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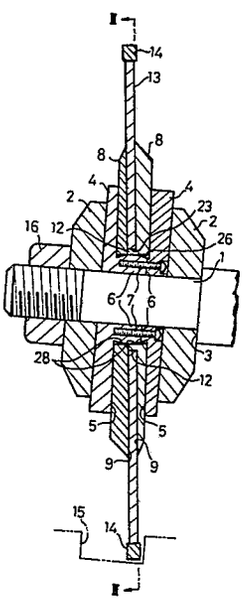
(54) **ROTARY CUTTER.**

(57) There are provided a pair of retaining plates (4) which are rotatable in unison on a rotary shaft (1) for a sawing machine such as a table saw or a radial saw or for a milling machine or the like, and a bearing cylinder (6) formed integrally with both the retaining plates (4) therebetween on the rotary shaft (1). A pair of clamping plates (8) are so mounted on the bearing cylinder (6) as to obliquely support a rotary cutter (13) at a predetermined angle with respect to the center axis of the rotary shaft (1), the rotary cutter operating to cut a groove (15) into a workpiece, and are secured under pressure to the retaining plates (4). By rokking the clamping plates (8) relatively between the retaining plates (4), the plates will tilt with respect to the center axis of the shaft (1). A number of cutting edges (14) formed on the outer periphery of the rotary cutter (13) have elliptical ends so that the floor of the groove will always be flat. The cutter (13) can be rotatably adjusted with respect to the clamping plates (8) on either side thereof.



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DESCRIPTION

TITLE OF THE INVENTION

Rotary Cutter

TECHNICAL FIELD

The present invention relates to a rotary cutter of the type in which the rotary blade of a sawing machine such as a table or radial saw or of a milling machine or the like is mounted at an angle with respect to a rotary arbor or shaft and in which grooves of any desired widths may be cut through changing the mounting angle of the rotary blade with respect to the rotary arbor or shaft.

BACKGROUND ART

The rotary cutter of the type having the rotary blade mounted on the arbor for cutting the grooves at an angle of inclination has been disclosed in U.S. Patent 1,568,199, U.S. Patent 2,544,814, U.S. Patent 4,018,256 and Japanese Utility Model Laying-Open Gazette 54-124,288. However, with these known devices, the various teeth on the outer periphery of the rotary blade are of the same configuration.

Hence, upon use of such type of the cutter for cutting a groove, the bottom surface of the groove may not be cut into a flat surface regardless of the groove width, but into an arcuate surface with its centre coincident with the centre of rotation of the rotary cutter. This phenomenon becomes more and more pronounced with increase of the groove width.

It is an object of the present invention to provide a rotary cutter in which the angle of inclination of a rotary blade can be changed as desired in such a manner that grooves of various widths may be cut and the bottom surface of the groove may always be cut to a substantially flat surface regardless of the width of the groove.

It is another object of the present invention to provide a rotary cutter in which each pressing member may be rotated in unison with the other pressing member of the pair and each clamping member may be rotated in unison with the other clamping member of the pair during rotational adjustment as will be described below, so that these members need not be rotated separately and hence the rotary blade may be adjusted easily as regards its mounting angle.

DISCLOSURE OF INVENTION

With the present invention, the pair of clamping disks 8 are rotatably and tiltably supported between the pair of pressing disks 4 and the rotary blade 13 is rotatably supported between said clamping disks 8. Thus, the desired mounting angle of the rotary blade 13 can be obtained as desired to enable the grooves 15 of various widths to be cut upon rotation of the rotary blade 13, and the bottom surface of the groove 15 to be formed to a substantially flat surface at all times regardless of the width of the groove.

Moreover, the pressing disks 4 are connected with each other by means of the fastening screws 7, and the pair of clamping disks 8 are unrotatably engaged with each other

through engagement of the engagement recesses 11 and engagement projections 12. Thus, the pair of pressing disks 4 and the pair of clamping disks 8 may be rotated in unison at the time of rotational adjustment between the pressing disks 4 and the clamping disks 8 or between the clamping disks 8 and the rotary blade 13, so that the disks 4 and 8 of each pair need not be rotated separately and hence the rotary blade 13 may be readily adjusted for tilting.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view of a rotary cutter embodying the present invention;

Fig. 2(a) and 2(b) are perspective views of clamping disks;

Fig. 3 is a cross-sectional view taken along line III-III of Fig. 1;

Fig. 4(a) is a diagram useful in describing the condition under which a groove is cut by a rotary blade;

Fig. 4(b) is a diagram useful in describing the tooth edge configuration of a multiplicity of cutting elements or teeth on the outer periphery of a rotary blade;

Fig. 5 is a diagram useful in describing the conditions under which a narrow groove is cut by the above-mentioned rotary blade; and

Fig. 6 is a diagram useful in describing the conditions under which a narrow groove is cut, with the above-mentioned rotary blade having been turned and adjusted with respect to a pair of clamping disks.

BEST MODE FOR CARRYING OUT THE INVENTION

Reference will now be had to the accompanying drawings for description of a preferred embodiment of the invention. On a rotating arbor or shaft 1 of a sawing or milling machine or the like are secured a pair of holding disks 2, the right-hand side surface of the rightward holding disk as seen in Fig. 1 being in abutting engagement with a step portion 3 on the rotating arbor 1.

A pair of pressing disks 4 are mounted on the arbor 1 between the pair of holding disks 2 and are pressedly engaged between the holding disks 2 so as to be capable of rotating in unison with the arbor. The inner confronting surfaces 5 of the pressing disks 4 are inclined with respect to the outer surfaces thereof and extend parallel to each other. The central portion of each inclined surface 5 of the pressing disks 4 is projectively provided with a pair of bearing sleeves 6, the radially outer peripheral surfaces of this pair of bearing sleeves 6 forming a portion of a spherical surface 26 whose centre is situated on a point on the central axis of the arbor 1, when the axial end faces of the respective bearing sleeves are abutted with each other as shown in Fig. 1. One of the bearing sleeves 6 projects by a greater length than the other. A pair of fastening screws 7 are passed through the shorter bearing sleeve 6 from outside and are screwed into the longer bearing sleeve 6 on the other pressing disk 4 for rotationally connecting the pressing disks 4 to each other.

A pair of clamping disks 8 are mounted between the two pressing disks 4 so as to be supported on the bearing sleeves

6 and are pressedly engaged and secured between the disks 4. The inner peripheral surface of a bore 28 of the clamping disks 8 is not curved but extends linearly axially as shown in Fig. 1. Each clamping disks 8 and each pressing disk 4 may be rotated relative to the other disk of each pair by relieving the pressure contact in a manner to be described below. The inner confronting surfaces 9 of the disks 8 are inclined with respect to the outer surfaces thereof and are extended parallel to each other.

The central portion of the inclined surface 9 on one of the clamping disks 8 is provided with an annular projection 10 which is interrupted by upper and lower recesses 11, as illustrated in Fig. 2(a). The inclined surface of the other clamping disk 8 is provided with upper and lower engagement projections 12 at locations corresponding to the engagement recesses 11, the projections 12 engaging with said recesses 11 for rotationally connecting the disks 8 to each other.

A rotary cutting blade 13 is clampedly held between the disks 8 and has a central opening 23 in which are engaged the ring-shaped projection 10 and engagement projections 12. The rotary cutting blade 13 is capable of being mounted perpendicularly to the axis of the arbor 1 or at an inclination with respect thereto. Upon removal of clamping action of the pressing disks 4, the rotary blade 13 and the pair of clamping disks may be rotated relative to one another.

The outer periphery of rotary blade 13 has a multiplicity of cutting elements or teeth 14 having end faces or cutting edges with continuously changing end skew angles as shown in

Figs. 4(a) and 4(b). More specifically, the end skew angles of the cutting elements are changed continuously from a maximum value for cutting elements A1, A2 for cutting both inner sides of a groove 15 of predetermined width, to a value of zero for cutting elements C1, C2 for cutting the central portion of the groove 15. Besides, the rotary cutter blade 13 has an overall elliptical shape, with the lengths of the cutting elements A1, A2; B1, B2; and C1, C2 becoming shorter in this sequence.

In Fig. 4(a), a plurality of lines 13a-13c symbolically represent the vertical and inclined attitudes of the rotary blade 13. In Fig. 4(b), cutting elements a1-c2, represented by lines 17 drawn tangentially to each of the cutting elements A1-C2, are projections of each of the cutting elements A1-C2 as viewed substantially from the tangential direction.

Screwed onto the end portion of the arbor 1 is a nut 16 which cooperates with the step portion 3 of the arbor 1 to tightly clamp such elements as the pairs of holding disks 2, pressing disks 4 and clamping disks 8.

Cutting the groove 15 as shown in Fig. 4(a) by utilizing the rotary blade 13 of the foregoing construction is accomplished by rotating the blade together with the arbor 1. Upon so doing, the angle portions on either side of the groove 15 are cut by the cutting elements A1, A2 which have the maximum length and whose end faces or cutting edges have the maximum end skew or bevel angles. As cutting proceeds, the groove 15 is cut successively inwardly from both of the angle portions by a multiplicity of cutting elements B1, B2 which

become gradually shorter than the cutting elements A1, A2 and whose cutting edges have end skew which also becomes gradually smaller than those of the cutting elements A1, A2. The central portion of the groove 15 is cut by the cutting elements C1, C2 which are the shortest of the cutting elements and whose cutting edges have zero end skew angles. Thus, the bottom surface of the groove 15 may be cut to a flat surface.

The mounting angle of inclination of the rotary blade 13 is changed in case of changing the width of groove 15 to be cut. For thus changing the mounting angle, the rotary blade 13 is rotated along with both clamping disks 8 with respect to the pair of pressing disks 4.

For performing this adjustment, the disks 8 are rotated with disks 4 remaining stationary, the radially inner surface of the disks 4 travelling on the radially outer spherical surface of the bearing sleeves 6. At such time, since the radially outer surface of the bearing sleeve 6 has the form of a portion of a spherical surface 26, both clamping disks 8 will be tilted smoothly along the spherical surface portion 26 while being held in linear contact with this surface at any position thereon, the line of contact between the spherical surface portion 26 and clamping disks 8 defining a circle. Upon completion of the tilting adjustment, the rotary blade 13 is clamped stably on the bearing sleeves 6 and will not vibrate radially of the arbor.

For changing the width of the groove 15 as described above, when, for example, the rotary blade 13 is brought to a more nearly vertical position for formation of a groove of

narrower width, as shown in Fig. 5, the relative position between the pressing disks 4 and clamping disks 8 is changed, because the rotary blade 13 is brought to the more erect position by the rotational adjustment of the clamping disks 8 with respect to the pressing disks 4, as described above. Consequently, once the rotary blade 13 has been erected and as long as the attitudes of the rotary blade 13 and clamping disks 8 are not corrected relative to one another, the cutting elements A1, A2 of maximum length and whose end faces or cutting edges have the maximum end skew angles, will not cut the side walls of the groove 15, contrary to what is intended. Instead, other cutting elements such as cutting elements B1, B2 will cut the side walls, the cutting elements C1, C2 will cut the groove 15 at portions offset towards one or the other sides.

If the angle portions inside the groove 15 are cut by the cutting elements B1, B2, the bottom surface of the groove will be cut by the cutting elements A1, A2, C1, C2. As a result, the bottom surface of the groove 15 will become uneven or irregular instead of being cut to a flat surface.

Such formation of an uneven bottom surface would occur similarly in the case in which the mounting angle of the rotary blade 13 is enlarged for cutting a wider groove.

Accordingly, when altering the mounting angle of the rotary blade 13 as described above, the rotary blade is rotated further and adjusted relative to the pair of clamping disks 8, so that the positions of the cutting elements A1, A2, which are of maximum length and have the maximum end skew or

bevel angles at the cutting edges will cut the angle portions inside the groove 15 as shown in Fig. 6.

Thus, from among the multiplicity of cutting elements 14 on the rotary blade 13, the cutting elements A1, A2 always cut the angle portions inside the groove 15, the cutting elements B1, B2 will cut the positions inwards of the groove sides, and the cutting elements C1, C2 will cut the central portion at the bottom of the groove. As a result, the bottom surface of the groove 15 becomes substantially flat or level without any extreme unevenness regardless of the prevailing groove widths.

It should be noted that, even with the adjustment described above, each of the cutting elements A1-C2 of the rotary blade 13 is formed so as to cut the bottom surface of the groove 15 to flatness when the rotary blade 13 is in the inclined state shown in Fig. 4(a). The bottom surface of the groove 15 therefore will always have some unevenness but this can be ignored since the amount of change in the level of the unevenness is extremely small.

INDUSTRIAL APPLICABILITY

With the present invention, the operation for adjusting the mounting angle of the rotary cutter 13 is as follows.

By loosening the nut 16 on the arbor, the pair of holding disks 2 are released from the clamping state. Then, the pair of clamping disks 8 and the rotary blade 13, so far bound to one another by means of the pair of pressing disks 4, are released through loosening the screws 7. In this state,

the integral rotation of the clamping disks 8 and the rotary blade 13 relative to the pressing disks 4 results in the desired larger or smaller tilt or mounting angle of the clamping disks 8 and rotary blade 13, the radially inner surfaces of the disks 8 travelling smoothly on bearing sleeves 6.

Once the mounting angle of the rotary blade 13 has been determined in this way, the rotary blade 13 is rotated relative to the clamping disks 8, until the cutting elements A1 and A2, whose cutting edges have the maximum end skew angles, have been brought to a position to cut both the angle portions of the groove 15.

Finally, the fastening screws 7 and nut 16 are fastened for securing the clamping disks 8 and the rotary blade 13 between the pair of pressing disks 4. Then the nut 16 is tightened for securing the disks 8 and the blade between the pair of holding disks 2.

CLAIMS

1. A rotary cutter comprising;

a rotary arbor (1) of a sawing machine or the like, a pair of pressing members (4) mounted on said arbor (1) for rotation integrally therewith, bearing sleeve means (6) mounted between said pressing members (4) and on said arbor (1) for rotation integrally with said pressing members (4), a pair of clamping members (8) pressedly held between said pressing members (4), said clamping members (8) being rotationally adjusted relatively to said pressing members (4) for adjustment of the angle of inclination of said clamping members with respect to the axis of said arbor (1), a groove cutting rotary blade (13) clampedly held between said clamping members (8) and adapted to be tilted along with said clamping members (8) with respect to the axis of said rotary arbor (1), and a spherical surface portion (26) for permitting a smooth tilting movement of said clamping members on said bearing sleeve means (6),

characterized in that

said rotary blade (13) is made to be rotationally adjustable between and with respect to said clamping members (8), that the rotary blade (13) has on the outer periphery a multiplicity of cutting elements or teeth (14) having end bevel angles continuously changed in such a manner that the teeth (A1, A2) designed to cut the two angle portions of the groove (15) have the maximum end bevel angle and the teeth (B1, B2) designed to cut the progressively

inner portions of the groove (15) have progressively decreasing end bevel angles until the teeth (C1, C2) designed to cut the centre of the groove (15), which has a zero end bevel angle.

2. The rotary cutter as claimed in claim 1 characterized through

a plurality of fastening screws (7) screwed from the outer side of one of the pressing members (4) into the bearing sleeve (6) of the opposite pressing member (4) for connecting the two pressing members (4) together for rotational coupling of the two pressing members.

3. The rotary cutter as claimed in claim 1 characterized in that

said pair of clamping members (8) have engagement projections (12) and engagement recesses (11) that are engaged together to effect rotational coupling between said pair of clamping members, said projections and recesses being designed, when thus engaged together, to fit a bore (23) of the rotary blade (13).

FIG. 1

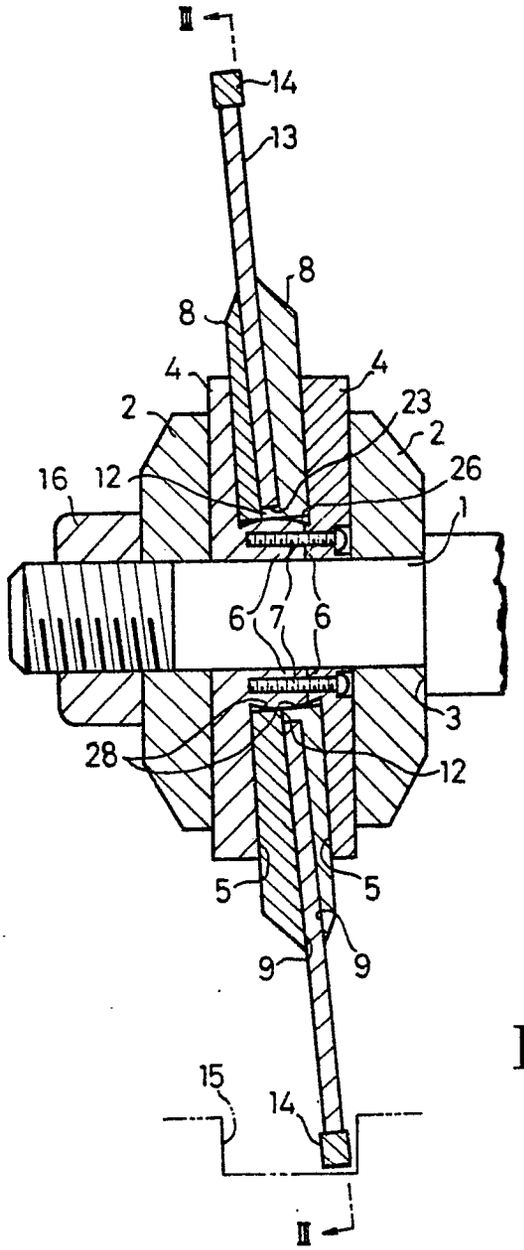


FIG. 2 (a)

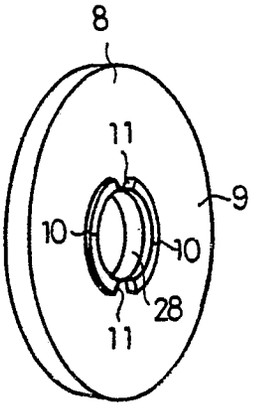


FIG. 2(b)

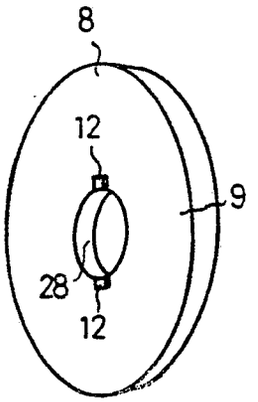


FIG. 3

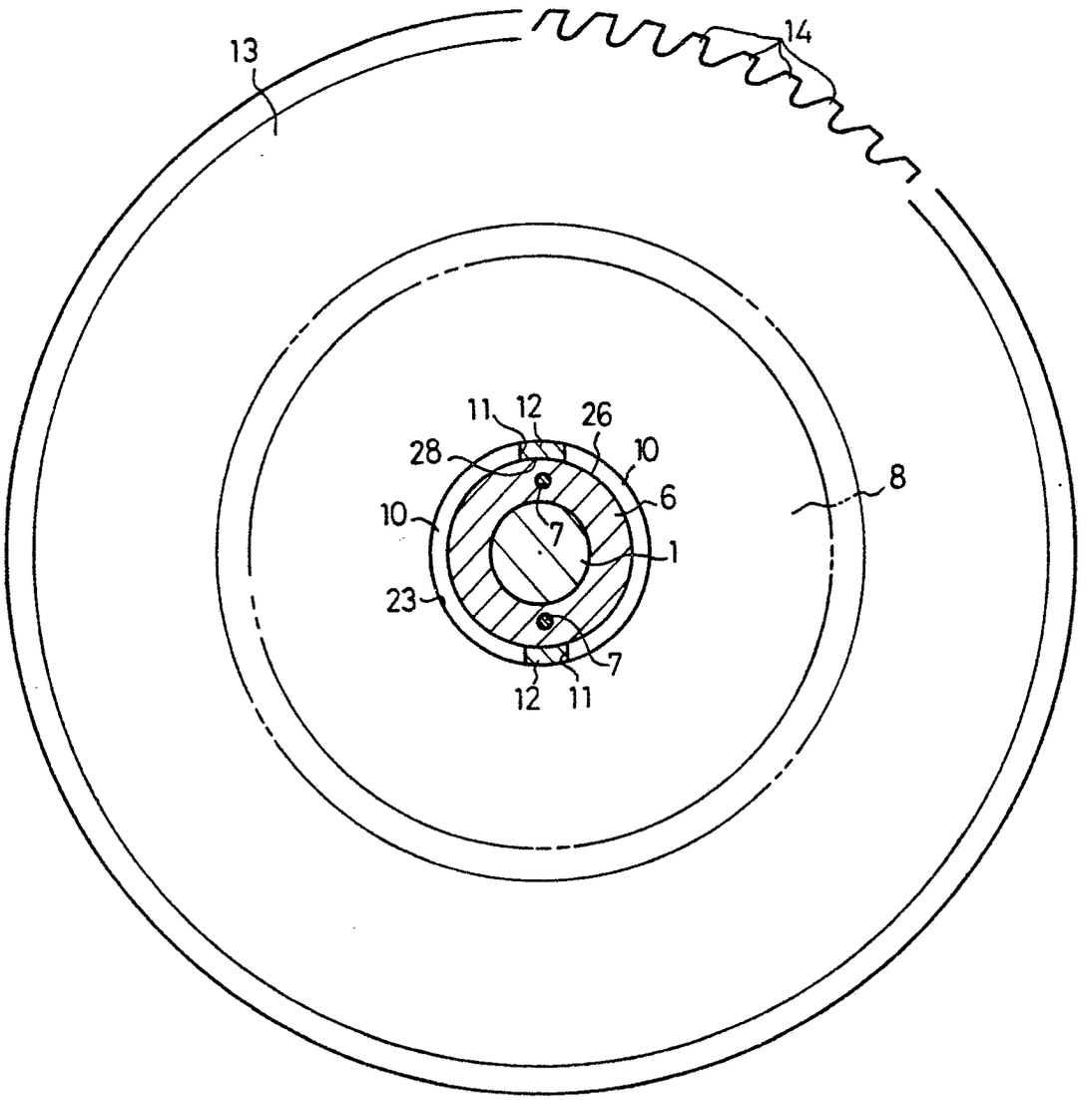


FIG. 4(a)

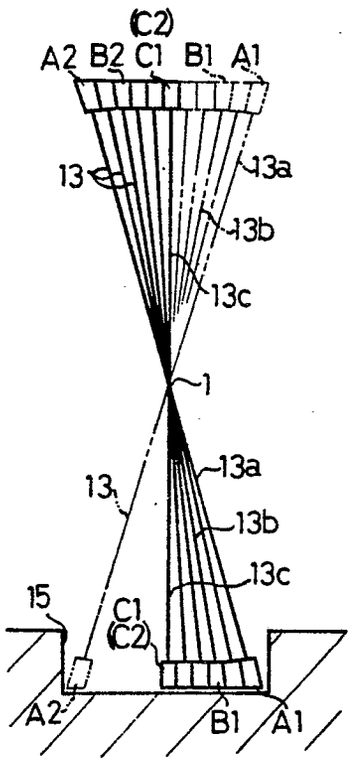


FIG. 4(b)

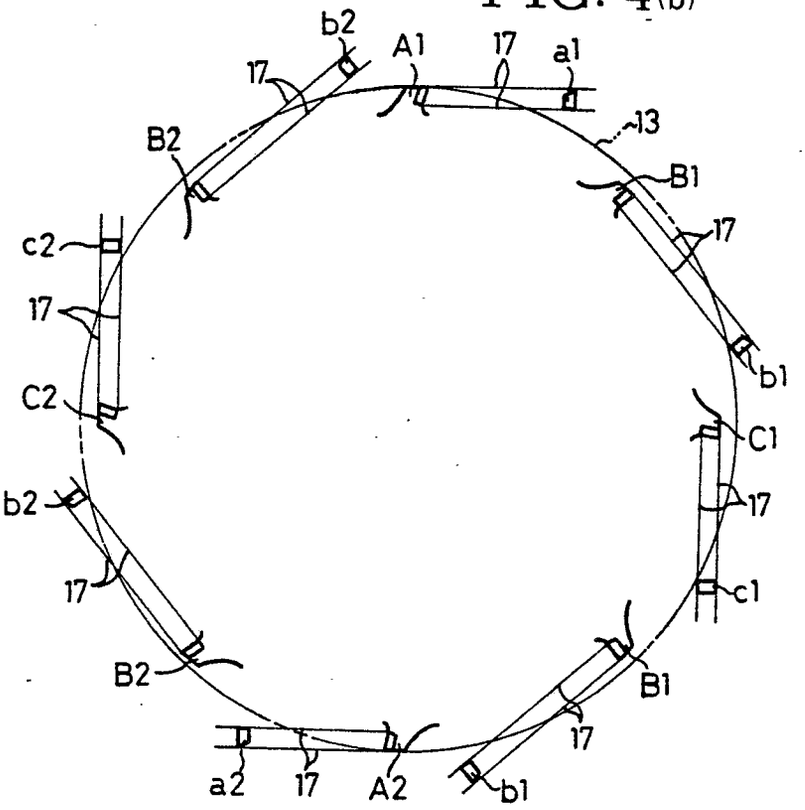


FIG. 5

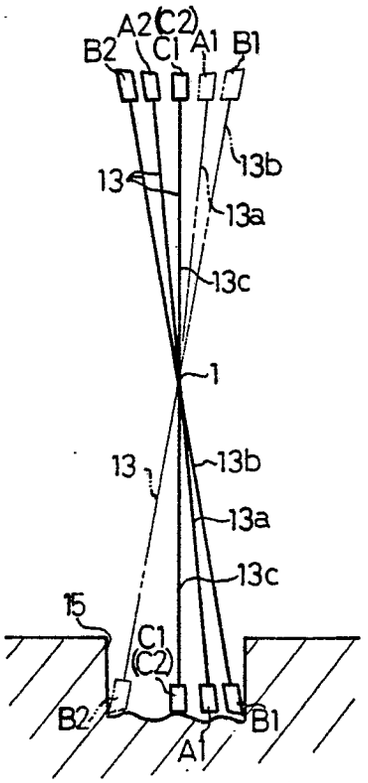
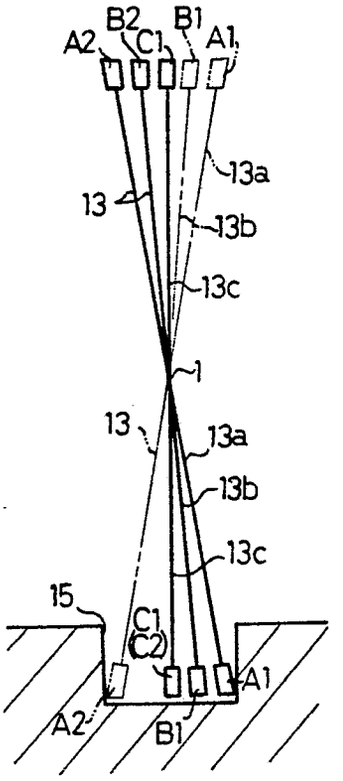


FIG. 6



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP81/00056

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] B27G13/14

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
I P C	B27G13/00, B23C5/08

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho 1911 - 1981

Kokai Jitsuyo Shinan Koho 1971 - 1981

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with Indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	GB, A, 1,538,424 1979-1-17 ELLIS G.A.	1, 2, 3

* Special categories of cited documents: [15]

"A" document defining the general state of the art

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"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
March 18, 1981 (18.03.81)	March 30, 1981 (30.03.81)
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Japanese Patent Office	