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## (54) Cutting disc equipped with replacable blades

(57) A blade-replaceable cutter, incorporating a disc-shape cutter body (11) having a plurality of joining seats (11a) for replaceable blades (13) formed on the same circumference in one side surface of an outer portion thereof. A mechanical unit for locating and securing the replaceable blades (13) to the joining seats (11a) is provided and the replaceable blade (13) is formed into a single side bevel circular knife shape and having a cutting edge line which can be changed by rotating the replaceable blade (13) about an axis perpendicular to the joining seat (11a). The replaceable blade (13) is joined in such a manner that portion of the leading end of the replaceable blade (13) projects over the outer periphery of the cutter body (11). Substantially overall portion of the side face of the replaceable blade which does not project over the outer periphery of the cutter body (11) does not project over the side surface of the cutter body (11) in a direction of the axis of rotation of the cutter and the portion of the leading end of the replaceable blade (13) projecting over the outer periphery of the cutter body (11) makes a positive radial clearance angle θ.

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## Description

**[0001]** The present invention relates to a blade-replaceable cutter for a multi-edged slitter mainly for use to cut and align the back pasting portion of a book which must be bound in a book binding process. More particularly, the present invention relates to an improvement in the shape of a replaceable blade and the cross sectional shape of the outer portion of the cutter body in a joining portion of a replaceable blade.

**[0002]** Hitherto, a cutter of the foregoing type has been known which has a structure, for example, as shown in Figs. 12 and 13. That is, a plurality of chip joining seats la are, at the same angular intervals, formed along the sunk portions on the same circumference of the outer bevel face of a disc-shape cutter body 1. The chip joining seats la are identically inclined at a predetermined angle in the direction of the rotation of the cutter. A rectangular plate-like chips 2 made of a hard material for a cutting edge, such as cemented carbide or high speed tool steel, are brazed to the side face of the cutter body such that the rectangular plate-like chips 2 project over the outer periphery of the cutter body. Moreover, the leading ends of the chips are sharpend.

**[0003]** As shown in Figs. 14 and 15, a replaceable blade type structure has been known. That is, a plurality of replaceable blade joining seats 5a identically inclined in a direction of the rotation of the cutter by a predetermined angle are formed on the same outer circumference of a disc-shape cutter body 5. Substantially rectangular plate-like replaceable blade chips 6 having joining holes formed previously and edged leading ends are joined to the cutter body 5 with bolts. Thus, the secured chips 6 project over the side face of the cutter body 5.

**[0004]** The foregoing conventional cutters incorporating the cutting edges having leading ends formed into the sharp knife shapes suffer from a problem in that the cutting edges easily become chipped. Although a relatively large number of cutting blades canbe provided, the sharp cutting edge and the large number of the blades cause impactive cutting noise having high frequencies to easily be produced. Thus, there arises a problem in that the environment for the cutting operation deteriorates owning to noise.

**[0005]** The operation for re-grinding the cutting edge is performed such that the leading end of the cutting edge on the side face of the cutter body is ground. Therefore, the thickness of the cutter is changed, that is, reduced whenever the re-grinding operation is performed. Hence it follows that the cutting positions with respect to a work which must be ground are changed. To make coincide the cutting position, fine adjustment of the positions of the chips must be performed when the cutter is joined to the finishing machine. The foregoing fine adjustment is an operation requiring significant skill. Undesirable collision of the cutting edge with a pressing roller or the like joined to the body of the finishing machine to overhang above the cutter frequently causes chipping of the cutting edge to occur. Hence it follows that workability excessively deteriorates. What is worse, cost reduction cannot be realized because of a required cost for repairing the blade.

**[0006]** In view of the foregoing, an object of the present invention is to provide a blade-replaceable cutter which is free from easy chipping, which permits quick repair if the cutting edge is chipped, which is able to eliminate cutting noise and which prevents considerable change in the thickness of the cutter after re-grinding has been performed.

**[0007]** To achieve the foregoing object, according to one aspect of the present invention, there is provided a blade-replaceable cutter, comprising: a disc-shape cutter body having a plurality of joining seats for replaceable blades formed on the same circumference in one side surface of an outer portion thereof; and mechanical means for locating and securing the replaceable blades to the joining seats, wherein the replaceable blade is formed into a single side bevel circular knife shape and having a cutting edge line which can be changed by rotating the replaceable blade around an axis perpendicular to the joining seat, and the replaceable blade is joined in such a manner that a portion of the leading end of the replaceable blade projects over the outer periphery of the cutter body, substantially overall portion of the side face of the replaceable blade which does not project over the outer periphery of the cutter body does not project over the side surface of the cutter body in a direction of the axis of rotation of the cutter and the portion of the leading end of the replaceable blade projecting over the outer periphery of the cutter body makes a positive radial clearance angle.

**[0008]** According to the present invention, the replaceable blade formed into the single side bevel circular knife is employed. Although the number of blades is reduced as compared with that of the conventional structure, the strength of the cutting edge can be raised. Thus, chipping of the cutting edge and impactive and grating cutting noise having high frequencies can be eliminated. Since the cutting position of the replaceable blade can be changed, quick repair is permitted if chipping of the cutting edge occurs. Each replaceable blade can be used many times and the number of re-grinding can be reduced. Moreover, the lifetime can be elongated. Since the bevel face of the replaceable blade is ground in place of grinding of the side face of the blade, the thickness of the cutter is not substantially changed when the re-ground replaceable blade has been joined to the cutter body. Therefore, substantially fine adjustment is not required and skillfulness is not required when the cutter is joined. Therefore, an unskilled worker is able to easily replace and regrind the blade-replaceable cutter according to the present invention. The working efficiency is improved.

**[0009]** The leading end of the cutting edge of the replaceable blade projecting over the outer periphery of the cutter body has the positive radial clearance angle.

Therefore, the overall portion of the side face of the replaceable blade is not brought into contact with the cutting surface. Therefore, the sharpness of the cutting surface does not deteriorate easily. The leading ends of the cutting edges which do not concern the cutting are embedded and retracted in the cutter body from the side surface of the cutter body. Only the portions of the cutting edges projecting over the outer periphery of the cutter body are used to perform cutting. Therefore, contact between the cutting edges which do not concern the cutting operation and cutting dust can be prevented. Hence it follows that the cutting edges can be protected. Thus, the sharpness of the cutting edges can always be maintained.

**[0010]** A structure may be employed in which the shape of the cutting edge line of the replaceable blade is formed into the circular shape or the polygonal shape, and the cutting edge is rotated and indexed by a locating mechanism. As a result, the replaceable blade in the form of a small chip formed into a single side bevel circular knife can accurately be rotated and indexed at a predetermined angle. When the replaceable blade is rotated and indexed, one replaceable blade can be used several times. Thus, the lifetime of each replaceable blade can be elongated. As described above, contact between the cutting edges which do not concern the cutting operation and cutting dust can be prevented. Therefore, the cutting edges are not damaged until the foregoing cutting edges are used to perform the cutting operation. A satisfactory sharpness of the cutting edge can be obtained when the cutting edge has been indexed. Thus, the lifetime can be stabilized. It leads to a fact that the lifetime of each replaceable blade can be elongated. Since the position of the cutting edge is changed if the cutting edge is worn, the cutting surface does not deteriorate. As a result, the lifetime can be elongated and the running cost can significantly be reduced.

**[0011]** A structure may be employed in which a portion of the replaceable blade with which the replaceable blade is joined and located with respect to the cutter body is formed into a polygonal cylindrical shape. Thus, the rotation of the replaceable blade is prevented such that at least two opposite sides of the polygon are held or two sides of the polygon are received by V-shape surfaces. When the position of the cutting edge is changed at the position at which the replaceable blade has been joined, indexing and location can easily and reliably be performed.

**[0012]** A structure may be employed in which a screw for clamping the replaceable blade is provided such that pressing force directed to the central portion of the cutter body acts on the replaceable blade after the replaceable blade has been clamped to the joining seat of the cutter body. As a result, the countersunk surface of the screw presses the 90°-countersunk surface of the replaceable blade when the replaceable blade is clamped with the countersunk head screw for clamping the replaceable blade. Thus, the fractional pressing force acts on the central portion of the cutter. Therefore, the side surfaces of the polygonal cylinder replaceable blade are strongly pressed against the reference surface of the wall of the joining seat. Thus, locating and securing can reliably be performed.

**[0013]** The invention may be carried into practice in various ways and some embodiments will now be described by way of example with reference to the accompanying drawings in which:

Fig. 1 is a side view showing a portion of a cutter body according to the present invention;
Fig. 2 is an enlarged cross sectional view showing a seat for joining a replaceable blade of the cutter body in a direction of the diameter of the cutter;
Fig. 3 is a fragmentary view taken in the direction of the arrows along line A-A shown in Fig. 1;
Fig. 4 is an enlarged cross sectional view showing a state in which the replaceable blade has been joined in a direction of the diameter of the cutter;
Fig. 5 is a fragmentary view taken in the direction of the arrows along line B-B shown in Fig. 1;
Fig. 6 is a side view showing the side face of the blade such that the replaceable blade according to the first embodiment is enlarged;
Fig. 7 is a side view showing a bevel face portion such that the replaceable blade according to the first embodiment is enlarged;
Fig. 8 is an enlarged front view showing the replaceable blade according to the first embodiment;
Fig. 9 is an enlarged vertical cross sectional view showing the replaceable blade according to the first embodiment;
Fig. 10 is an enlarged side view showing a replaceable blade according to a second embodiment;
Fig. 11 is an enlarged front view showing the replaceable blade according to the second embodiment;
Fig. 12 is a side view showing a portion of a conventional cutter having a structure in which the cutting edges are fixed;
Fig. 13 is a vertical cross sectional view showing a portion of the conventional cutter having a structure in which the cutting edges are fixed;
Fig. 14 is side view showing a portion of a conventional cutter having a structure in which the cutting edges are replaceable; and
Fig. 15 is a vertical cross sectional view showing a portion of a conventional cutter having a structure in which the cutting edges are replaceable.

**[0014]** Embodiments of the present invention will now be described with reference to Figs. 1 to 5 which show a portion of the cutter body and Figs. 6 to 9 which are enlarged views showing a replaceable blade.

**[0015]** A plurality of replaceable blade joining seats 11a and chamfered countersunk holes 11b are formed by cutting. The replaceable blade joining seats 11a and

the chamfered countersunk holes 11b formed substantially concentrically are provided for the side surface of a disc-shape cutter body 11 perpendicular to an axis of rotation of the cutter body 11. Note that the replaceable blade joining seats 11a and the chamfered countersunk holes 11b are formed at the same angular intervals (note that a necessity that the angles are the same can be eliminated). The chamfered countersunk hole 11b is formed into a nearly circular shape from which the outside of the outer periphery of the cutter body 11 has been removed. The removed portion of the chamfered countersunk hole 11b is substantially 1/3 of a circle. The diameter of the chamfered countersunk hole 11b is slightly larger than the diameter of a replaceable blade 13 which must be joined to the chamfered countersunk hole 11b. The depth of the chamfered countersunk hole 11b is larger than the bevel face portion of the replaceable blade.

**[0016]** The joining seat 11a formed at substantially the central portion of the chamfered countersunk hole 11b is provided for the bottom of a rectangular countersunk hole. When the bossed portion of the replaceable blade 13 according to first and second embodiments to be described later is formed into a hexagonal shape, the foregoing rectangular countersunk hole is surrounded by the following walls. That is, the walls include walls 11d and 11e of the joining seat 11a formed at substantially the same distances from a tapped hole 11g formed at substantially the central portion (note that the distance between the walls 11d and 11e of the joining seat 11a has a tolerance which is produced when clearance fit is performed and the distance is the same as 2 m shown in Fig. 7). The walls 11d and 11e are opposite to each other at the both side of the tapped hole 11g. The walls include a wall 11c of the joining seat 11a distant from the tapped hole 11g and formed adjacent to the central portion and an outer wall 11f of the joining seat 11a more distant from the tapped hole 11g as compared with the wall 11c of the joining seat 11a.

**[0017]** The tapped hole 11g is formed at a position at which the distance from the tapped hole 11g and the central wall 11c of the joining seat 11a is slightly shorter than radius r of the polygonal cylindrical bossed portion for the replaceable blade. Therefore, when the replaceable blade 13 has been clamped by a countersunk head screw, the circular-arc surface of the bossed portion of the replaceable blade is pressed against the central wall 11c of the joining seat 11a which serves as a reference surface for joining the cutter body 11. As a result, a required accuracy of the outer surface of the replaceable blade can be maintained.

**[0018]** When the replaceable blade 13 has been clamped to the joining seat 11a for the replaceable blade 13, a positive radial clearance angle $\theta$ of 0.5° to 5° (2° in this embodiment) is given to the cutting edge by inclining the surface of the joining seat 11a for the replaceable blade 13 with respect to a surface which is perpendicular to the axis of rotation of the cutter. The walls 11d and 11e of the joining seat 11a distant from the tapped hole 11g in the joining seat 11a for the same distance and paralleling each other and the central wall 11c of the joining seat 11a more distant from the central portion as compared with the walls 11d and 11e of the joining seat 11a are finished to have excellent accuracy so as to serve as reference surfaces.

**[0019]** The depth of the joining seat 11a for each replaceable blade and disparity of the distance between the wall 11c of the joining seat 11a which serves as the reference surface for joining the replaceable blade and the center of the cutter body and the distance between the tapped hole 11g from the same exerts an adverse influence on stabilization of the position of the outer cutting edge line of the cutter. Therefore, machining must carefully be performed.

**[0020]** Also a case of the bossed portion of the replaceable blade is formed into a regular octagon or quadrangle, the walls 11d and 11e of the joining seat 11a are formed to be distant from the tapped hole for the same distance. Moreover, the wall 11c of the joining seat 11a is formed to be distant for a distance which is slightly shorter than the foregoing distance.

First Embodiment

**[0021]** A shown in Figs. 6 to 9, a replaceable blade chip 13 which is joined to the joining seat 11a is a dish-like shape having a diameter with which a portion of the cutting edge 13a projects over the outer periphery of the cutter body when the replaceable blade chip 13 has been clamped to the joining seat 11a. The cross sectional shape of the replaceable blade chip 13 is formed into a single side bevel circular knife. The ridge of the outer periphery is formed into the cutting-blade line 13a. A bossed portion 13b having an end surface 13c, which is a reference surface which is pressed and fixed against the surface of the joining seat 11a, is formed to project over the central portion of the back face of the blade (the bevel surface). The bossed portion 13b has the end surface 13c which parallels a side face 13d of the blade. The bossed portion 13b is formed into a polygonal cylinder having an outer surface which has small circular-arc portions.

**[0022]** It is preferable that the polygonal cylinder is an even-numbered polygonal cylinder which permits easy locating when the position of the cutting edge is changed by rotating the replaceable blade 13. In this embodiment, a regular hexagonal shape is employed. When the even-numbered polygon, such as the rectangle, hexagon or octagon, is employed, the two opposite sides are parallel surfaces. As a result, joining to the walls 11e and 11d of the joining seat 11a, which are reference surfaces, can easily and accurately be performed. Note that the shape is not limited to the even-numbered regular polygon. When an odd-numbered polygon, such as a regular triangle or a regular pentagon, is employed, the walls of the joining seat 11a are

made correspond to the employed shape. The walls 11d and 11e of the joining seat 11a, which are reference surfaces, can be formed into V-shapes each having a vertex facing the central portion. A shape except for the regular polygon may be employed from a viewpoint of practical use.

**[0023]** The replaceable blade 13 has a rake side face 13d on the side face thereof which has a central portion provided with a joining through hole 13e countersunk-chambered at 90°. The bossed portion 13b of the replaceable blade 13 is inserted into the rectangular countersunk hole provided for the joining seat 11a. The hexagonal surfaces of the bossed portion are placed along the walls 11c, 11d and 11e of the joining seat 11a which is a reference surface. Then, the 90°-countersunk head screw 14 is inserted into the through hole 13e of the replaceable blade 13, and then screwed in the tapped hole 11g formed in the joining seat 11a for the replaceable blade 13, followed by tightening the 90°-countersunk head screw 14. Since the tapped hole 11g is formed slightly adjacent to the wall 11c of the joining seat 11a, the clamping force of the 90°-countersunk head screw 14 causes the countersunk surface to be pressed against the countersunk surface of the through hole 13e of the replaceable blade 13 in the axial direction of the 90°-countersunk head screw. Thus, the fractional pressing force directed to the central portion presses and fixes the bossed portion 13b against the wall 11c of the joining seat 11a which is the reference surface. As a result, the replaceable blade 13 can accurately and reliably be secured with a satisfactory accuracy of the outer surface of the replaceable blade 13,

**[0024]** The length of projection of the polygonal-cylinder-shape bossed portion 13b of the replaceable blade 13 is longer than the depth of the joining seat 11a. Therefore, the end surface 13c of the replaceable blade 13 can reliably be seated in the joining seat 11a. The thickness of the portion of the bevel face 13f adjacent to the central portion is smaller than the depth of the chamfered countersunk hole 11b of the cutter body 11. When the replaceable blade 13 is pressed and secured in the joining seat 11a by the positive radial clearance angle $\theta$ , the overall portion of the replaceable blade 13, which does not project over the outer periphery of the cutter body 11, is embedded in the chamfered countersunk hole 11b such that projection from the side surface of the cutter body 11 toward the axis of rotation of the cutter is prevented. Since the joining seat 11a is inclined by 2°, the portion of the replaceable blade 13 projecting over the outer surface of the cutter body 11 projects over the side surface of the cutter body 11 by a distance corresponding to the radial clearance angle of 2°. The walls 11d and 11e of the joining seat 11a, which are parallel reference surfaces of the joining seat 11a for the replaceable blade 13, serve as stoppers for preventing rotation of the replaceable blade 13.

**[0025]** The squareness of the end surface 13c, which is the reference surface for the bossed portion 13b, with respect to the 90°-countersunk surface of the replaceable blade 13, and the parallelism between the end surface 13c and the side face 13d of the replaceable blade 13 are important factors. When the position of the cutting edge is changed by rotating the replaceable blade 13, the foregoing factors exert an influence on the stability of the cutting edge line. It is preferable that the replaceable blade 13 is made of a hard material for the edge of the blade, such as cemented carbide or high-speed tool steel. As an alternative to this, it is preferable that at least either of the bevel face 13f or the side face 13d of the replaceable blade 13 is coated with a chrome nitride layer made of CrN or $Cr_2N$ or a mixture of CrN and $Cr_2N$ and having a thickness of 0.5 μm to 6.0 μm. That is, it is preferable that the replaceable blade 13 is made of a hard material for the edge subjected to wear-resisting surface treatment.

**[0026]** The replaceable blades 13 are joined to the joining seats 11a for all of replaceable blade 13 of the cutter body 11, and then clamped with the countersunk head screws 14. Then, the cutter is joined to the cutting machine so as to cut and align the back pasting portion of a book which must be bound. Since the circular replaceable blades are employed, the cutting edges are able to cut at a small angle of inclination with respect to the direction of the tangent of a rotational circle of the cutter. Therefore, the wedge angle at the cutting position of the cutting edge is considerably reduced as compared with the cross sectional angle of the cutting edge portion of the replaceable blade 13. As a result, a sharp cutting edge can be realized.

**[0027]** If the sharpness deteriorates after a large number of cutting operations, the countersunk head screw 14 is loosen to slightly move the replaceable blade 13 in an upward direction. Then, the regular hexagonal cylinder of the bossed portion 13b is removed from the hole in the joining seat. Then, the replaceable blade 13 is rotated by one pitch to expose a new cutting edge portion. Then, the regular hexagonal cylinder is inserted into the hole in the joining seat 11a, followed by clamping and securing the replaceable blade 13 with the countersunk head screw 14. After the replaceable blade 13 has been rotated six times, the replaceable blade 13 must be again ground. Therefore, the replaceable blade 13 is removed. Then, a rod-shape jig is used which has a diameter somewhat smaller than the diameter of the replaceable blade 13, which exhibits accurate squareness of the surface for joining the replaceable blade 13 with respect to the axis of rotation, which is provided with a boss arranged to be inserted into the through hole 13e of the replaceable blade 13 and which is formed at the center thereof. The rake surface of the side face of the replaceable blade 13 is brought into contact with the jig, followed by screwing and securing a fixing bolt into a central hole of the jig.

**[0028]** Then, the jig is rotated around the axis of rotation to perform grinding with a flat grind stone having a grinding surface which parallels the bevel face 13f. As

a result of the foregoing grinding operation, the cutting edge line 13a is formed on a plane perpendicular to the central axis of the replaceable blade 13 such that the cutting edge line 13a is concentric with the central axis of the replaceable blade 13. Since the bevel face 13f of the replaceable blade 13 is again ground, the thickness of the replaceable blade 13 is not substantially changed. Also change in the thickness realized after the replaceable blade 13 has been joined to the cutter body 11 is slight change corresponding to the radial clearance angle θ. Therefore, substantially no fine adjustment is required.

**[0029]** To realize accurate leading end of each of the replaceable blades 13, the grinding operation must be performed such that the diameters of all of the replaceable blades 13 of one cutter are the same.

Second Embodiment

**[0030]** A second embodiment will now be described with reference to Figs. 10 and 11 which show a replaceable blade having a cutting edge line formed into a polygonal shape.

**[0031]** A replaceable blade according to the second embodiment has a shape of a single side bevel circular knife having a cutting edge line formed into a polygonal shape, such as a regular rectangle, a square pentagon, a square hexagon or a square octagon. Figs. 10 and 11 show a replaceable blade 15 having a cutting edge line 15b formed into the square hexagon. A pressing end surface 15a, a bossed portion 15c in the form of the hexagonal cylinder, a 90°-countersunk hole 15c and a through hole in the countersunk head screw are the same as the corresponding elements according to the first embodiment.

**[0032]** Also the chamfered countersunk hole 11b of the cutter body 11, the walls 11c, 11d and 11e of the joining seat 11a and the replaceable blade joining seat 11a are the same as those of the replaceable blade according to the first embodiment. Therefore, description of the same elements and that of the operation of the same elements are omitted.

**[0033]** A re-grinding operation is performed such that a bevel face 15d is ground in such a manner that the rod-shape grinding jig is not rotated. The amount of feeding of the grindstone is made to be constant to sequentially grind an indexed portions of the swaged surface 15d for a predetermined angular degree. It is convenient to employ a grinder having a structure with which the axis of rotation of the jig can be rotated and indexed. Also the material of the blade and wear-resisting surface treatment are the same as those according to the first embodiment.

**[0034]** Also the bossed portion of the replaceable blade are formed into the square polygonal shape to correspond to the square polygonal shape of the cutting edge line. To maintain a required accuracy of the outer line of each of the cutting edges, it is preferable that the bossed portion has a polygonal shape having a small circular-arc shapes similarly to the replaceable blade according to the first embodiment.

## Claims

1. A blade-replaceable cutter, comprising: a disc-shaped cutter body (11) having a plurality of joining seats (11a) for replaceable blades (13) formed on the same circumference in one side surface of an outer portion thereof; and mechanical mans (14,11g) for locating and securing the replaceable blades (13) to the joining seats (11a), characterised in that the replaceable blade (13) is formed into a single side bevel circular knife shape and has a cutting edge position which can be changed by rotating the replaceable blade (13) about an axis perpendicular to the joining seat (11a), and the replaceable blade (13) is joined in such a manner that a portion of its leading end projects over the outer periphery of the cutter body (11), substantially overall portion of the side face of the replaceable blade (13) which does not project over the outer periphery of the cutter body (11) does not project over the side surface of the cutter body in a direction of the axis of rotation of the cutter and the portion of the leading end of the replaceable blade (13) projecting over the outer periphery of the cuter body (11) makes a positive radial clearance angle θ.

2. A blade-replaceable cutter as claimed in Claim 1, characterised in that the shape of the cutting edge line of the replaceable blade (13) is formed into a circular shape or a polygonal shape, and the cutting edge is rotated and indexed by a locating mechanism.

3. A blade-replaceable cutter as claimed in Claim 1 or Claim 2, characterised in that a portion of the replaceable blade (13) with which the replaceable blade is joined and located with respect to the cutter body (11) is formed into a polygonal cylindrical shape.

4. A blade-replaceable cutter as claimed in any one of Claims 1 to 3, characterised in that a screw (14) for clamping the replaceable blade (13) is provided such that pressing force directed to the central portion of the cutter body (11) acts on the replaceable blade (13) after the replaceable blade (13) has been clamped to the joining seat (11a) of the cutter body (11).

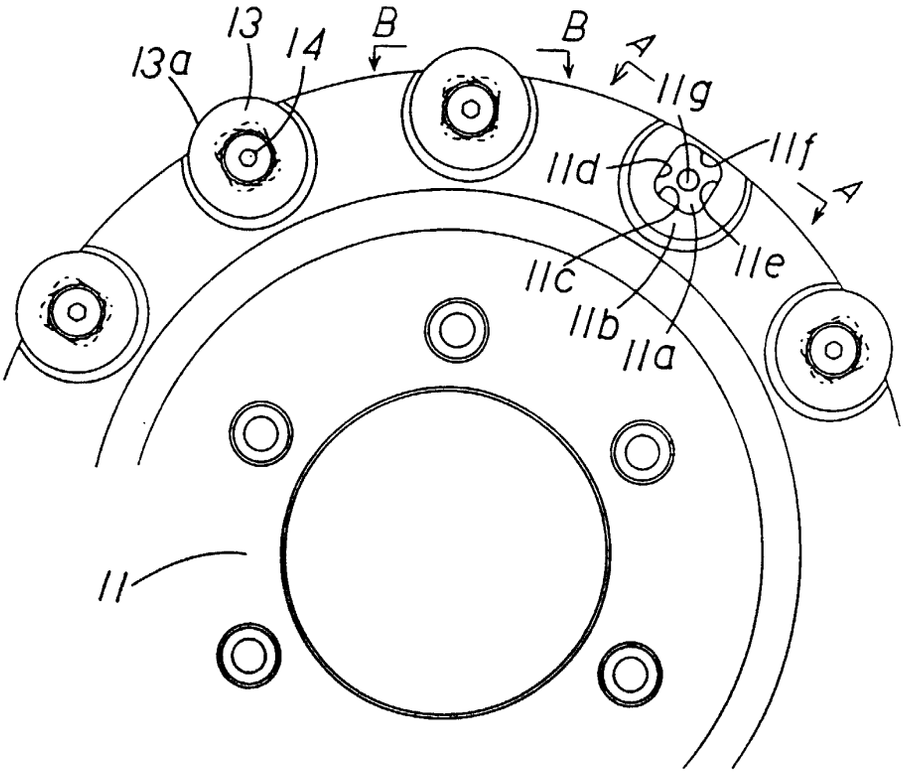
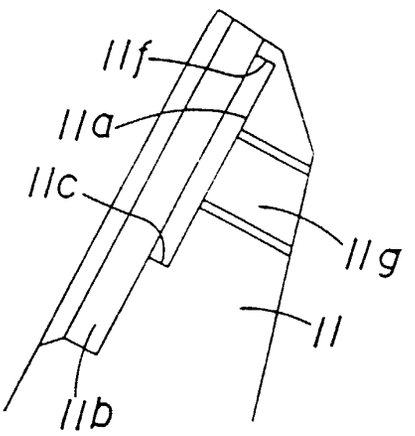

13
13a
14
B
B
A
11g
11d
11f
A
11e
11c
11b
11a
11

Fig. 1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11b

Fig. 2

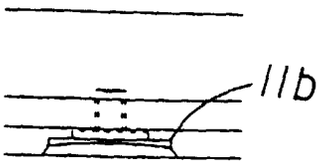


Fig. 3

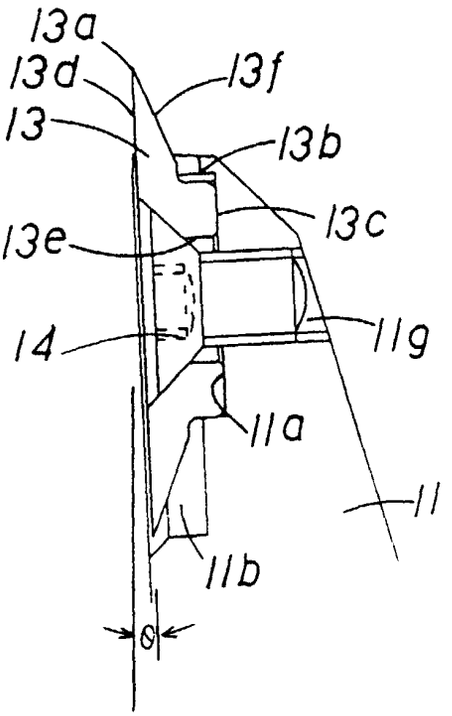


Fig. 4

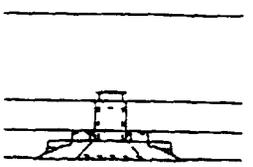

Fig. 5

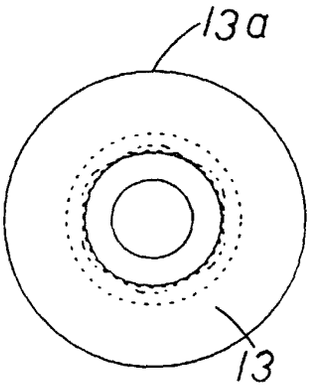


Fig. 6

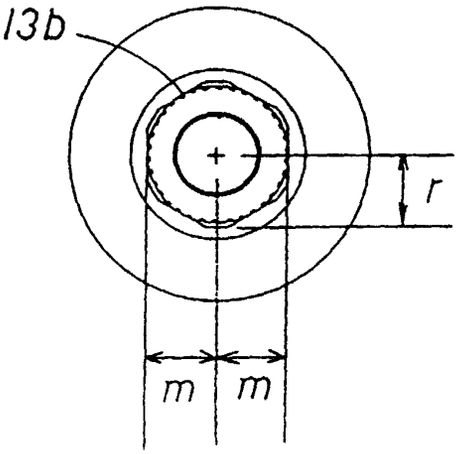


Fig. 7

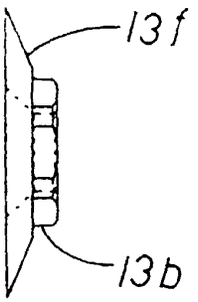


Fig. 8

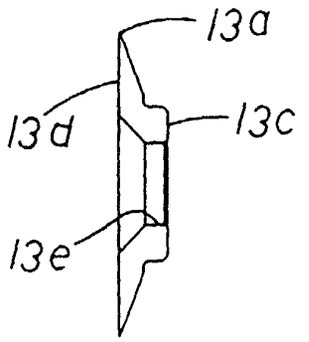


Fig. 9

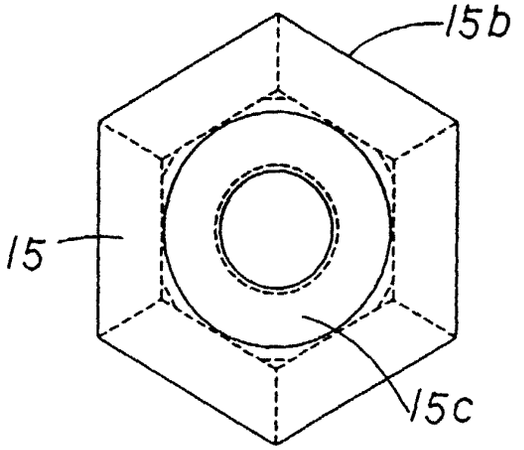


Fig. 10

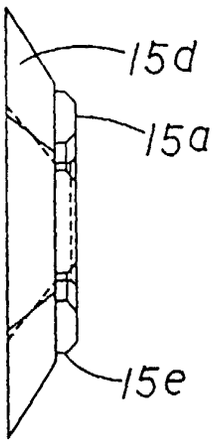


Fig. 11

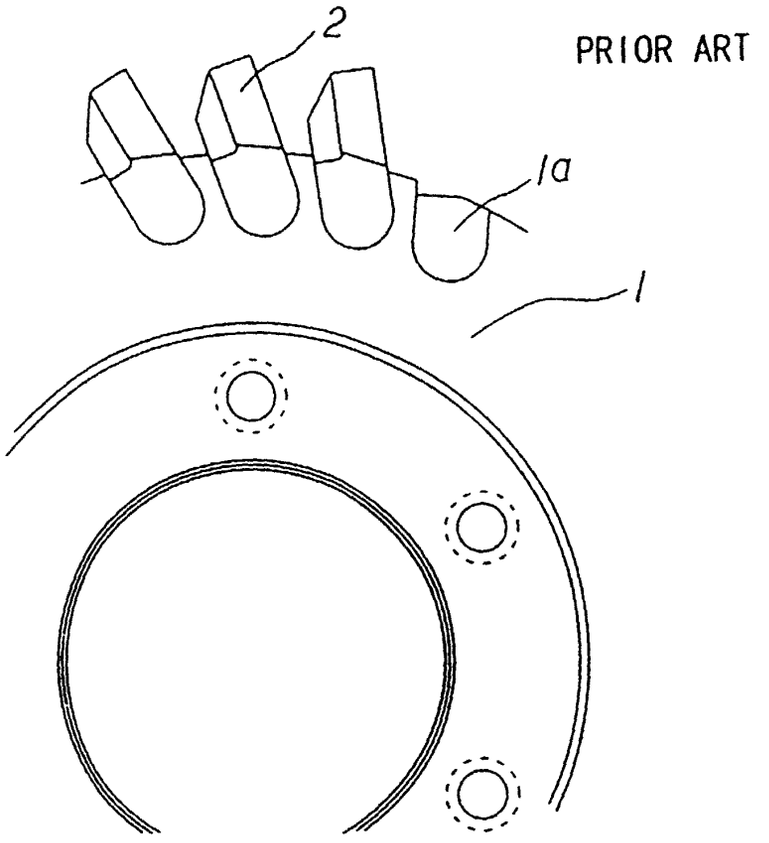


Fig. 12

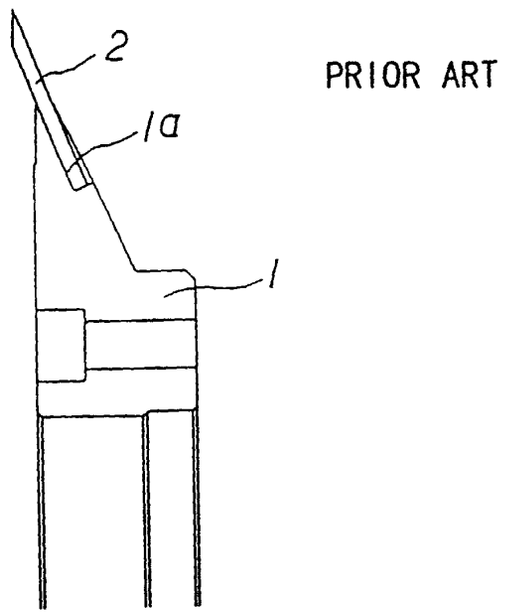


Fig. 13

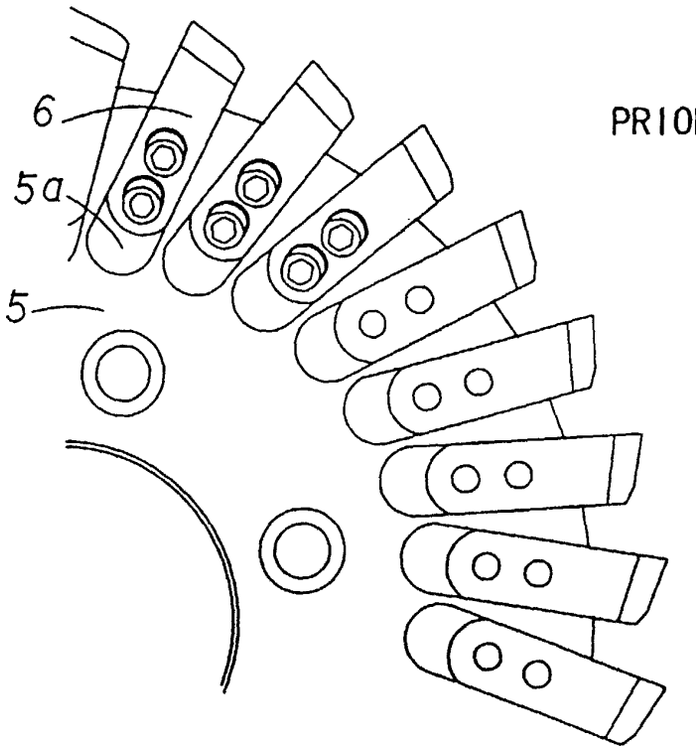


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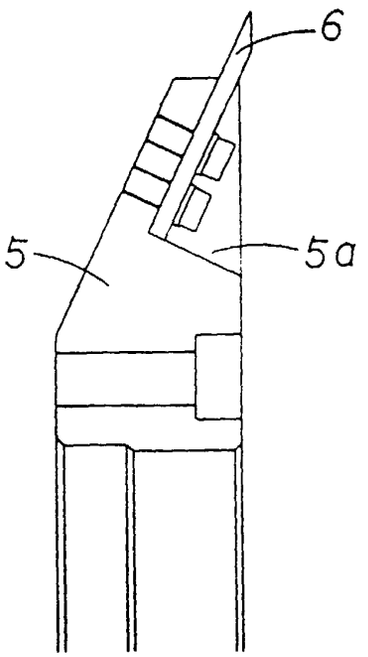
Fig. 14




PRIOR ART

Fig. 15