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(72) Inventors:
• **TAKAHASHI, Yuji**
Anjo-shi
Aichi 446-8502 (JP)
• **KOIKE, Yoichiro**
Anjo-shi
Aichi 446-8502 (JP)

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(71) Applicant: **Makita Corporation**
Anjo-shi, Aichi 446-8502 (JP)

(74) Representative: **Kramer - Barske - Schmidtchen**
European Patent Attorneys
Landsberger Strasse 300
80687 München (DE)

(54) **ROTARY BLADE TOOL FIXING DEVICE**

(57) A fixing device for fixing a rotary blade to a spindle in a bench circular saw, for example, has a structure in which it is difficult to achieve structural compactification in radial size. Therefore, there has been a problem of sacrificing an inclination angle and a cutting depth of the rotary blade. Provided is a fixing device free from such problems owing to employment of a structure which can be easily compactified in a radial direction. Cam portions (12c and 13d) are provided on respective surfaces opposite to each other of an intermediate flange (12) and an outer flange (13) so as to mesh with each other. The cam portions (12c and 13d) slide with each other with a rotational force imparted to the rotary blade so that the rotational force is converted into a displacement in a direction of an axis (J) of the intermediate flange (12) and is applied in a direction of clamping the rotary blade (2).

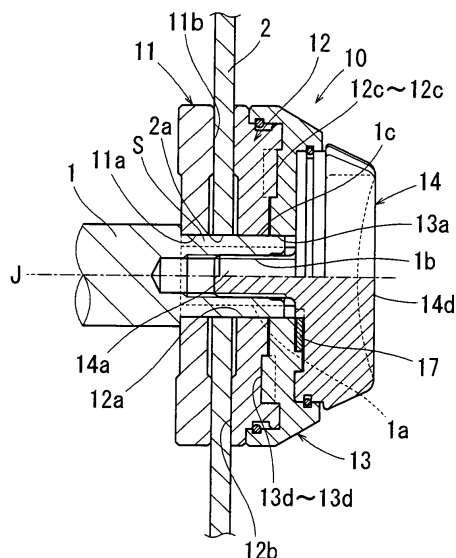


FIG. 1

Description

Technical Field

[0001] The present invention relates to a fixing device, for example, for attaching a circular cutting blade (rotary blade) to a spindle in a portable circular saw and to a tool-less type fixing device which can easily be fastened by a manual manipulation and which can reliably prevent slippage (relative rotation) of the rotary blade relative to the spindle during use thereof.

Background Art

[0002] One conventional example of the tool-less type fixing device allowing an operator to attach and detach, without use of special tools, a circular rotary blade to the leading end of a spindle rotated by a drive motor is disclosed in Japanese Laid-Open Patent Publication No. 2001-96407. The conventional fixing device is constructed to have a ratchet mechanism for engaging and disengaging meshing of teeth with recessed portions on the outer peripheral side by displacing claw portions in a radial direction thereof.

In addition, as an alternative, there has been provided a fixing device which can be firmly fastened by a manual manipulation owing to a structure incorporating therein a planetary gear train for speed reduction.

Patent Document 1: Japanese Laid-Open Patent Publication No. 2001-96407

Disclosure of the Invention

Problems to be solved by the Invention

[0003] However, many of those conventional fixing devices have relatively large diameters because it is structurally difficult to achieve compactification in its radial direction. Therefore, there has been a problem in that the conventional fixing devices cannot be applied directly to, for example, portable circular saws. Regarding the portable circular saws, in a case of performing oblique cutting in which cutting blades are inclined and obliquely cut into materials to be subjected to cutting, for the purpose of enabling oblique cutting at large angles while avoiding interference of the fixing device with the materials to be subjected to cutting, it is desirable that the sizes in the radial and axial directions of the fixing device are as small as possible. Further, in the portable circular saws, when a fixing device having a large diameter is mounted to a center of the rotary blade, an upper limit of a cutting depth of the rotary blade with respect to the materials to be subjected to cutting is lowered. In this regard also, it was difficult to apply the conventional fixing devices directly to the cutting machines of this type.

Under the circumstances, the present invention has been made for the purpose of providing a fixing device for a rotary blade, with which the rotary blade can be firmly

fixed by a manual manipulation, in which slippage of the rotary blade relative to a spindle is not caused owing to cutting resistance or at a time of braking, and which is compact in a radial direction thereof and consequently can easily be applied to a circular saw capable of performing the oblique cutting.

Means for solving the Problems

[0004] Thus, the present invention provides a fixing device having structures described in respective claims. According to a fixing device as described in claim 1, when rotational resistance such as cutting resistance is imparted to a rotary blade, a relative rotational force is imparted between an intermediate flange and an inner flange or an outer flange, and the relative rotational force is converted into an axial force in a direction of an axis of a spindle via a cam meshing portion. The axial force is added to a clamping force of a fixing flange. As a result, the rotary blade is more firmly clamped between the inner flange and the outer flange, thereby being fixed more firmly to the spindle with respect to the rotation. Thus, it is only necessary for a user to lightly tighten the fixing flange at the time of mounting the rotary blade.

When no rotational resistance is not imparted to the rotary blade, the relative rotational force of the intermediate flange to the inner flange or the outer flange is not imparted. As a result, the axial force of the cam meshing portion is eliminated, and hence the fixing flange can be easily loosened.

As described above, the axial force produced in the cam meshing portion provided between the intermediate flange and the inner flange or the outer flange is utilized. Therefore, the rotary blade can be more firmly fixed without impairing compactness in the radial direction of the spindle, and eventually, can be easily applied to a circular saw or the like provided with a function of oblique cutting.

[0005] According to a fixing device as described in claim 2, the rotational resistance against the rotary blade acts as an external force for displacing the rotary blade in the rotational direction relative to the spindle (rotational force, hereinafter also simply referred to as rotational resistance). Meanwhile, the inner flange is fixed to the rotation fixing portion with respect to the rotation, and the intermediate flange is mounted to the rotation fixing portion so as to be relatively rotatable. Thus, the rotational resistance imparted to the rotary blade acts as a rotational force for rotating the intermediate flange with respect to the spindle. Owing to the rotational resistance, when being displaced in the rotational direction relative to the spindle, the intermediate flange is displaced in the rotational direction relative to the outer flange whose rotation is restricted by the rotation fixing portion. When the intermediate flange is displaced in the rotational direction relative to the outer flange, displacements of cam portions thereof in the circumferential direction (sliding operation) are produced. With this, the rotational resistance partially acts on the intermediate flange as a force com-

ponent (axial force) in the direction of the axis of the spindle, and acts on the intermediate flange as a pressing force to the rotary blade.

As described above, when high rotational resistance at the time of working or high inertia at the time of braking (hereinafter also simply referred to as rotational resistance) is imparted to the rotary blade, the rotational resistance or the like is partially converted via the sliding operation between the cam portions of the intermediate flange and the cam portions of the outer flange into an axial force for pressing the intermediate flange against the rotary blade. As a result, slippage in the rotational direction of the rotary blade relative to the inner flange can be prevented. With this, when a user manually couples the fixing flange with respect to the spindle by screwing, the rotational force of the rotary blade relative to the spindle is converted into the axial force for pressing the rotary blade toward the inner flange in the fixing device. With this, slippage of the rotary blade can be prevented. Therefore, it is possible to reliably prevent slippage of the rotary blade without impairing conventional operability.

Further, the axial force is produced by the sliding operation of the cam portions provided on the surfaces opposed to each other of the intermediate flange and the outer flange, and the clamping force of the rotary blade between the inner flange and the intermediate flange is increased by the axial force. Unlike the conventional methods, the movement in the radial direction of the spindle is not utilized, and hence the size in the radial direction of the fixing device is more easily compactified in comparison with that of conventional ones. The sizes in the radial direction and the axial direction of the spindle of the fixing device are compactified, whereby it is possible to set the inclination angle of the rotary blade of a portable circular saw at the time of oblique cutting to be large, and also possible to set the cutting depth into the material subjected to cutting to be large. Accordingly, the fixing device can be easily applied to the portable circular saw or the like.

According to a fixing device as described in claim 3, in addition to the above-mentioned operation and effects, the rotational force of the rotary blade (inertia at the time of activation or stopping and rotational resistance at the time of processing) is reliably transmitted to the intermediate flange so that the sliding operation of the cam portions can be efficiently produced. With this, it is possible to efficiently increase the pressing force of the intermediate flange to the rotary blade.

The frictional resistance of the intermediate flange relative to the rotary blade can be properly set based on materials thereof and an average diameter in the contact area. Further, inversely, a lubricant is interposed or applied between the cam surfaces of the cam portions, or the inclination angle of the cam surface is properly set, whereby the sliding resistance of the cam portions is reduced as much as possible in comparison with the frictional resistance of the intermediate flange relative to the

rotary blade.

[0006] According to a fixing device as described in claim 4, when no rotational resistance is not imparted to the rotary blade, the intermediate flange having the cam portions and the rotary blade are more easily displaced in the rotational direction relative to the inner flange, and eventually, to the spindle. With this, the cam portions are reliably restored to an initial position of meshing most deeply with each other, and a screw coupling force (screwing force) of the fixing flange to the spindle is weakened. As a result, it is possible to easily loosen the fixing flange with a small rotational manipulating force.

According to a fixing device as described in claim 5, the inner flange is fixed to the rotation fixing portion of the spindle with a play within a predetermined angular range. Therefore, the displacement of the intermediate flange relative to the rotation fixing portion is more easily obtained at the time no rotational resistance is not imparted to the rotary blade. With this, the fixing device smoothly shifts to a state in which the cam portions of the intermediate flange and the cam portions of the outer flange mesh most deeply with each other, whereby the screw coupling force of the fixing flange is reliably loosened.

According to a fixing device as described in claim 6, at the time no rotational resistance is not imparted to the rotary blade, the cam portions of the intermediate flange and the cam portions of the outer flange are reliably restored to the initial position (position of meshing most deeply with each other) by an elastic force of the cover. Therefore, the screw coupling force of the fixation flange is reliably loosened.

According to a fixing device as described in claim 7, at the time no rotational resistance is not imparted to the blade, the intermediate flange is restored to the initial position by an initial position biasing means, and the fixing device can be reliably shifted so that the cam portions of the intermediate flange and the cam portions of the outer flange mesh most deeply with each other. With this, the screw coupling force of the fixing flange relative to the spindle is loosened, whereby the fixing flange can be easily loosened with a small force in the case of replacing the rotary blade or the like.

According to a fixing device as described in claim 8, when the cam meshing portion is positioned on the side (inner flange side) opposite to that in the structure described in claim 2 relative to the rotary blade, the same operation and effects as those in the case of the structure described in claim 2 can also be obtained. Also in the fixing device described in claim 8, at the time no rotational resistance is imparted to the rotary blade, the intermediate flange is reliably displaced in the rotational direction. Thus, the fixing device reliably shifts to the state (initial state) in which the cam portions of the intermediate flange and the cam portions of the inner flange mesh most deeply with each other. With this, it is possible to reliably loosen the screw coupling force of the fixing flange relative to the spindle, thereby possible to easily loosen the fixing flange with a small rotational manipulating force.

According to a fixing device as described in claim 9, the cam meshing portions are arranged on both sides relative to the rotary blade. Thus, the displacements of an inner intermediate flange and an outer intermediate flange in the direction of the axis of the spindle approximately double, the deepest meshing with the cam portions occurring at the time no rotational resistance is imparted to the rotary blade. Therefore, the screw coupling force of the fixing flange relative to the spindle can be loosened more reliably. Also in the fixing device described in claim 9, at the time no rotational resistance is imparted to the rotary blade, the inner intermediate flange and the outer intermediate flange are more easily displaced in the rotational directions. Accordingly, it is ensured that the cam portions shift to a state of meshing most deeply with each other, whereby the screw coupling force of the fixing flange relative to the spindle can be loosened.

Brief Description of the Drawings

[0007]

FIG 1 is a vertical sectional view of a fixing device according to a first embodiment, for illustrating a state of a rotary blade fixed to a spindle by means of the fixing device.

FIG 2 is an exploded view of the fixing device according the first embodiment.

FIG. 3 is a view taken from the direction of arrows (III)-(III) of FIG. 2, and is a plan view of an intermediate flange.

FIG 4 is a sectional view taken along arrows (IV)-(IV) of FIG 3, and is a developed view of cam portions of the intermediate flange.

FIG 5 is a view taken from the direction of the arrows (V)-(V) of FIG 2, and is a plan view of an outer flange.

FIG 6 is a plan view of a fixing flange.

FIG 7 is a vertical sectional view of a fixing device according to a second embodiment, for illustrating the state of the rotary blade fixed to the spindle by means of the fixing device.

FIG 8 is a horizontal sectional view of a fixing device according to a third embodiment, for illustrating the state of the rotary blade fixed to the spindle by means of the fixing device.

FIG 9 is a vertical sectional view of a fixing device according to a fourth embodiment, for illustrating the state of the rotary blade fixed to the spindle by means of the fixing device.

FIG 10 is a vertical sectional view of a fixing device according to a fifth embodiment, for illustrating the state of the rotary blade fixed to the spindle by means of the fixing device.

FIG. 11 is a vertical sectional view of a fixing device according to a sixth embodiment, for illustrating the state of the rotary blade fixed to the spindle by means of the fixing device.

FIG 12 is a sectional view taken along arrows

(XII)-(XII) of FIG 11, and is a horizontal sectional view of the fixing device according to the sixth embodiment.

5 Best Modes for carrying out the Invention

[0008] Next, a first embodiment of the present invention is described with reference to FIGS. 1 to 6. In the first embodiment described below, there is exemplified a fixing device 10 for mounting a disk-shaped rotary blade 2 to a spindle 1 of a portable circular saw. The spindle 1 of a circular sawing machine is rotated about an axis J by a drive motor incorporated in a main body. At the leading end of the spindle 1, a small diameter portion 1c is formed in a stepped configuration to form an end portion Sa perpendicular to the axis J. Flat surfaces 1a and 1a parallel with each other are provided on the small diameter portion 1c, with the axis J positioned therebetween. The two flat surfaces 1a and 1a define a so-called two surface width portion S having an oval shape in cross-section at the small diameter portion 1c of the spindle 1. The two surface width portion S corresponds to an example of the rotation fixing portion described in claims. Hereinafter, the two surface width portion S is referred to as a rotation fixing portion S.

A threaded hole 1b is provided in the leading end surface of the spindle 1 (leading end surface of the rotation fixing portion S). The threaded hole 1b is provided along the central axis J of the spindle 1 at a predetermined depth. The rotary blade 2 is mounted to the rotation fixing portion S of the spindle 1 so as to be immovable in the direction of the axis J and non-rotatable about the axis J.

The fixing device 10 according to this embodiment includes an inner flange 11 for contacting with one side surface of the rotary blade 2 (left side surface in FIGS. 1 and 2), an intermediate flange 12 for contacting with the other end surface of the rotary blade 2 (right side surface in FIGS. 1 and 2), an outer flange 13 for clamping the intermediate flange 12 between the outer flange 13 and the rotary blade 2, and a fixing flange 14 for clamping the outer flange 13 between the fixing flange 14 and the intermediate flange 12.

The inner flange 11 has a disk shape, and an oval through-hole 11a is provided at the center thereof. The rotation fixing portion S is inserted into the through-hole 11a. Thus, the inner flange 11 is mounted to the spindle 1 in a state of being fixed with respect to the rotation.

Further, the inner flange 11 is mounted to the end portion Sa of the rotation fixing portion S in a state of being in contact therewith while the displacement thereof in the direction of the axis J (left hand in FIGS. 1 and 2) is restricted.

An annular contact surface 11b is provided by thinning the central portion of the side surface of the inner flange 11 on the rotary blade 2 side (right side surface in the figure). The contact surface 11b is brought to contact with the one side surface of the rotary blade 2 (left side surface in the figure).

[0009] The inner flange 11 is mounted to the rotation fixing portion S of the spindle 1, and then the rotary blade 2 is mounted thereto. A circular attachment hole 2a is provided at the center of the rotary blade 2. The rotation fixing portion S is inserted into the attachment hole 2a, and the rotary blade 2 is attached to the rotation fixing portion S of the spindle 1. Thus, the rotary blade 2 is mounted to the rotation fixing portion S while the rotation thereof about the axis J is not directly fixed. Although the illustration is omitted, a cutting edge is provided over the entire periphery of the rotary blade 2.

The rotary blade 2 is mounted, and then the intermediate flange 12 is mounted thereto. The intermediate flange 12 has a disk shape of substantially the same outer diameter as that of the inner flange 11, and an attachment hole 12a having a circular shape of the same diameter as that of the rotary blade 2 is provided at the center thereof. Thus, the intermediate flange 12 is also mounted to the rotation fixing portion S while the rotation thereof about the axis J is not directly fixed.

An annular contact surface 12b is provided by thinning the central portion of the side surface of the intermediate flange 12 on the rotary blade 2 side (left side surface in the figure). The contact surface 12b is brought to contact with the other side surface of the rotary blade 2 (right side surface in the figure).

In this context, the frictional resistance between the contact surface 12b of the intermediate flange 12 and the rotary blade 2 is set to be higher than the sliding resistance (frictional resistance) between cam portions 12c and 13d described below. The contact surface 12b of the intermediate flange 12 is treated with so-called knurling (surface treatment for increasing frictional resistance) so that the frictional resistance thereof against the rotary blade 2 is set to be increased. Meanwhile, cam surfaces of the cam portions 12c and 13d are formed to be flat and smooth so that the sliding resistance therebetween is set to be sufficiently lower than the frictional resistance of the intermediate flange 12 against the rotary blade 2.

[0010] Next, a plurality of cam portions 12c-12c are provided on the right side surface of the intermediate flange 12. As illustrated in FIG. 3, the cam portions 12c-12c include the plurality (six in the figure) of cam portions 12c-12c provided along the same circumference. As illustrated in FIG. 4, each of the cam portions 12c has a triangular shape with its height continuously varying in accordance with the direction of the axis J.

A groove portion 12d is formed over the entire peripheral surface of the intermediate flange 12. A retaining ring 15 is fitted to the groove portion 12d.

The intermediate flange 12 is mounted, and then the outer flange 13 is mounted to the rotation fixing portion S. The outer flange 13 also has a substantially disk shape, and an oval through-hole 13a is provided at the center thereof similarly to the inner flange 11. The outer flange 13 is non-rotatably mounted to the rotation fixing portion S of the spindle 1 while the rotation fixing portion S is inserted into the through-hole 13a.

In FIGS. 1 and 2, an accommodating portion 13b for accommodating the intermediate flange 12 is provided on the left side surface of the outer flange 13. A groove portion 13c to which the retaining ring 15 is fitted is formed on the entire periphery of the inner wall surface of the accommodating portion 13b. By way of the retaining ring 15, the outer flange 13 and the intermediate flange 12 are assembled in a state of being rotatable relative to each other and being not separable from each other in the direction of the axis J.

Note that, the width of the groove portion 12d on the intermediate flange 12 side is formed to be larger than that of the groove portion 13c of the outer flange 13 side so that the retaining ring 15 is displaceable in the direction of the axis J. Thus, the intermediate flange 12 and the outer flange 13 are assembled with each other so as to be relatively displaceable from each other within a small range in the direction of the axis J (range of relatively displacing in the direction of axis J due to the sliding operation of cam portions 12c and 13c).

[0011] Next, on the bottom portion of the accommodating portion 13b, a plurality (six in this embodiment) of cam portions 13d to 13d are provided to oppose to the cam portions 12c to 12c of the intermediate flange 12.

The plurality of cam portions 13d to 13d are provided along the circumference of substantially the same diameter as that of the cam portions 12c to 12c on the intermediate flange 12 side. Further, each of the cam portions 13d is formed so as to be the same shape and size as that of each of the cam portions 12c on the intermediate flange 12 side. Thus, the cam portions 12c to 12c of the intermediate flange 12 and the cam portions 13d to 13d of the outer flange 13 are in a state of being meshed with each other. Mutual meshing between the cam portions 12c to 12c and the cam portions 13d to 13d corresponds to the cam meshing portion described in claims (hereinafter, the same applies).

According to the cam meshing portion constituted as described above by the intermediate flange 23 and the outer flange 13 paired with each other, when the outer flange 13 and the intermediate flange 12 are rotated relatively to each other as illustrated in FIG 4, the meshing between the cam portions 13d to 13d and the cam portions 12c to 12c is shifted in the circumferential direction so as to generate relative displacement in the direction of the axis J, and hence the outer flange 13 and the intermediate flange 12 are displaced relatively to each other in the direction of the axis J. In the case of this embodiment, in the state of being mounted to the spindle 1 as described later, the outer flange 13 is fixed immovably in the direction of the axis J, and therefore, when a relative rotational force with respect to the intermediate flange 12 is applied to the outer flange 13, a part of the rotational force acts as a large external force (axial force P) in the direction of pressing the intermediate flange 12 against the rotary blade 2 through the sliding operation between the cam portions 12c and the cam portions 13d. The axial force P acts as a clamping force for clamping the rotary blade

2 between the intermediate flange 12 and the inner flange 11 whose axial movement is restricted relative to the rotation fixing portion S.

In FIGS. 1 and 2, an accommodating portion 13e for accommodating the fixing flange 14 is provided on the right side surface of the outer flange 13. A groove portion 13f is similarly formed on the entire periphery of the inner wall surface of the accommodating portion 13e. A retaining ring 16 is fitted to the groove portion 13f.

Further, an annular spring accommodating portion 13g is provided at the bottom portion of the accommodating portion 13e. A plate spring 17 for preventing backlash and loosening of the fixing flange 14 is accommodated on the inner peripheral side of the spring accommodating portion 13g. As illustrated in FIG 5, in the inner wall surface of the spring accommodating portion 13g, a large number of semicircular engagement recessed portions 13h to 13h are formed along the circumferential direction.

[0012] The fixing flange 14 has a substantially disk shape and a fixing thread portion 14a provided at the center on the left side surface thereof in FIGS. 1 and 2. The fixing thread portion 14a is screwed into the threaded hole 1b provided in the end surface of the spindle 1.

On the base portion of the fixing thread portion 14a, a spring step portion 14b is provided in a stepped manner. The plate spring 17 is arranged on the outer peripheral side of the spring step portion 14b. The spring step portion 14b has substantially the same vertical size as the thickness of the plate spring 17. As illustrated in FIG 5, at the circumferentially quadrisectioned positions along an inner peripheral hole 17a of the plate spring 17, engagement protruding portions 17b to 17b are provided in a state of radially protruding toward the center. Correspondingly, engagement recessed portions 14c to 14c for fitting the engagement protruding portions 17b without backlash are formed at the peripheral quadrisectioned positions of the spring step portion 14b. In a state in which the engagement protruding portions 17b are fitted into the engagement recessed portions 14c without backlash, the spring step portion 14b is inserted into the inner peripheral hole 17a of the plate spring 17. Thus, the plate spring 17 is mounted to the spring step portion 14b in a state of being relatively non-rotatable about the axis J, and accordingly, is integrally rotated with the fixing flange 14 by a rotational manipulation of the fixing flange 14.

The plate spring 17 is provided with four engagement claw portions 17c to 17c projecting in a curved manner from the circumferentially quadrisectioned positions toward the outer peripheral side thereof and extending in the same direction substantially along the circumferential direction. Each of the engagement claw portions 17c is resiliently biased toward the radially outer peripheral side. As illustrated in FIG 5, the leading end portion of each of the engagement claw portions 17c is formed so as to be a semicircular shape and are fitted by a resilient force into each of the engagement recessed portions 13h provided in the spring accommodating portion 13g of the outer flange 13, and with this, the fixing flange 14 is pre-

vented from being loosened relative to the outer flange 13, and eventually, the fixing thread portion 14a is prevented from being loosened relative to the threaded hole 1b. It is possible to rotationally manipulate the fixing flange 14 while displacing each of the engagement claw portions 17c to the inner peripheral side against the resilient force, whereby it is possible to tighten the fixing screw portion 14a into the threaded hole 1b of the spindle 1, and inversely, to loosen the fixing screw portion 14a relative thereto.

[0013] A groove portion 14e is formed over the entire peripheral surface of the fixing flange 14. The retaining ring 16 is fitted into the groove portion 14e. By way of the retaining ring 16, the fixing flange 14 is assembled with the outer flange 13 in a state of being inseparable therefrom in the direction of the axis J and relatively rotatable about the axis J. As a result, the fixing flange 14, the outer flange 13, and the intermediate flange 12 are assembled into one assembly. In this assembled state, the fixing thread portion 14a of the fixing flange 14 is positioned coaxially with respect to the axis J and positioned centrally of the through-hole 13a of the outer flange 13 and the attachment hole 12a of the intermediate flange 12. At this position, the fixing thread portion 14a of the fixing flange 14 is tightened into the threaded hole 1b of the spindle 1.

In FIGS. 1 and 2, a pinch portion 14d to be pinched by finger tips of a user is provided at the center of the right side surface of the fixing flange 14. As illustrated in FIG. 6, around the pinch portion 14d, a slip-preventing portion 14f for preventing slippage at the time of rotational manipulation is provided along the annular range. The user can rotationally manipulate the fixing flange 14 also by pressing the fingertips against the slip-preventing portion 14f instead of the pinch portion 14. In comparison with the case of rotationally manipulating the fixing flange 14 by pinching the pinch portion 14, the rotational manipulation can be performed more quickly in the case of rotationally manipulating the fixing flange 14 by pressing the fingertips against the slip-preventing portion 14f.

[0014] According to the fixing device 10 of the first embodiment structured as described above, it is possible to firmly attach the rotary blade 2 to the spindle 1 by a manual manipulation without use of special tools, thereby enabling to reliably prevent slippage of the rotary blade 2 relative to the inner flange 11, for example during use of the rotary tool.

When attaching the rotary blade 2 to the rotation fixing portion S of the spindle 1, the inner flange 11 of the fixing device 10 is first mounted to the rotation fixing portion S. The inner flange 11 is mounted relatively non-rotatably to the spindle 1 in a state in which the rotation fixing portion S is inserted into the through-hole 11a thereof.

The inner flange 11 is mounted, and then the rotary blade 2 is mounted to the rotation fixing portion S. The rotation fixing portion S is inserted into the attachment hole 2a of the rotary blade 2, and the contact surface 11b of the inner flange 11 is brought into contact with one side sur-

face (left side surface in FIG 1) of the rotary blade 2. At this stage, the rotary blade 2 is rotatable about the axis J relative to the spindle 1 and the rotation fixing portion S thereof.

Next, the intermediate flange 12, the outer flange 13, and the fixing flange 14 assembled to each other are mounted to the rotation fixing portion S. In this case, the pinch portion 14d is pinched with fingertips so as to rotationally manipulate the fixing flange 14 in a tightening direction, whereby the fixing screw portion 14a is tightened into the threaded hole 1b of the spindle 1. As the fixing screw portion 14a is tightened into the threaded hole 1b, the rotation fixing portion S of the spindle 1 is inserted into the attachment hole 12a of the intermediate flange 12, and then into the through-hole 13a of the outer flange 13. At an initial stage of tightening the fixing thread portion 14a, at which screw-tightening resistance is small, the fingertips are pressed against the slip-preventing portion 14f of the fixing flange 14 so as to rotationally manipulate the fixing flange 14, whereby the rotational manipulation can be quickly performed.

During the rotational manipulation of the fixing flange 14, the plate spring 17 is integrally rotated with the fixing flange 14. Thus, while each of the engagement claw portions 17c of the plate spring 17 is engaged with and disengaged from the engagement recessed portions 13h on the outer flange 13 side against an resilient biasing force, the fixing flange 14 is rotated. The rotational operability of the fixing flange 14 is enhanced owing to clicking sound produced at the time the engagement claw portions 17c engage with and disengage from the engagement recessed portions 13h. The engagement claw portions 17c are fitted into the engagement recessed portions 13h so as to be engaged therewith, whereby the fixing flange 14, and eventually, the fixing thread portion 14a is prevented from being loosened relative to the threaded hole 1b.

[0015] When the fixing screw portion 14a is tightened into the threaded hole 1b, the contact surface 12b of the intermediate flange 12 is brought into contact with the other side surface of the rotary blade 2 (right side surface in FIG. 1). Further, the cam portions 12c to 12c on the intermediate flange 12 side and the cam portions 13d to 13d on the outer flange 13 side come to mesh completely with each other without being shifted in the circumferential direction. As a result, both the flanges 12 and 13 become closest to each other in the direction of the axis J. FIG. 1 illustrates this state. As illustrated in the figure, the intermediate flanges 12 and the outer flange 13 become closest to each other in the direction of the axis J, and hence the retaining ring 15 is positioned on the left side in the width direction of the groove portion 12d of the intermediate flange 12.

In this manner, when the fixing flange 14 is rotated by manual manipulation so that the fixing screw portion 14a thereof is firmly tightened into the threaded hole 1b of the spindle 1, attachment of the rotary blade 2 to the spindle 1 is completed.

In this attachment state, when the cutting resistance is imparted to the rotary blade 2 or the inertia at the time of braking or activation is produced therein so as to apply a force to the rotary blade 2 in the direction of causing the rotary blade 2 to be rotated relatively to the spindle 1 (rotational resistance), this rotational resistance acts as an external force in the direction of pressing the intermediate flange 12 against the rotary blade 2 because the frictional resistance of the contact surface 12b of the intermediate flange 12 against the rotary blade 2 is larger than the sliding resistance between the cam portions 12c to 12c and the cam portions 13d to 13d, and the inner flange 11 and the outer flange 13 are rotationally integrated with each other via the rotation fixing portion S. That is, a rotational force for relatively rotating the rotary blade 2 to the spindle 1 (external force such as inertial force or cutting resistance) acts as an external force in the direction of relatively displacing the cam portions 12c to 12c and 13d to 13d in the circumferential direction. Therefore, owing to the sliding operation between the cam portions 12c and the cam portions 13d, a force component of the rotational force in the direction of the axis J acts as the large axial force P in the direction of pressing the intermediate flange 12 against the rotary blade 2. With this, the rotary blade 2 is clamped between the inner flange 11 and the intermediate flange 12 with a large force, whereby the rotary blade 2 is prevented from being slipped relative to the inner flange 11.

[0016] As described above, the fixing device 10 according to the first embodiment has a function of converting the rotational resistance imparted to the rotary blade 2 into a force for clamping the rotary blade 2 between the inner flange 11 and the intermediate flange 12 (clamping force). Thus, it is ensured that the rotary blade 2 is prevented from slipping relative to the inner flange 11. Further, the rotary blade 2 is firmly fixed with the axial force P produced by the cam meshing portions, and hence it is only necessary for a user to lightly tightening the fixing thread portion 14a of the fixing flange 14 when attaching the rotary blade. In this regard also, the fixing device 10 can be used more conveniently.

In addition, the function of converting the rotational resistance imparted to the rotary blade 2 into the clamping force (axial force P) for the rotary blade 2 is structurally realized by a slight displacement of the intermediate flange 12 relative to the outer flange 13 in the direction of the axis J. Compactification in the radial direction can be easily achieved in comparison with conventional structures in which a ratchet mechanism for engaging and disengaging meshing of teeth with recessed portions on the outer peripheral side by displacing claw portions in the radial direction, or in which a speed reduction gear train is arranged in the radial direction. Thus, the illustrated fixing device 10 can be applied to a portable circular saw without sacrificing the inclination angle of the rotary blade, the cutting depth of the rotary blade, and the like, at the time of performing oblique cutting.

Further, the cam portions 12c of the intermediate flange

12 and the cam portions 13d of the outer flange 13 are formed to be a triangular shape, and hence the rotational resistance in any direction of the intermediate flange 12 relative to the outer flange 13 (displacement in rotational direction) is also converted into the axial force P in the direction of the axis J of the intermediate flange 12 (pressing force against rotary blade 2). Thus, according to the fixing device 10 in this embodiment, it is possible to be functioned for rotational forces in any of the directions caused by the cutting resistance imparted to the rotary blade 2 during a cutting process and by the inertia at the time of starting the rotation of the rotary blade 2 (activation) and at the time of stopping the same (braking).

[0017] Various modifications can be made to the above-mentioned first embodiment. For example, FIGS. 7 to 12 illustrate second to sixth embodiments. In each of those embodiments, for parts and structures similar to those in the first embodiment, the same reference symbols are used, and the description thereof is omitted. FIG. 7 illustrates a fixing device 20 according to the second embodiment.

The fixing device 20 according to the second embodiment is different from the first embodiment mainly in the structure of an inner flange 21. The inner flange 21 according to the second embodiment has a boss portion 21a provided at the center thereof. The boss portion 21a protrudes toward the rotary blade 2 (right side in FIG 7). The boss portion 21a is inserted in the attachment hole 2a of the rotary blade 2 in a state of being relatively rotatable without backlash.

On the inner peripheral side of the boss portion 21a, there is formed a through-hole 21b having a two surface width sufficiently larger than the two surface width of the rotation fixing portion S in size. Thus, the inner flange 21 is mounted to the spindle 1 in a relatively rotatable state within a predetermined angular range in a rotational direction thereof.

Between the inner flange 21 and the rotary blade 2, there is clamped a disk-shaped slipping flange 22. As illustrated in the figure, the boss portion 21a of the inner flange 21 is inserted into the central hole of the slipping flange 22. Further, the peripheral portion of the slipping flange 22 is folded back toward the inner flange 21. A folded-back end portion 22a thus formed is engaged with an engagement groove portion 21c provided in the peripheral surface of the inner flange 21. Thus, the slipping flange 22 is mounted in a state of covering substantially the entire surface on the rotary blade 2 side of the inner flange 21 and in a state of being relatively rotatable about the axis J of the spindle 1 and being not to be detach in the direction of the axis J.

By way of the slipping flange 22, the frictional resistance of the inner flange 21 in the rotational direction against the rotary blade 2 is significantly reduced. The slipping flange 22 corresponds to an example of the friction reducing means described in claims. Meanwhile, similarly to the first embodiment, an intermediate flange 23 is in contact with the side surface on the opposite side of the

rotary blade 2 with large frictional resistance.

The intermediate flange 23 is different from the intermediate flange 12 according to the first embodiment in that a central attachment hole 23a thereof is formed as a two surface width hole. The attachment hole 23a of the intermediate flange 23 is formed to have the same diameter and the same dimension of the two surface width as those of the through-hole 21b of the inner flange 21. Thus, the intermediate flange 23 is mounted to the rotation fixing portion S in a rotatable state within a predetermined angular range. The relatively rotatable angle of the intermediate flange 23 and the inner flange 21 to the rotation fixing portion S is set to an angle corresponding to the relative rotation of the cam meshing portion at which an axial force sufficient for reliably fixing the rotary blade 2 can be produced. Accordingly, the through-holes of the inner flange 21 and the intermediate flange 23 may be formed not as two surface width holes but as normal circular holes so as not to be restricted in the rotational direction relative to the rotation fixing portion S.

[0018] Similarly to the first embodiment, the intermediate flange 23 is provided with the cam portions 12c to 12c, and the cam portions 13d to 13d of the outer flange 13 mesh with the cam portions 12c to 12c. The fixing thread portion 14a of the fixing flange 14 is tightened into the threaded hole 1b of the spindle 1 so that the rotary blade 2 is clamped between the inner flange 21 and the intermediate flange 23. The cam portions 12c to 12c of the intermediate flange 23 and the cam portions 13d to 13d of the outer flange 13 mesh with each other with a tightening force (axial force P) of the fixing thread portion 14a.

Similarly to the first embodiment, at the center of the outer flange 13 paired with the intermediate flange 23 for constituting the cam meshing portion, there is formed the through-hole 13a having a two surface width (oval shape). The rotation fixing portion S is inserted into the through-hole 13a without a play in the rotational direction thereof. Thus, the outer flange 13 is mounted to the rotation fixing portion S in a state of being relatively non-rotatable.

In the fixing device 20 according to the second embodiment structured as described above, when cutting resistance is imparted to the rotary blade 2, the cutting resistance acts as a relative rotational force between the intermediate flange 23 and the outer flange 13. The relative rotational force acts as the axial force P on the rotary blade 2 through the meshing operation between the cam portions 12c and 13d, and the rotary blade 2 is firmly clamped between the inner flange 21 and the intermediate flange 23 with the axial force P. As a result, rotational torque of the spindle 1 is efficiently transmitted to the rotary blade 2.

When the spindle 1 stops and cutting resistance (rotational resistance) is not imparted to the rotary blade 2, the meshing between the cams 12c and 13d is loosened. As a result, a clamping force of the inner flange 21 and the intermediate flange 23 against the rotary blade 2 is

lowered, and a tightening force of the fixing thread portion 14a, which acts on the flanges 21, 23, and 13, is reduced. Thus, it is possible to easily rotate the fixing flange 14 with a small force in the loosening direction.

Especially, in the case of the second embodiment, the slipping flange 22 is clamped between the inner flange 21 and the rotary blade 2. Thus, at the time no cutting resistance is imparted to the rotary blade 2, the rotation of the rotary blade 2 and the intermediate flange 23 more easily occurs relative to the inner flange 21, and eventually, the rotation fixing portion S. Accordingly, the cam portions 12c and 13d are more easily loosened, whereby the tightening force of the fixing thread portion 14a is more reliably reduced. As a result, it is possible to rotationally manipulate the fixing flange 14 in the loosening direction further easily.

Further, in the second embodiment, the inner flange 21 is mounted to the rotation fixing portion S of the spindle 1 in a rotatable state within a predetermined angular range. In this regard also, the cam portions 12c and 13d are more easily loosened in comparison with the first embodiment, and eventually, the fixing flange 14 is more easily rotated in the loosening direction with a smaller force.

[0019] Next, FIG. 8 illustrates a fixing device 30 according to the third embodiment, in which a further modification is added to the second embodiment. The fixing device 30 according to the third embodiment is different from the fixing device 20 according to the second embodiment in that a cover 35 made of elastic rubber is mounted around an intermediate flange 31, an outer flange 32, and a fixing flange 33. For, the parts and structures similar to those in the first and second embodiment, the same reference symbols are used, and the description thereof is omitted.

In the first and second embodiments, the retaining ring 15 restricts the displacement (detachment) of the outer flange 13 relative to the intermediate flange 23 in the direction of the axis J, and the retaining ring 16 restricts the displacement (detachment) of the fixing flange 14 relative to the outer flange 13 in the direction of the axis J. In the fixing device 30 according to the third embodiment, the cover 35 restricts these displacements. The entire peripheral surfaces of the intermediate flange 31, the outer flange 32, and the fixing flange 33 are respectively provided with engagement groove portions 31a, 32a, and 33a. Correspondingly, the cover 35 has a substantially conical tubular shape having a diameter reducing toward the fixing flange 33, and three engagement protruding portions 35a, 35b, and 35c are respectively formed correspondingly to the engagement groove portions 31a, 32a, and 33a on the entire inner peripheral surface thereof. The engagement protruding portion 35a on the largest diameter side is fitted along the engagement groove portion 31a of the intermediate flange 31, the engagement protruding portion 35c on the smallest diameter side is fitted along the engagement groove portion 33a of the fixing flange 33, and the engagement pro-

truding portion 35b provided therebetween is fitted along the engagement groove portion 32a of the outer flange 32. Each of the widths of the engagement protruding portions 35a, 35b, and 35c, and each of the widths of the engagement groove portions 31a, 32a, and 33a are dimensioned for allowing the engagement protruding portions 35a, 35b, and 35c to be elastically deformed in the width directions thereof and pressed into the engagement groove portions 31a, 32a, and 33a, respectively. Thus, the relative rotation between the intermediate flange 31, the outer flange 32, and the fixing flange 33 is performed by elastic deformation of the cover 35 in the rotational direction. In a state in which no external force in the rotational direction is imparted to each of the flanges 31, 32, and 33, the flanges 31, 32, and 33 are mutually maintained in a predetermined positional relation by the cover 35. In this embodiment, the predetermined position is set to be a position (initial position) at which the cam portions 12c of the intermediate flange 31 and the cam portions 13d of the outer flange 32 mesh most deeply with each other.

[0020] Similarly to the first and second embodiments, the cam portions 12c to 12c of the intermediate flange 31 and the cam portions 13d to 13d of the outer flange 32 mesh with each other. The engagement between both the cam portions 12c and 13d is biased toward the initial position where they mesh most deeply with each other (position at which intermediate flange 31 and outer flange 32 are brought to be closest to each other in the direction of axis J) by an elastic force in the rotational direction of the cover 35. Further, also in the third embodiment, at the center of the intermediate flange 31, there is provided a through-hole 31b of a hole shape having a two surface width similar to the intermediate flange 23 according to the second embodiment. The rotation fixing portion S of the spindle 1 is passed through the through-hole 31b. Thus, the intermediate flange 31 is mounted in a rotatable state within a predetermined angular range in a rotational direction thereof similarly to the inner flange 21.

In the fixing device 30 according to the third embodiment structured as described above, by an elastic force in the rotational direction of the cover 35, the cam portions 12c of the intermediate flange 31 and the cam portions 13d of the outer flange 32 are biased in the direction of meshing most deeply with each other. Thus, when the cutting resistance is no longer applied to the rotary blade 2, the engagement between the cam portions 12c and 13d is instantly and reliably transferred to an initial state, in which the engagement becomes most deeply by the elastic force of the cover 35. As a result, the clamping force of the inner flange 21 and the intermediate flange 31 against the rotary blade 2 is released, and the tightening force of the fixing thread portion 14a is reduced. Thus, it is possible to rotationally manipulate the fixing flange 35 more reliably with a small force in the loosening direction. Further, in the fixing device 30 according to the third embodiment, the cover 35 covers the periphery around between the intermediate flange 31, the outer flange 32,

and the fixing flange 33. Therefore, intrusion of foreign matters into between the flanges 31, 32, and 33 is prevented in advance.

Although the illustration is omitted, the following modifications can be made to the third embodiment described above. In the third embodiment, there is illustrated a structure in which the intermediate flange 31, the outer flange 32, and the fixing flange 33 are engaged with each other in the rotational direction by means of the single cover 35, and the cover 35 covers the periphery thereof. However, separate covers may elastically bias in the rotational direction between the intermediate flange 31 and the outer flange 32 and between the outer flange 32 and the fixing flange 33 and may cover the peripheries thereof.

Further, not by means of the cover 35 made of elastic rubber, the flanges 31, 32, and 33 may be resiliently biased in the rotational direction to each other by, for example, torsion coil springs interposed therebetween. Even in the structure in which the torsion coil springs are used as an initial position biasing means, the cam portions 12c and 13d can be biased in the direction of meshing most deeply with each other, and hence the same operations and effects as those described above can be obtained, although the foreign matter intrusion preventing function may be lowered. Accordingly, the cover may be omitted between the outer flange 32 and the fixing flange 33.

[0021] Next, FIG. 9 illustrates a fixing device 40 according to the fourth embodiment. The fixing device 40 according to the fourth embodiment is different from the fixing device 20 of the second embodiment in that the positions of the cam meshing portion (cam portions 12c to 12c and 13d to 13d) and the slipping flange 22 are changed to be reversed with respect to the rotary blade 2. The fixing device 40 according to the fourth embodiment corresponds to the embodiment of the invention described in claim 8. For arts and structures similar to those in the second embodiment the same reference symbols are used, and the description thereof is omitted. In the case of the fourth embodiment, an inner flange 41 and an intermediate flange 42 are arranged on the left side in the figure relative to the rotary blade 2 (base portion side of spindle 1), and an outer flange 43 and the fixing flange 14 are arranged on the right side in the figure (leading end side of the spindle 1).

Cam portions 41a to 41a are provided on the side surface on the rotary blade 2 side of the inner flange 41, and cam portions 42a to 42a are provided on the side surface opposite to the rotary blade 2 side of the intermediate flange 42. Both the cam portions 41a to 41a and 42a to 42a are in mesh with each other.

A through-hole 41b having a two surface width is provided at the center of the inner flange 41. The rotation fixing portion S of the spindle 1 is inserted into the through-hole 41b. In the case of the fourth embodiment, the inner flange 41 is non-rotatably mounted to the spindle 1. As is already apparent from the above, the flanges on the

side of being paired with the intermediate flanges for constituting the cam meshing portions (outer flanges 13 and 32 in the first to third embodiments and inner flange 41 in the fourth embodiment) are non-rotatably mounted to the rotation fixing portion S.

At the center of the intermediate flange 42, there is provided a boss portion 42b. The boss portion 42b is inserted in the attachment hole 2a of the rotary blade 2 without backlash in the radial direction, whereby the rotary blade 2 is held in contact with the side surface of the intermediate flange 42. On the inner peripheral side of the boss portion 42b, there is provided a through-hole 42c having a two surface width correspondingly to the rotation fixing portion S of the spindle 1. Note that, similarly to the through-hole 21b of the inner flange 21 in the second embodiment, the through-hole 42c is dimensioned for allowing the intermediate flange 42 to rotate relative to the rotation fixing portion S of the spindle 1 within a predetermined angular range.

By way of a retaining ring 44, the inner flange 41 and the intermediate flange 42 are allowed to be relatively rotated about the axis J, while the displacement in the direction of the axis J is restricted within a predetermined range, whereby the detachment thereof is prevented.

Similarly to the slipping flange 22 of the second embodiment, the outer flange 43 is in contact with the rotary blade 2 while a slipping flange 45 made of a material having small frictional resistance is clamped between the outer flange 43 and the rotary blade 2. The slipping flange 45 also corresponds to an example of the friction reducing means described in claims.

[0022] At the center of the slipping flange 45, there is provided a through-hole 45b having a circular shape of the same diameter as that of the attachment hole 2a of the rotary blade 2. The rotation fixing portion S of the spindle 1 is passed through the through-hole 45b. The outer peripheral side of the slipping flange 45 is folded back similarly to the second embodiment, and a folded-back portion 45a thus formed is inserted into an engagement groove 43b provided over the entire outer peripheral surface of the outer flange 43. Thus, the slipping flange 45 is mounted not to be displaceable in the direction of the axis J and to be relatively rotatable about the axis J in a state of covering substantially the entire side surface of the outer flange 43.

Also, on the inner peripheral side of the outer flange 43, there is provided a through-hole 43a having a two surface width. The rotation fixing portion S of the spindle 1 is passed through the through-hole 43a. Similarly to the through-hole 42c of the intermediate flange 42, the through-hole 43a is dimensioned to have a two surface width for allowing the outer flange 43 to be rotated within a predetermined range in the rotational direction relative to the rotation fixing portion S. By way of the retaining ring 16, the outer flange 43 and the fixing flange 14 are assembled such that they are allowed to be rotated relatively about the axis J, while their displacement in the direction of the axis J is restricted to prevent detachment

from each other.

By the fixing device 40 according to the fourth embodiment structured as described above, the same operations and effects as those in the above-mentioned embodiments can also be obtained. When a user lightly tightens the fixing flange 14, the rotary blade 2 is clamped between the intermediate flange 42 and the outer flange 43 owing to a tightening force of the fixing thread portion 14a. When cutting resistance is imparted to the rotary blade 2, the meshing between the cam portions 41a and 42a becomes shallower, and a clamping force of the intermediate flange 42 and the outer flange 43 is increased. Thus, the rotary blade 2 is firmly fixed to the rotation fixing portion S in a state of being non-rotatable and immovable in the axial direction. When no cutting resistance is no longer imparted to the rotary blade 2, the meshing between the cam portions 41a and 42a becomes deeper so that the cam meshing portion is restored to the initial position. Thus, the clamping force of the intermediate flange 42 and the outer flange 43 is reduced, whereby the tightening force of the fixing thread portion 14a is weakened so that it is possible to rotationally manipulate the fixing flange 14 in a loosening direction with a small force. Further, the slipping flange 45 is clamped on the side of the outer flange 43, and the outer flange 43 is mounted to the rotation fixing portion S in a rotatable state within a predetermined angular range. Thus, the relative rotation between the rotary blade 2 and the intermediate flange 42 more easily occurs relative to the outer flange 43, and eventually, relative to the rotation fixing portion S. As a result, it is possible to displace the intermediate flange 42 in the direction in which the cam portions 41a and 42a mesh more deeply with each other, to thereby more reliably reduce the tightening force of the fixing thread portion 14a.

[0023] Next, FIG. 10 illustrates a fixing device 50 according to the fifth embodiment, which is a combination of the second embodiment and the fourth embodiment. The fixing device 50 according to the fifth embodiment is different from the first to fourth embodiments in that the cam meshing portions are provided on both sides with respect to the rotary blade 2. That is, while one set of the cam portions is provided in the first to fourth embodiments, two sets of cam portions are provided in the fifth embodiment. The fixing device 50 according to the fifth embodiment corresponds to the embodiment of the invention described in claim 9. For parts and structures similar to those in the first to fourth embodiments, the same reference symbols are used, and the description thereof is omitted.

The fixing device 50 includes an inner flange 51, an inner intermediate flange 52, an outer intermediate flange 53, an outer flange 54 and the fixing flange 14 in the order from the left side in FIG. 10. On the left side in the figure with respect to the rotary blade 2, a combination of the inner flange 41 and the intermediate flange 42 in the fourth embodiment is used, and on the right side in the figure with respect to the rotary blade 2, a combination

of the intermediate flange 23 and the outer flange 13 in the second embodiment is used. Note that, the slipping flange 22 is not used in the case of the fifth embodiment. Cam portions 51a of the inner flange 51 and cam portions 52a of the inner intermediate flange 52 mesh with each other, and cam portions 53a of the outer intermediate flange 53 and cam portions 54a of the outer flange 54 mesh with each other. At the respective centers of the inner flange 51 and the outer flange 54, there are provided through-holes 51b and 54b each having a two surface width, and the rotation fixing portion S of the spindle 1 is passed on their inner peripheral sides in a state of being relatively non-rotatable. At the respective centers of both the intermediate flanges 52 and 53, there are provided through-holes 52b and 53b each having a two surface width. Note that, each of the two surface widths of both the through-holes 52b and 53b is dimensioned for allowing relative rotation of both the intermediate flanges 52 and 53 within a predetermined angular range in the rotational direction relative to the rotation fixing portion S of the spindle 1. A boss portion 52c is provided at the center of the inner intermediate flange 52. The through-hole 52b is provided on the inner peripheral side of the boss portion 52c. The boss portion 52c is inserted into the attachment hole 2a of the rotary blade 2 without backlash in the radial direction.

By way of the retaining ring 44, the inner flange 51 and the inner intermediate flange 52 are combined with each other without backlash in the direction of the axis J while being relatively rotatable about the axis J. Further, by way of the retaining ring 15, the outer intermediate flange 53 and the outer flange 54 are combined with each other, and by way of the retaining ring 16, the outer flange 54 and the fixing flange 14 are combined with each other, in either case, without backlash in the direction of the axis J while being relatively rotatable about the axis J.

[0024] In the fixing device 50 according to the fifth embodiment, which is provided with two sets of the cam meshing portions, when the cutting resistance is no longer imparted to the rotary blade 2, relative rotational forces are no longer imparted between the inner flange 51 and the inner intermediate flange 52 and between the outer intermediate flange 53 and the outer flange 54. As a result, the meshing of the cam portions on both the sides of the rotary blade 2 becomes most deeply so that the tightening force of the fixing thread portion 14a is instantly weakened. Accordingly, it is possible to rotationally manipulate the fixing flange 14 in a loosening direction with a small force.

Especially, in the case of the fifth embodiment, two sets of the cam portions are provided on both sides of the rotary blade 2. Thus, when the rotational resistance is no longer imparted to the rotary blade 2 and consequently rotational forces are no longer imparted to both the intermediate flanges 52 and 53, the deepest meshing with the cam portions 51a and 54a occurs, respectively. As a result, it is possible to obtain a displacement amount of both the intermediate flanges 52 and 53 in the direction

of the axis J, which is approximately twice as large as that in the case of the second or fourth embodiment, thereby enabling to more reliably and quickly loosen the fixing screw portion 14a.

Further, by the axial force P produced by two sets of the cam portions, the rotary blade 2 is firmly fixed. Therefore, it is only necessary for a user to lightly tighten the fixing flange 14 at the time of mounting the blade. In this regard, similarly to the above-mentioned embodiments, the fixing device 50 can be used more conveniently.

[0025] Next, FIGS. 11 and 12 illustrate a fixing device 60 according to the sixth embodiment. The fixing device 60 is constructed to interpose two plate springs 61 and 62 between the intermediate flange 23 and the outer flange 13 in the fixing device 20 according to the second embodiment. For parts and structures similar to those in the second embodiment, the same reference symbols are used, and the description thereof is omitted.

In the case of the sixth embodiment, at the center of an intermediate flange 63, there is provided a through-hole 63a formed to have a two surface width for allowing the intermediate flange 63 to be rotated within a predetermined angular range in the rotational direction relative to the rotation fixing portion S of the spindle 1. The rotation fixing portion S of the spindle 1 is passed through the through-hole 63a. As illustrated in FIG. 12, in two areas on the periphery of the through-hole 63a, there are provided semicircular spring accommodating portions 63b and 63c. Both the spring accommodating portions 63b and 63c are formed in the side surface on the fixing flange 14 side to have small depths in the thickness direction of the intermediate flange 63 (direction of axis J). The plate springs 61 and 62 are accommodated in the spring accommodating portions 63b and 63c, respectively.

Both the plate springs 61 and 62 are small pieces having band plate shapes and are bent at both end portions thereof. Respective bent end portions 61a, 61 a, 62a, and 62a of the plate springs 61 and 62 are resiliently engaged with larger diameter side surfaces of the spring accommodating portions 63b and 63c, and are retained in such a state that both the plate springs 61 and 62 are shored. Thus, both the plate springs 61 and 62 are fixed so as not to shift about the axis J or in the radial direction. Both centers with respect to the longitudinal directions of the plate springs 61 and 62 are in contact with flat surfaces 1a of the rotation fixing portion S of the spindle 1, respectively. The interval between both the plate springs 61 and 62 substantially corresponds to the surface width between the two flat surfaces 1a and 1a of the spindle 1. With biasing forces of both the plate springs 61 and 62, an intermediate flange 63 is biased to be restored to a predetermined position (position at which both plate springs 61 and 62 are in contact with the flat surfaces 1a of the rotation fixing portion S of spindle 1, that is, a position illustrated in FIG. 12, hereinafter referred to as initial position) about the axis J of the spindle 1 (in a rotational direction).

In addition, the positional relation between both the plate

springs 61 and 62 and the flat surface 1a of the rotation fixing portion S is properly set such that cam portions 63d to 63d of the intermediate flange 63 and cam portions 64a to 64a of an outer flange 64 mesh most deeply with each other in a state in which the intermediate flange 63 is restored to the initial position with the biasing forces of both the plate springs 61 and 62. The outer flange 64 has a through-hole 64b provided at the center thereof and formed as a hole having a two surface width, and hence is mounted to the rotation fixing portion S in a state of being fixed with respect to the rotation.

[0026] In the fixing device 60 according to the sixth embodiment structured as described above, the intermediate flange 63 is biased by the plate springs 61 and 62 to the initial position at which the cam portions 63d and 64a mesh most deeply with each other. Thus, when the rotational resistance is no longer imparted to the rotary blade 2 and the intermediate flange 63, the intermediate flange 63 is reliably and instantly restored to the initial position by the biasing forces of both the plate springs 61 and 62. As a result, the cam portions 63d of the intermediate flange 63 and the cam portions 64a of the outer flange 64 mesh most deeply with each other, and the clamping force of the inner flange 21 and the intermediate flange 63 against the rotary blade 2 is instantly released. With this, the tightening force of the fixing thread portion 14a against the threaded hole 1b is weakened, and hence, in the case of replacing the rotary blade 2 and the like, the fixing flange 14 can be easily rotated with a small force in the loosening direction.

When the spindle 1 is rotated again so as to perform a cutting process, rotational resistance is imparted to the rotary blade 2. As a result, the intermediate flange 63 is displaced from the initial position against the biasing forces of both the plate springs 61 and 62, and the cam portions 63d thereof and the cam portions 64a of the outer flange 64 are displaced relative to each other. With this, the clamping force of the intermediate flange 63 and the inner flange 21 is instantly increased, whereby a state is achieved in which the rotary blade 2 is firmly fixed to the spindle 1 in the rotational direction and in the direction of the axis J. Further, similarly to the second embodiment, the slipping flange 22 is clamped between the inner flange 21 and the rotary blade 2, and the inner flange 21 is mounted to the rotation fixing portion S of the spindle 1 with a suitable play in the rotational direction. Thus, when rotational resistance is no longer imparted after completion of the cutting process, the rotation of the rotary blade 2 and the intermediate flange 63 relative to the inner flange 21 is caused more easily. In this regard also, the rotational manipulation in the loosening direction of the fixing flange 14 can be more easily performed.

[0027] Other various modifications can be made to the embodiments described above. For example, in the first embodiment, there is illustrated the structure in which so-called knurling is applied on the contact surface 12b of the intermediate flange 12, whereby frictional resistance of the contact surface 12b of the intermediate flange

12 against the rotary blade 2 is set to be larger than frictional resistance between the cam portions 12c to 12 and 13d to 13d. In this context, it may be possible to construct such that materials contacting or sliding contacting with each other are properly set, whereby the frictional resistance of the intermediate flange 12 against the rotary blade 2 is set to be larger than the frictional resistance between the cam portions 12c to 12c and the cam portions 13d to 13d.

Further, in the illustrated embodiments, it may be possible to construct such that liners with high slide ability are attached to the cam portions 12c to 12 and the cam portions 13d to 13d or a lubricant is applied thereto so as to lower sliding resistance thereof, and a slip-preventing member is attached to the contact surface 12b of the intermediate flange 12 so that a suitable difference is obtained between the sliding resistance between the cam portions 12c and 13d and the frictional resistance of the intermediate flange 12 against the rotary blade 2.

Further, the contact area of the contact surface 12a of the intermediate flange 12 with the rotary blade 2 may be increased, whereby the frictional resistance thereof can be set to be larger than the sliding resistance between the cam portions 12c and 13d. With this, the same operations and effects as described above can be obtained.

In addition, the contact surface 12b of the intermediate flange 12 with the rotary blade 2 is positioned on the outer peripheral side of the sliding-contact portion between the cam portions 12c and 13d, and hence large frictional resistance can be easily obtained for the former.

Further, in the embodiments, there is illustrated the structure in which the threaded hole 1b is provided at the leading end of the spindle 1 and the fixing thread portion 14a is provided to the fixing flange 14. On the contrary, it may be possible to construct such that a threaded shaft portion is provided on the spindle 1 side and a female thread portion (nut portion) is provided on the fixing flange 14 side, so that they are threadably coupled to each others.

[0028] Further, in the second, third, and sixth embodiments, there is illustrated the structure in which the slipping flange 22 is used as the friction reducing means for reducing the frictional resistance in the rotational direction of the inner flange 21 against the rotary blade 2 in comparison with the frictional resistance in the rotational directions of the intermediate flanges 23, 31, and 63 against the rotary blade 2. In this context, it may be possible to construct such that, as the friction reducing means, a lubricant such as molybdenum grease is further applied onto one or both of the surfaces of the slipping flange 22, or a surface layer with high slide ability is coated by plating or the like on one or both of the inner flange 21 and the rotary blade 2, whereby the frictional resistance in the rotational direction of the inner flange 21 against the rotary blade 2 is reduced.

Further, it is possible to construct such that, as a friction reducing means, a thrust bearing is interposed in place of the slipping flange 22, whereby friction in the rotational

direction of the inner flange against the rotary blade is reduced. In addition, in place of the slipping flange 22 as a friction reducing means, the flanges on the side of not constituting the cam meshing portions by being paired with the intermediate flanges (inner flange 21 according to the second and third embodiments, outer flange 43 according to the fourth embodiment, and inner flange 21 according to the sixth embodiment) can be constructed to be relatively rotatable to the rotation fixing portion S at least within a predetermined angular range, whereby a relative displacement in the cam meshing portion can be further facilitated. The rotation within a predetermined angular range can be obtained not only in the structure in which the through-hole allowing the rotation fixing portion S to pass therethrough is formed as a circular hole, but also by loosening the restriction in the rotational direction (enlarging a two surface width) even in the case of a through-hole having a two surface width.

In addition, as a structure common to the illustrated embodiments, the following basic structure can be led. First, the intermediate flange is not fixed to the rotation fixing portion S with respect to the rotation. Second, the flange paired with the intermediate flange for constituting the cam meshing portion is fixed to the rotation fixing portion S with respect to the rotation. Third, the flange which does not constitute the cam meshing portion by being paired with the intermediate flange is not fixed to the rotation fixing portion S with respect to the rotation. Fourth, even when the flange which does not constitute the cam meshing portion by being paired with the intermediate flange is similarly fixed to the rotation fixing portion S with respect to the rotation, the friction reducing means is interposed between the flange and the rotary blade, whereby the relative rotation of the rotary blade relative to the rotation fixing portion S is facilitated by the relative rotation therebetween. As a result, the same function as that of the third structure can be obtained.

In the third structure, it is possible to incorporate a structure in which the through-hole is formed as a circular hole, and consequently there is no restriction in the rotational direction unless the rotation is fixed by the rotation fixing portion S, or a structure in which, the through-hole is formed as a hole having a two surface width but the two surface width is loose enough in comparison with the two surface width dimension of the rotation fixing portion S, and consequently there is a play within a predetermined range in the rotational direction. With any of the third and fourth structures, it is possible to produce the axial force P sufficient for firmly clamping the rotary blade by the relative rotation of the cam portions meshing with each other in the cam meshing portion at a predetermined angle, and inversely, possible to release the axial force P. Further, while the two surface width portion S is illustrated as a rotation fixing portion, alternatively, a shaft portion rectangular in cross-section or hexagonal in cross-section may be incorporated as the rotation fixing portion.

In addition, although the illustration is omitted, in the fourth and fifth embodiments, it is possible to construct

such that the initial position biasing means as illustrated in the third and sixth embodiments are used, whereby the cam meshing portion is biased in the direction in which the meshing of the cam meshing portions becomes most deeply.

Further, in the sixth embodiment, there is illustrated the structure in which, regarding the position in the rotational direction of the intermediate flange 63 relative to the rotation fixing portion S, the two plate springs 61 and 62 are used as the initial position biasing means for biasing toward the initial position at which the cam portions 63d to 63d of the intermediate flange 63 and the cam portions 64a to 64a of the outer flange 64 most deeply mesh with each other. However, alternatively, it is possible to construct such that coil springs such as compression springs, tension springs, or torsion springs or other biasing means are used.

Further, although there is illustrated the case where the rotary blade 2 is fixed to the spindle 1 of a portable circular saw, the fixing device according to the present invention may be similarly applied in the case of attaching the rotary blade to spindles of other rotary tools such as a bench type or installation type circular sawing machine, a grinder, or a polishing instrument.

Claims

1. A device for fixing a rotary blade to a rotation fixing portion of a rotatable spindle, comprising:

an inner flange and an outer flange fixing the rotary blade to the rotation fixing portion with respect to the rotation by clamping the rotary blade from both sides thereof; and

a fixing flange producing, with respect to the inner flange and the outer flange, a clamping force against the rotary blade in a direction of an axis of the spindle by tightening a fixing screw portion into an end surface of the rotation fixing portion; wherein the fixing device is constructed such that:

an intermediate flange is interposed between the rotary blade and the inner flange and/or between the rotary blade and the outer flange, a cam meshing portion is provided between the intermediate flange and the inner flange paired therewith and/or between intermediate flange and the outer flange paired therewith, the cam meshing portion being constituted by meshing of cam portions varying in height in the direction of the axis of the spindle;;

a member serving as the inner flange and/or the outer flange and paired with the intermediate flange so as to constitute the cam meshing portion, is fixed to the rotation fixing portion with respect to the rotation; and
by rotational resistance imparted to the rotary

blade, the intermediate flange is rotated relative to the member paired with the intermediate flange for constituting the cam meshing portion, so that an axial force in the direction of the axis of the spindle is produced in the cam meshing portion.

2. The fixing device according to claim 1 constructed such that the fixing device is provided with the inner flange fixed to the rotation fixing portion with respect to the rotation and contacting with an end portion of the rotation fixing portion so as to be restricted in displacement in the direction of the axis of the spindle; the intermediate flange clamping the rotary blade between the intermediate flange and the inner flange and rotatable relative to the rotation fixing portion; the outer flange clamping the intermediate flange between the outer flange and the rotary blade and fixed to the rotation fixing portion with respect to the rotation; and the fixing flange clamping the outer flange between the fixing flange and the intermediate flange and threadably coupled immovably in the direction of the axis of the spindle by tightening the fixing thread portion into the end surface of the rotation fixing portion; wherein:

the cam meshing portion is provided between the intermediate flange and the outer flange; and a relative rotational force relative to the outer flange, which is imparted to the intermediate flange via the rotary blade, is converted via the cam meshing portion into a pressing force of the intermediate flange in the direction of the axis of the spindle against the rotary blade.

3. The fixing device according to claim 2, wherein frictional resistance in a rotational direction of the intermediate flange relative to the rotary blade is set to be higher than sliding resistance of the cam portions.
4. The fixing device according to claim 2 or 3, wherein a friction reducing means is interposed between the rotary blade and the inner flange, for reducing frictional resistance in a rotational direction of the inner flange against the rotary blade in comparison with the frictional resistance in the rotational direction of the intermediate flange against the rotary blade.
5. The fixing device according to any one of claims 2 to 4, wherein the inner flange is rotatably attached to the rotation fixing portion of the spindle.
6. The fixing device according to any one of claims 2 to 5, wherein a cover is attached between the intermediate flange and the outer flange so as to cover peripheries thereof, the cover is imparted with an elastic force in the rotational direction and is engaged with the intermediate flange and the outer flange in

the rotational direction, and, regarding a position of the intermediate flange in the rotational direction relative to the outer flange, biasing is made toward an initial position at which the cam portions of the intermediate flange and the cam portions of the outer flange mesh most deeply with each other.

7. The fixing device according to any one of claims 2 to 6, wherein, regarding a position of the intermediate flange in the rotational direction relative to the spindle, an initial position biasing means is interposed between the intermediate flange and the rotation fixing portion of the spindle, for biasing toward an initial position at which the cam portions of the intermediate flange and the cam portions of the outer flange mesh most deeply with each other.
8. The fixing device according to claim 1 constructed such that the fixing device is provided with the inner flange fixed to the rotation fixing portion with respect to the rotation and contacting with an end portion of the rotation fixing portion so as to be restricted in displacement in the direction of the axis of the spindle; the intermediate flange clamped between the inner flange and the rotary blade and is allowed to be rotated relative to the rotation fixing portion; the outer flange clamping the rotary blade between the outer flange and the intermediate flange; and the fixing flange clamping the outer flange between the fixing flange and the rotary blade and threadably coupled immovably in the direction of the axis of the spindle by tightening the fixing thread portion into the end surface of the rotation fixing portion; wherein:

the cam meshing portion is provided between the inner flange and the intermediate flange; and a relative rotational force relative to the inner flange, which is imparted to the intermediate flange via the rotary blade, is converted via the cam meshing portion into a pressing force of the intermediate flange in the direction of the axis of the spindle against the rotary blade.

9. The fixing device according to claim 1 constructed such that the fixing device is provided with the inner flange fixed to the rotation fixing portion with respect to the rotation and contacting with an end portion of the rotation fixing portion so as to be restricted in displacement in the direction of the axis of the spindle ; an inner intermediate flange clamped between the inner flange and the rotary blade and allowed to be rotated relative to the rotation fixing portion; an outer intermediate flange clamping the rotary blade between the outer intermediate flange and the inner intermediate flange and allowed to be rotated relative to the rotation fixing portion; the outer flange clamping the outer intermediate flange between the outer flange and the rotary blade and fixed to the

rotation fixing portion with respect to the rotation; and the fixing flange clamping the outer flange between the fixing flange and the outer intermediate flange and threadably coupled immovably in the direction of the axis of the spindle by tightening the fixing thread portion into the end surface of the rotation fixing portion; wherein:

the cam meshing portions, in which the cam portions varying in height in the direction of the axis of the spindle mesh with each other, are respectively provided between the inner flange and the inner intermediate flange and between the outer flange and the outer intermediate flange; and relative rotational forces relative to the inner flange and the outer flange, which are imparted to the inner intermediate flange and the outer intermediate flange via the rotary blade, are converted via the cam meshing portions constituted by the two sets of the cam portions into pressing forces of the inner intermediate flange and the outer intermediate flange in the direction of the axis of the spindle against the rotary blade.

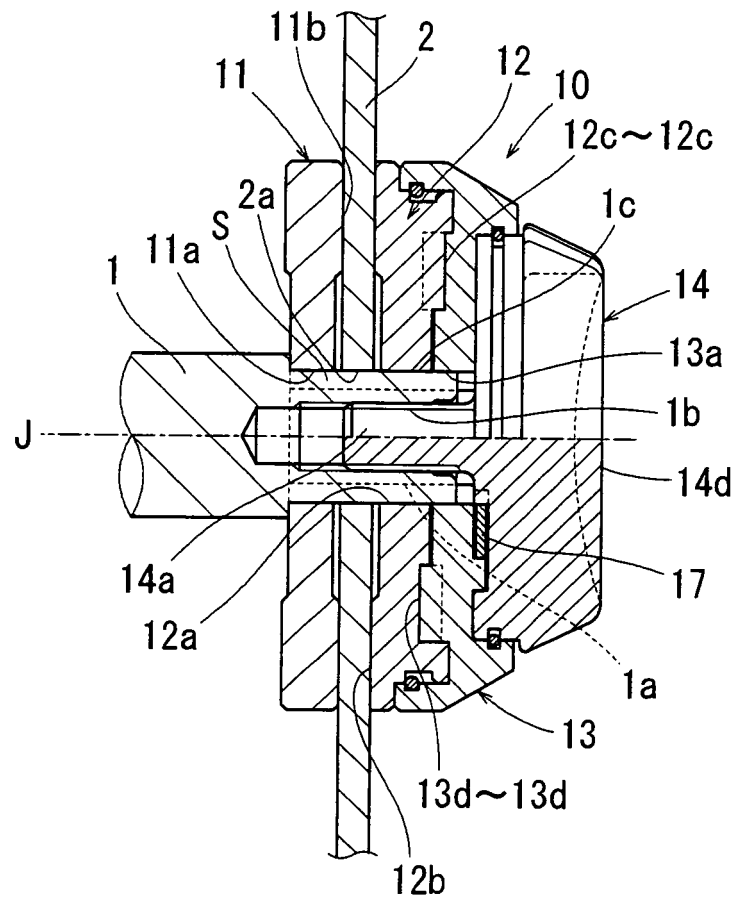


FIG. 1

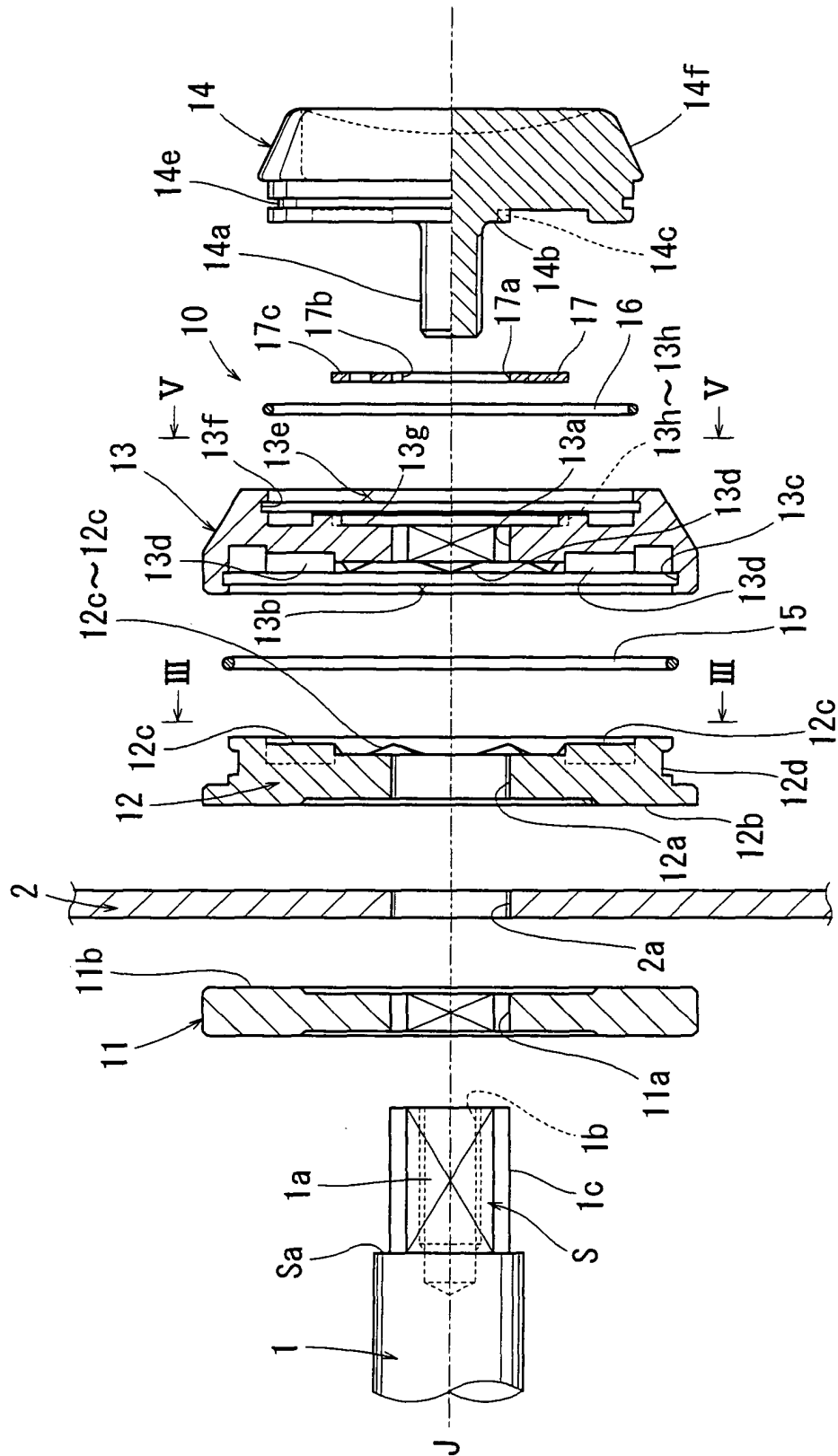


FIG. 2

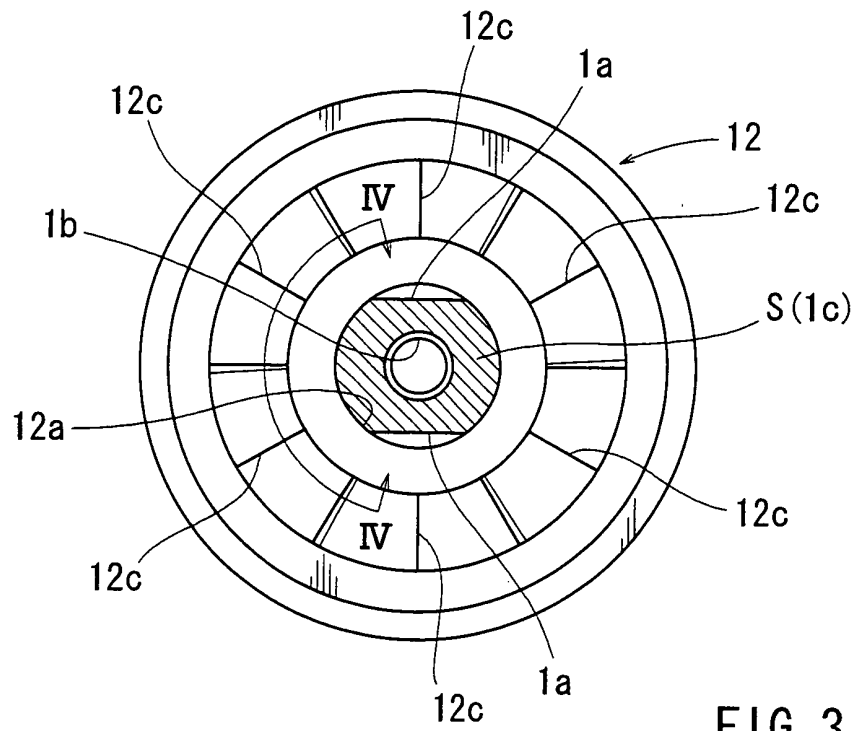


FIG. 3

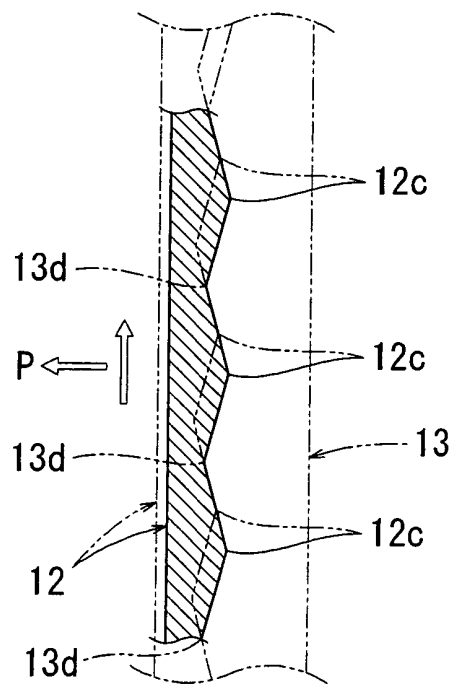


FIG. 4

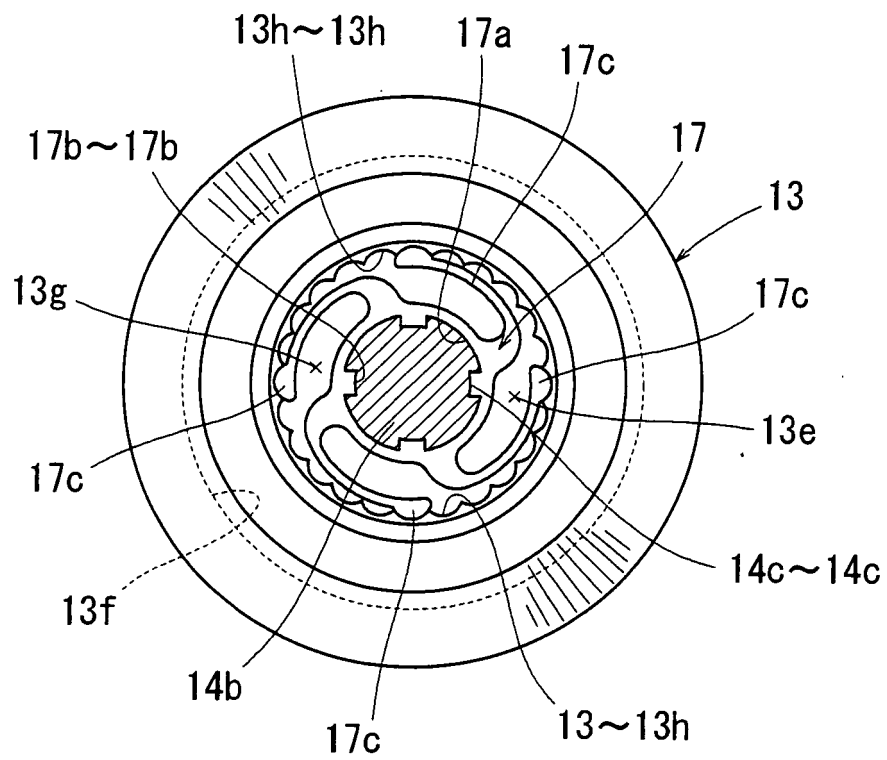


FIG. 5

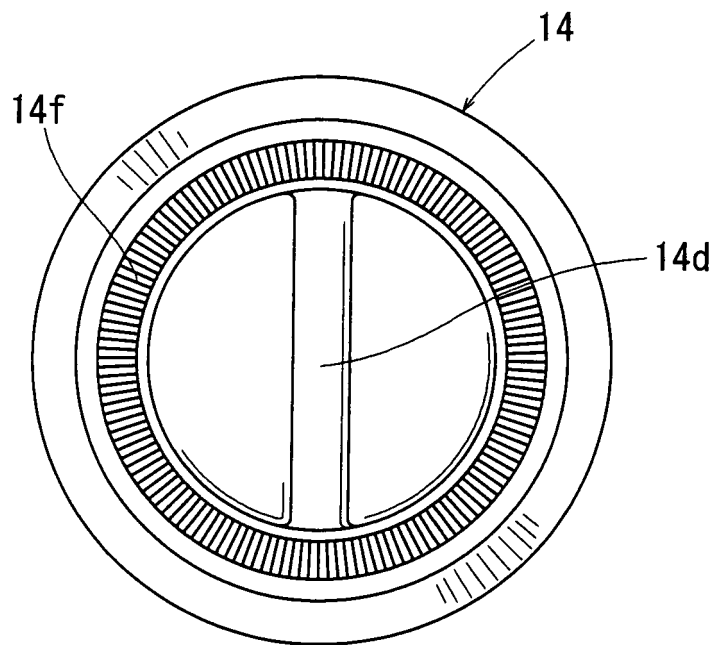


FIG. 6

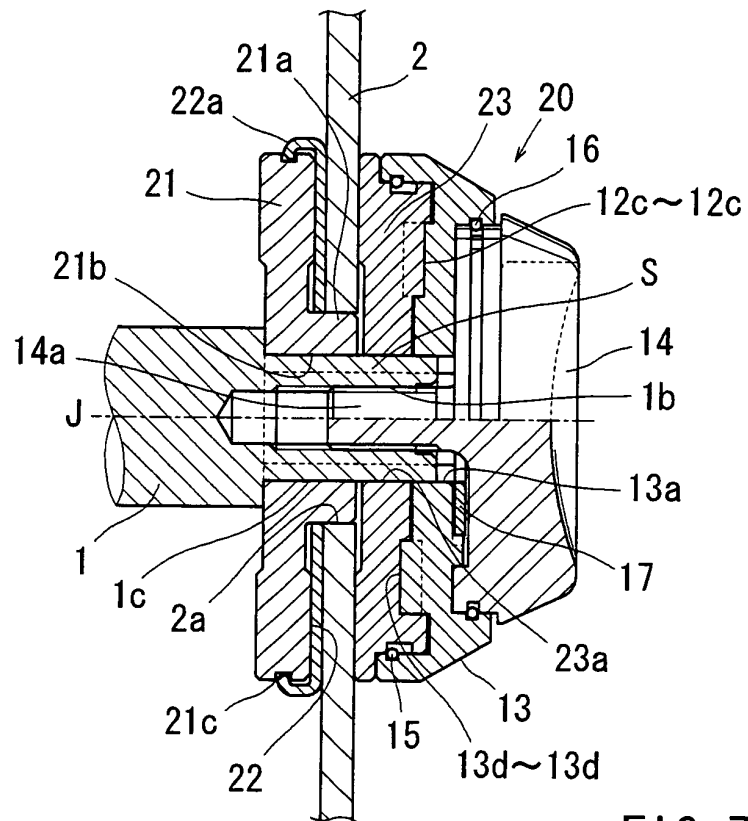


FIG. 7

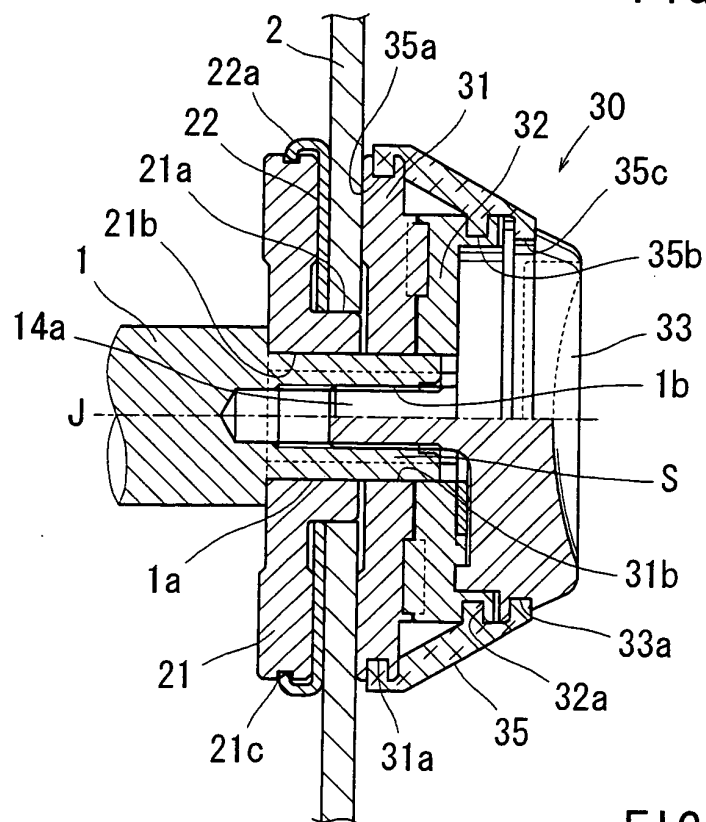


FIG. 8

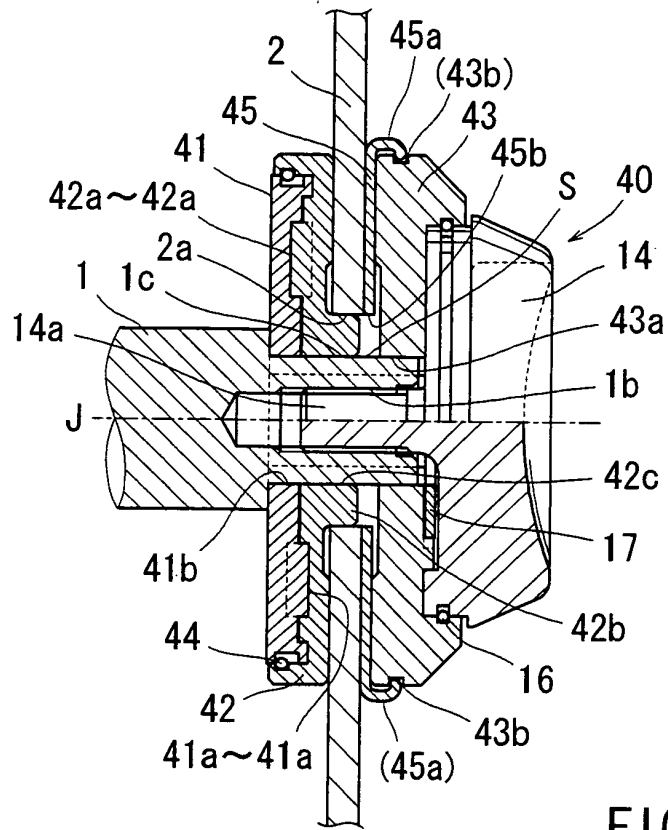


FIG. 9

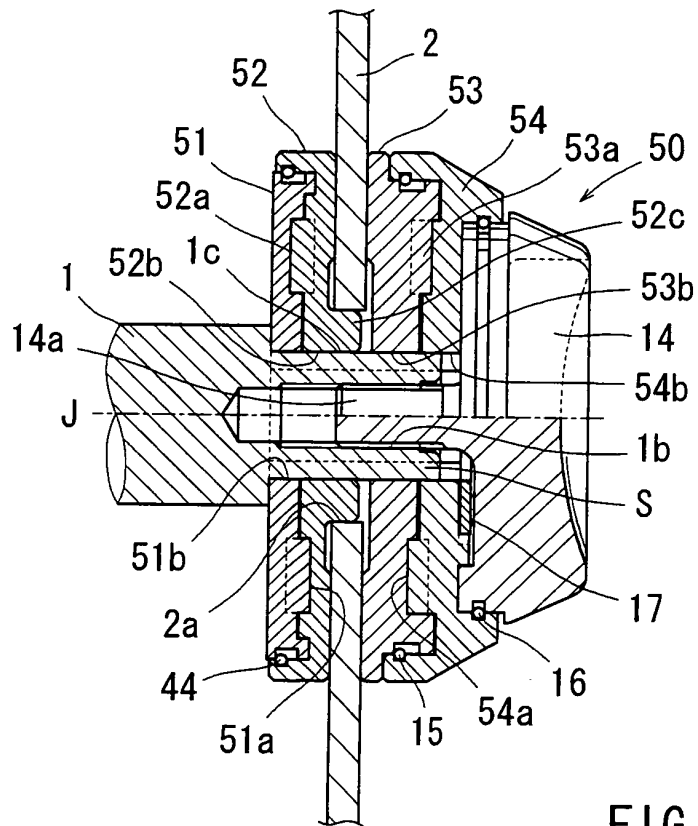


FIG. 10

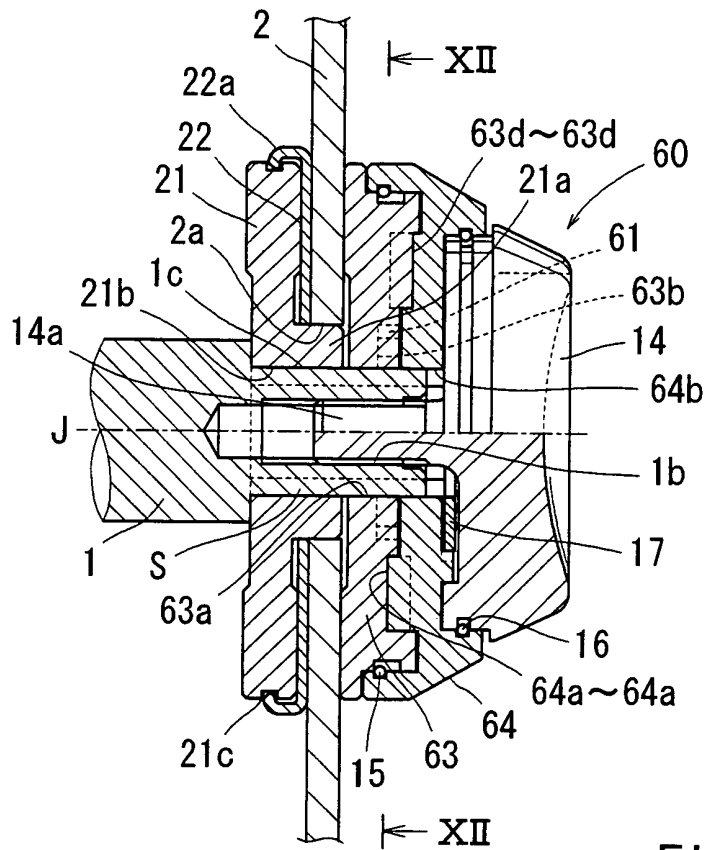


FIG. 11

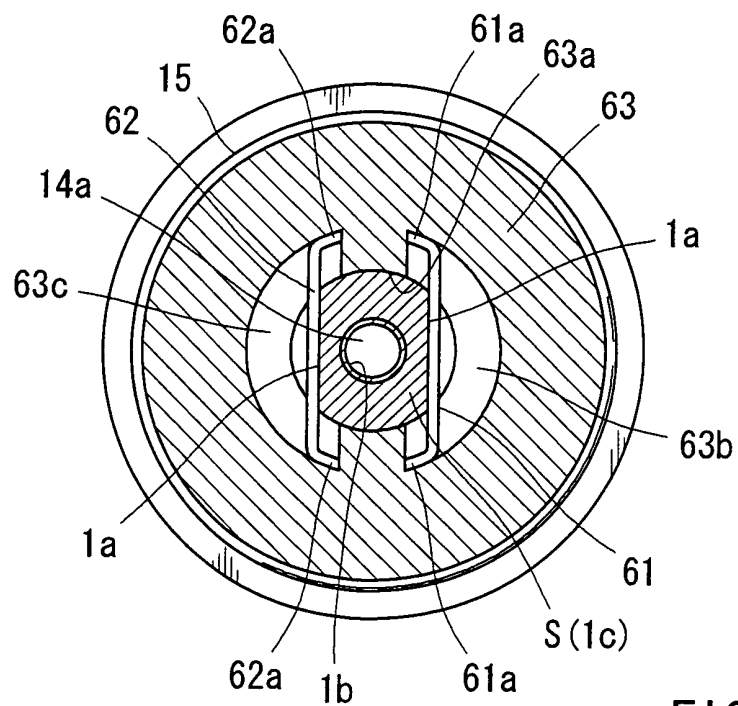


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/074419

A. CLASSIFICATION OF SUBJECT MATTER

B23B31/02 (2006.01) i, B23D61/02 (2006.01) i, B24B45/00 (2006.01) n

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)

B23B31/02, B23D61/02, B24B45/00

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	1996-2008
Kokai Jitsuyo Shinan Koho	1971-2008	Toroku Jitsuyo Shinan Koho	1994-2008

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 11-226869 A (Makita Corp.), 24 August, 1999 (24.08.99), Par. Nos. [0014] to [0034]; all drawings (Family: none)	1-3, 5, 8-9 4, 6-7
Y A	JP 2001-150208 A (Makita Corp.), 05 June, 2001 (05.06.01), Par. Nos. [0007] to [0012]; all drawings (Family: none)	1-3, 5, 8-9 4, 6-7
A	JP 2002-103236 A (Toyoda Machine Works, Ltd.), 09 April, 2002 (09.04.02), Par. No. [0019] (Family: none)	3

☒ 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
29 February, 2008 (29.02.08)Date of mailing of the international search report
11 March, 2008 (11.03.08)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/074419

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-233367 A (NSK Ltd.), 29 August, 2000 (29.08.00), Par. No. [0034] (Family: none)	3
A	JP 10-156609 A (Power Tool Holders Inc.), 16 June, 1998 (16.06.98), Full text; all drawings & US 5899648 A & WO 1998/025034 A1	1-9
A	JP 2-501907 A (Robert Bosch GmbH), 28 June, 1990 (28.06.90), Full text; all drawings & US 4955744 A & WO 1988/005386 A1	1-9

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001096407 A [0002]