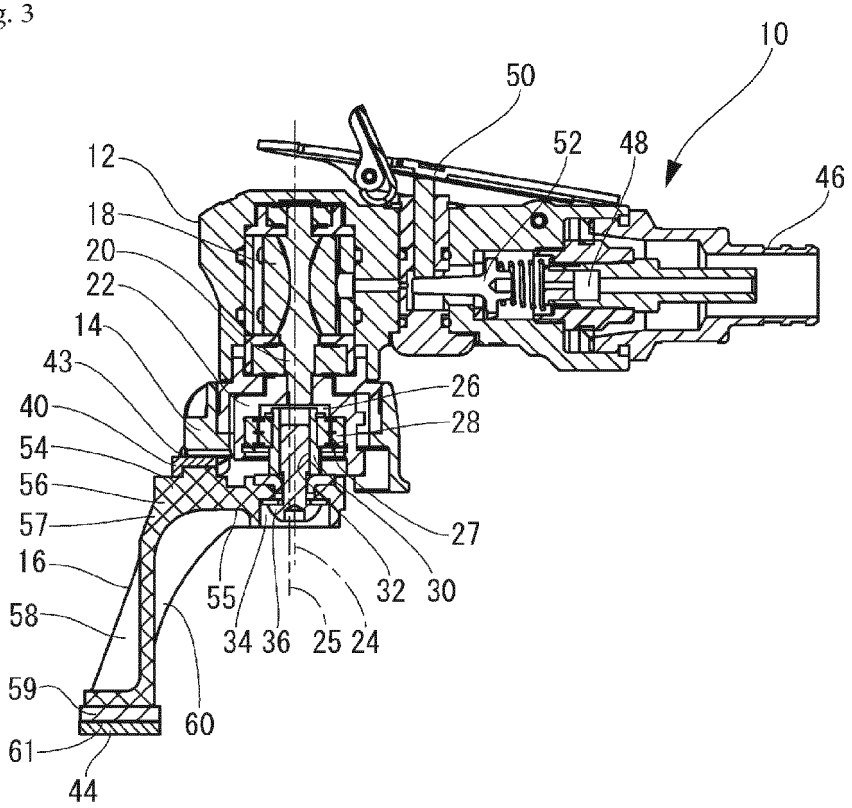
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Fig. 4

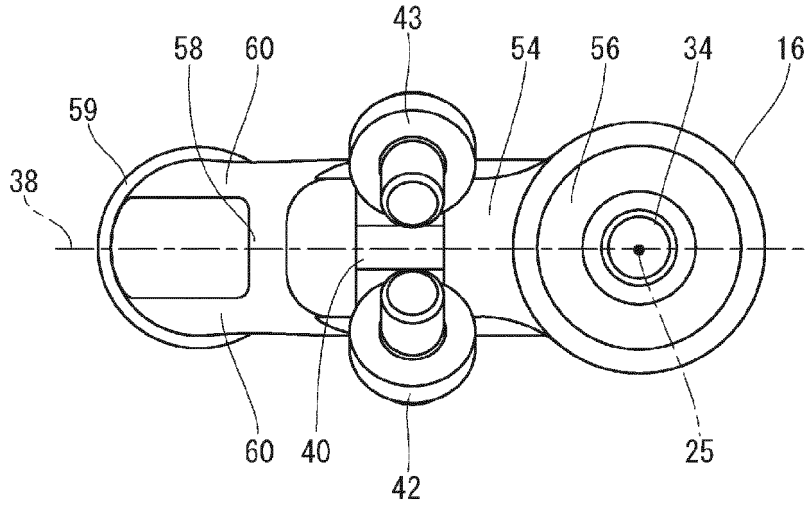
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Fig. 5

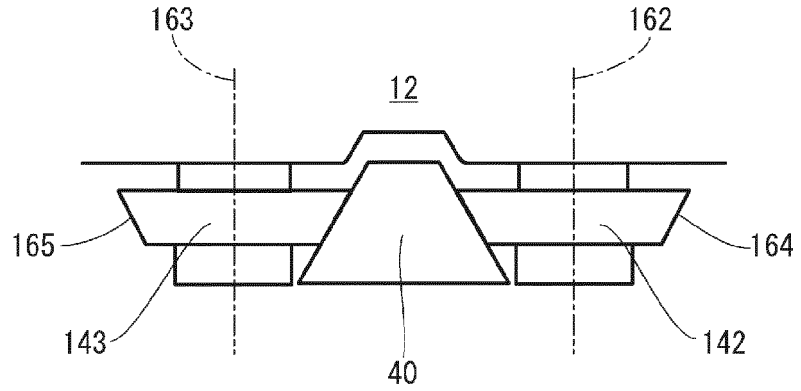


Fig. 6

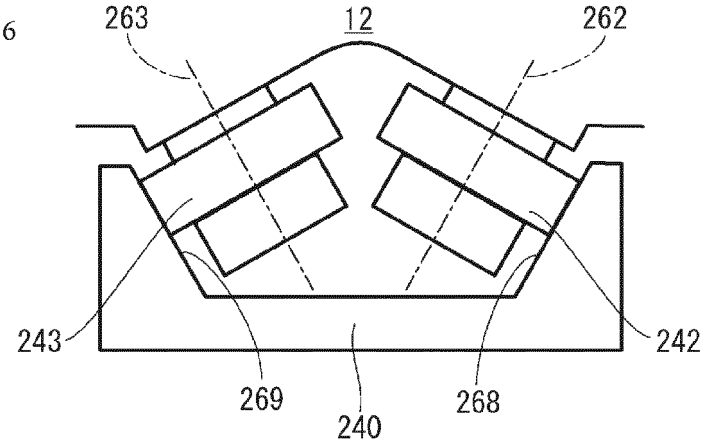


Fig. 7

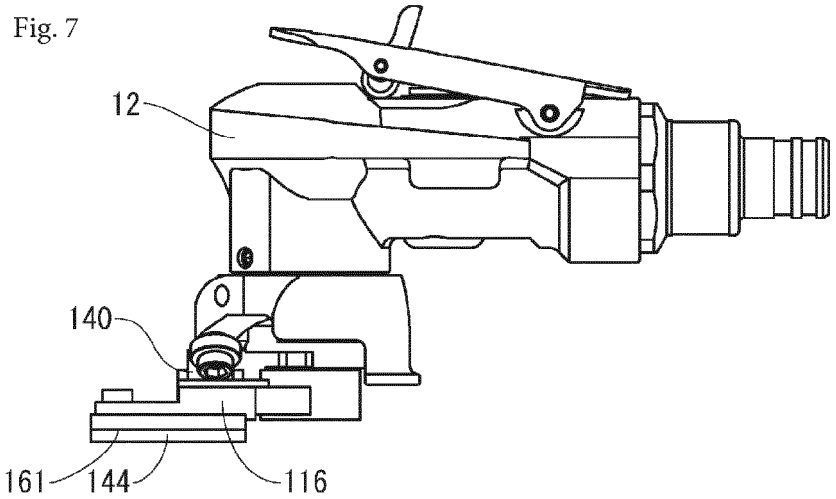
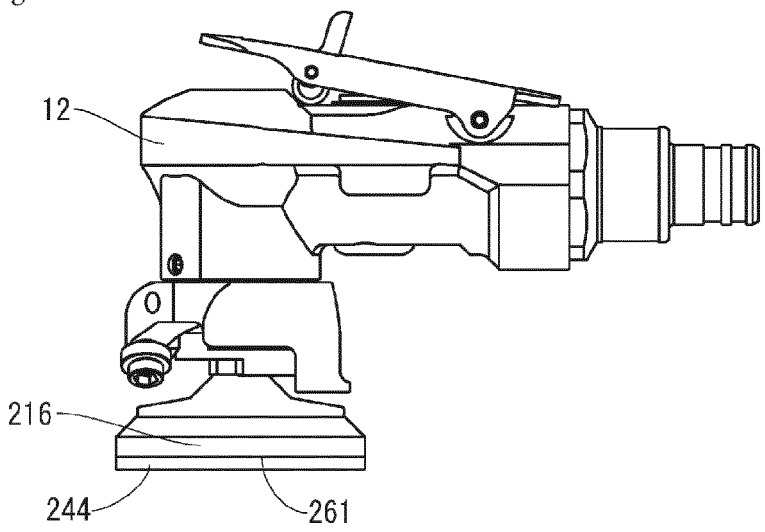


Fig. 8



riINTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/055554

A. CLASSIFICATION OF SUBJECT MATTER
B24B23/04(2006.01)i, *B24B23/02*(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)
B24B23/04, B24B23/02

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 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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 A	JP 5363870 B2 (Nitto Kohki Co., Ltd.), 11 December 2013 (11.12.2013), paragraphs [0025] to [0037]; fig. 1 to 4, 7 (Family: none)	1-2,5-8 3-4
Y	JP 8-332020 A (Michiaki EKIDA), 17 December 1996 (17.12.1996), paragraphs [0016] to [0017]; fig. 2 to 3 (Family: none)	1-2,5-8

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

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Date of the actual completion of the international search	Date of mailing of the international search report
21 April 2015 (21.04.15)	12 May 2015 (12.05.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 161342/1988(Laid-open No. 82456/1990) (Mitsubishi Heavy Industries, Ltd.), 26 June 1990 (26.06.1990), fig. 1 (Family: none)	1-8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5363870 B **[0003]**