(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 April 2011 (28.04.2011)

PCT

(10) International Publication Number
WO 2011/048587 A1

(51) International Patent Classification:
B23C 5/08 (2006.01) *B23C 5/26* (2006.01)

(21) International Application Number:
PCT/IL2010/000815

(22) International Filing Date:
7 October 2010 (07.10.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201722 22 October 2009 (22.10.2009) IL

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: MILLING CUTTER

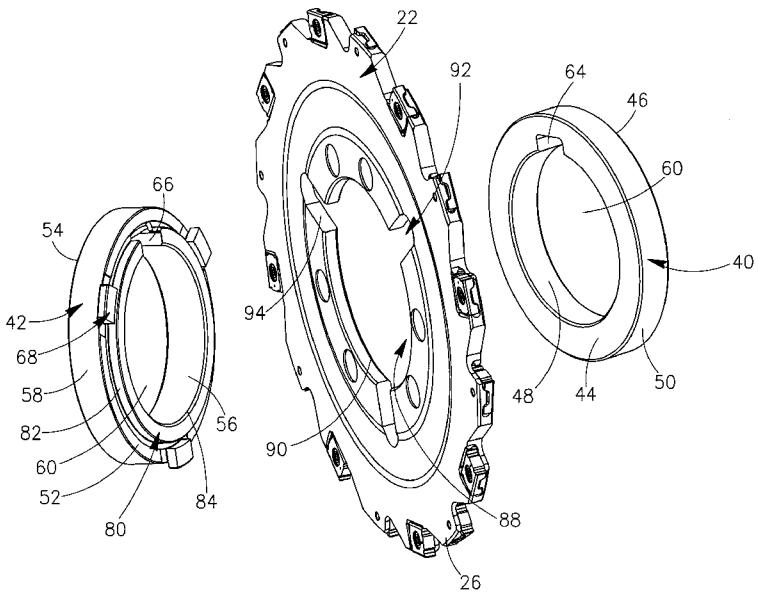

FIG. 3

(57) Abstract: A milling cutter (20, 12, 220) includes a disk like cutter body (22) having radially directed slots (92) and a central aperture (88). An exchangeable hub of the milling cutter has two adapter members (40, 42, 240, 242) located on either side of the cutter body (22) and having an inner side wall (44, 52; 152; 244, 252). One of the adapter members (42, 242) has at least two protrusions (68, 268) formed on the adapter inner side wall (52, 152, 252) and one of the two adapter members (42, 240) has a raised portion (80,180, 280) located on the adapter inner side wall (52, 152, 244). The adapter members (40, 240, 242) maybe secured to the cutter body by the protrusions positioned in the slots and the raised portion positioned in the central aperture.

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MILLING CUTTER

FIELD OF THE INVENTION

[001] The present invention relates to milling cutters and in particular to milling cutters with disk like cutter bodies.

BACKGROUND OF THE INVENTION

[002] Such milling cutters are typically used for slotting operations and have a hub with an axially centered hole for receipt of a support shaft of a machine spindle. Since the hole has a given diameter, the milling cutter can only be used with a shaft of a given diameter.

[003] Milling cutters with exchangeable hubs are also known, wherein hubs can be prepared with any required hole diameter. When it is required to use the milling cutter with a support shaft having a diameter different from that of the hole diameter, the hub which is attached to the cutter body can be removed and a new hub with the required diameter can be attached to the cutter body in its place. However they generally employ screws (or bolts) to attach the hub to the cutter body. The use of screws is time consuming and may be disadvantageous in that rotative motion is imparted by the hub to the cutter body via the screws, thereby exposing the screws to shear forces which could damage them.

[004] US 7,112,013 discloses a milling cutter with an exchangeable hub. The milling cutter has a disk like cutter body having radially directed slots and a central aperture. The exchangeable hub comprises two adapter members located on either side of the cutter body. One of the adapter members has a raised portion located in the central aperture. The adapter members are secured to

the cutter body by means of pins which are located in blind holes in the adapter members and which pass through engagement members positioned in the slots. The pins and the engagement members are detached from the adapter members, which can result in longer production time and less firm device.

[005] It is an object of the present invention to provide a milling cutter with an exchangeable hub that significantly reduces or overcomes the aforementioned disadvantages. Furthermore, it is an object of the present invention to provide a method of securing the hub to the cutter body which substantially overcomes these disadvantages. It is a further object of the present invention to provide exchangeable hubs that will enable an increased depth of cut when the hole diameter is reduced.

SUMMARY OF THE INVENTION

[006] In accordance with the present invention there is provided a milling cutter having an axis of rotation and comprising:

a generally disk-shaped cutter body, having two side surfaces and an outer peripheral surface therebetween, the axis of rotation being perpendicular to the side surfaces;

a plurality of circumferentially spaced apart cutting portions located around the outer peripheral surface of the cutter body;

a central aperture in the cutter body, having an aperture inner surface;

at least two radially directed slots in the cutter body, each slot having a slot inner surface opening out to the central aperture;

[007] In accordance with embodiments of the present invention, there are provided two adapter members located on either side of the cutter body, each adapter member having an inner side wall in abutment with respective side surfaces of the cutter body, the two adapter members each having central holes and drive keyway members, one of the adapter members having at least two protrusions formed on the adapter inner side wall;

[008] In accordance with embodiments of the present invention, there is provided an axially extending circularly shaped raised portion located on the inner side wall of one of the adapter members and concentric with the central hole thereof, the raised portion having an outer surface

in juxtaposition with the aperture inner surface; each protrusion having a peripheral surface in juxtaposition with the slot inner surface.

[009] In accordance with some embodiments, the slots are generally rectangular in shape.

[0010] In accordance with some embodiments, the protrusions are generally rectangular in shape.

[0011] There is also provided in accordance with embodiments of the present invention a method for constructing a milling cutter comprising the steps of:

(i) providing a generally disk-shaped cutter body, having first and second side surfaces and a central aperture and at least two radially directed slots, each slot having a slot inner surface opening out to the central aperture;

(ii) providing first and second adapter members, each adapter member comprising a central hole, an inner side wall and a drive keyway member, the second adapter member having at least two protrusions, each protrusion having a peripheral surface formed in the adapter inner side wall, and one of the first and second adapter members having an axially extending circularly shaped raised portion concentric with the central hole thereof, the raised portion having an outer surface and an inner surface;

(iii) placing the second adapter member adjacent the second side surface of the cutter body with the protrusions located in the slots; and

(iv) placing the first adapter member adjacent the first side surface of the cutter body, such that the inner side wall of the first adapter member abuts the first side surface, and the drive keyway member of the first adapter member is adjacent the drive keyway member of the second adapter member;

wherein the raised portion is located in the aperture of the cutter body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] For a better understanding of the present invention and to show how the same may be carried out in practice, reference will now be made to the accompanying drawings, in which:

Fig. 1 is a perspective view of a milling cutter according to a first embodiment of the present invention;

Fig. 2 is an edge view of the milling cutter shown in Fig. 1;

Fig. 3 is an exploded view of the milling cutter shown in Fig. 1;

Fig. 4 is a side view of a second adapter member according to the first embodiment of the present invention showing its inner side wall;

Fig. 5 is a side view of the second adapter member shown in Fig. 4 showing its outer side wall;

Fig. 6 is a side view of the milling cutter shown in Fig. 1;

Fig. 7 is a cross sectional view taken along the line VII-VII in Fig. 6;

Fig. 8 is a side view of the milling cutter shown in Fig. 1 with a first adapter member removed;

Fig. 9 is a cross sectional view taken along the line IX-IX in Fig. 8;

Fig. 10 is a side view of the milling cutter in accordance with the present invention with a hub having a different diameter to that shown in Figs. 1 to 9, with the first adapter member removed;

Fig. 11 is a cross sectional view taken along the line XI-XI in Fig. 10;

Fig. 12 is an exploded view of a milling cutter according to a second embodiment of the present invention;

Fig. 13 is a side view of a second adapter member according to the second embodiment of the present invention showing its inner side wall;

Fig. 14 is side view of a first adapter member according to the second embodiment of the present invention showing its inner side wall;

Fig. 15 is a side view of the milling cutter shown in Fig. 12;

Fig. 16 is a cross sectional view taken along the line XVI-XVI in Fig. 15;

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0013] Attention is drawn to Figs. 1 and 2, showing a milling cutter **20** in accordance with a first embodiment of the present invention. The milling cutter **20** has a generally disk-shaped cutter body **22**, having first and second opposing, generally parallel, side surfaces **24**, **26** and an outer peripheral surface **28** extending between the two side surfaces **24**, **26**. The milling cutter **20** has an axis of rotation **R** which is perpendicular to the two side surfaces **24**, **26**. The milling cutter **20** has a hub **30** with an axially centered hub hole **32** for receipt of a support shaft of a machine spindle (not shown). Rotative motion is imparted to the hub **30** of the cutter via a drive

key (also not shown) which mates with a drive keyway **34**. A plurality of circumferentially spaced apart cutting portions **36** are located around the outer peripheral surface **28** of the cutter body **22**, each cutting portion **36** being provided with a cutting insert **38**.

[0014] Attention is now additionally drawn to Fig. 3. The hub **30** includes first and second adapter members **40**, **42** located on either side of the cutter body **22**. The first adapter member **40** has a first inner side wall **44**, an opposing first outer side wall **46** and first inner and outer peripheral edge surfaces **48**, **50** extending therebetween. Similarly, the second adapter member **42** has a second inner side wall **52**, an opposing second outer side wall **54** and second inner and outer peripheral edge surfaces **56**, **58** extending therebetween. The first and second adapter members **40**, **42** have axially centered identical central holes **60**. The central holes **60** form together the hub hole **32**. Similarly, the first and second adapter members **40**, **42** have first and second drive keyway members **64**, **66**, respectively, which together form the drive keyway **34** of the hub **30**.

[0015] Attention is now drawn to Figs. 4 and 5. The second adapter member **42** has three protrusions **68** formed on the second inner side wall **52** and protrudes therefrom. Each protrusion **68** includes a radially outer end **70**, an opposing radially inner end **72**, and a peripheral surface **74** extending therebetween. The protrusion **68** further contains inner and outer side surfaces **76**, **78**. The outer side surface **78** is partly in abutment with the second inner side wall **52** and partly protrudes from the second outer peripheral edge surface **58**.

[0016] Each protrusion **68** is adjacent to an axially extending circularly shaped raised portion **80** concentric with the central hole **60** of the second adapter member **42**. The raised portion **80** has an outer surface **82** and an inner surface **84** and an axially facing annularly shaped bridging surface **86** extending between the outer surface **82** and the inner surface **84**. The inner surface **84** forms part of the inner peripheral edge surfaces **56**.

[0017] As can be seen in Fig. 3, the cutter body **22** has a central aperture **88** bounded by an axially extending aperture inner surface **90**. The cutter body **22** is provided with three radially directed generally rectangular slots **92**, each having a slot inner surface **94** that open out to the central aperture **88** and to the first and second side surfaces **24**, **26**. At least a portion of the slot inner surface **94** faces in a circumferential direction.

[0018] In accordance with the first embodiment of the present invention, the milling cutter **20** is assembled by placing the second adapter member **42** adjacent the second side surface **26** with

the raised portion **80** located adjacent the aperture **88**. The second adapter member **42** is urged towards the cutter body **22** until the second inner side wall **52** abuts the second side surface **26**. In this position the raised portion **80** is fully inside the aperture **88** with the outer surface **82** of the raised portion **80** in juxtaposition with the aperture inner surface **90**, and each protrusion **68** is fully inside the slot **92** with the peripheral surfaces **74** of the protrusions **68** in juxtaposition with the slot inner surface **94**.

[0019] The milling cutter **20** is now partially assembled as shown in Figs. 8 and 9. All that remains is to attach the first adapter member **40** to the partially assembled milling cutter **20**. This is done by placing the first adapter member **40** adjacent the first side surface **24** with the first drive keyway member **64** aligned with the second drive keyway member **66**. The first inner side wall **44** abuts the first side surface **24**, thereby bringing the milling cutter **20** into an assembled state, that is forming the milling cutter **20**, as shown in Figs. 1, 2, 6 and 7. The assembly of the milling cutter **20**, in accordance with the order of operations and the support shaft of a machine spindle, as described above is by no means binding. The assembly of the milling cutter **20** can be carried in and out in any desired feasible order.

[0020] As mentioned above, the hub hole **32** receives a support shaft of a machine spindle for rotating the milling cutter **20**. Wherein, rotative motion is imparted to the hub **30** via a drive key of the support shaft which mates with drive keyway **34**. In turn, the hub **30** imparts rotative motion to the cutter body **22** via the coupling between the protrusions **68** and the slots **92**.

[0021] With respect to Figs. 8 and 9, the following five parameters are defined: the hole diameter **D1** of the hub **30** (which is equal to the diameters of the central holes **60**), the hub diameter **d1**, the radial thickness **R1** of the raised portion **80**, the radial depth **T1** of the second inner side wall **52**, and the depth of cut **A1** of the milling cutter. These parameters are required when comparing two similar milling cutters as will be done below.

[0022] The milling cutter **20** shown in Figs. 1 to 9, in accordance with the first embodiment of the present invention, can only be used in conjunction with a support shaft having a diameter generally equal to, but slightly less than, the diameter **D1** of the hub hole **32**. If the milling cutter is to be used with a different machine spindle having a support shaft with a different diameter, then a hub having a hole with an appropriate diameter (generally equal to, but slightly greater than, the diameter of the support shaft) has to be used.

[0023] Attention is now drawn to Figs. 10 and 11, showing a milling cutter **120** in accordance with a variation of the first embodiment of the present invention, suitable for use with a support shaft having a smaller diameter than the milling cutter **20** shown in Figs. 1 to 9. The hole diameter **D2** of a hub **130** of the milling cutter **120** is smaller than the hole diameter **D1** of the hub **30** of the milling cutter **20**. The radial thickness **R2** of a raised portion **180** of the hub **130** of the milling cutter **120** is larger than the radial thickness **R1** of the raised portion **80** of the hub **30** of the milling cutter **20**. Respectively, the radial depth **T2** of a second inner side wall **152** of the milling cutter **120** can be made smaller than the radial depth **T1** of the second inner side wall **52** of the milling cutter **20**. The hub diameter **d2** of the milling cutter **120** is smaller than the hub diameter **d1** of the milling cutter **20**, a direct result of reducing the radial depth **T2** of the second inner side wall **152** of the milling cutter **120**. As a result, the milling cutter **120** has a greater depth of cut **A2** than the depth of cut **A1** of the milling cutter **20**.

[0024] Attention is now drawn to Figs. 12 to 16 showing a milling cutter **220** in accordance with a second embodiment of the present invention. Since the milling cutter **220** has many features which are similar to those of the milling cutter **20**, the similar features of the milling cutter **20** will be referred to herein below by reference numerals which are shifted by 200 from those of the milling cutter **20**. In the second embodiment, a first adapter member **240** of the milling cutter **220** includes a raised portion **280**, and a second adapter member **242** of the milling cutter **220** includes protrusions **268**. In other words, in the second embodiment, the protrusions and the raised portion are on different adapter members.

[0025] A first adapter member **240** has a first inner side wall **244**, an opposing first outer side wall **246** and first inner and outer peripheral edge surfaces **248**, **250** extending therebetween. Similarly, the second adapter member **242** has a second inner side wall **252**, an opposing second outer side wall **254** and second inner and outer peripheral edge surfaces **256**, **258** extending therebetween. The first and second adapter members **240**, **242** have axially centered central holes **260**. The central holes **260** form together a hub hole **232** of a hub **230** of the milling cutter **220**. Similarly, the first and second adapter members **240**, **242** have first and second drive keyway members **264**, **266**, respectively, which together form a drive keyway **234** of the hub **230**.

[0026] The second adapter member **242** has three protrusions **268** formed on the second inner side wall **252** and protrudes therefrom. Each protrusion **268** includes a radially outer end **270**, an

opposing radially inner end **272,** and a peripheral surface **274** extending therebetween. The protrusion **268** further includes inner and outer side surfaces **276, 278**. The outer side surface **278** is partly in abutment with the second inner side wall **252** and partly protrudes from the second outer peripheral edge surface **258**.

[0027] The first adapter member **240** has an axially extending circularly shaped raised portion **280** concentric with the central hole **260**. The raised portion **280** has an outer surface **282** and an inner surface **284** and an axially facing annularly shaped bridging surface **286** extending between the outer surface **282** and the inner surface **284**. The inner surface **284** forms part of the inner peripheral edge surfaces **256.**

[0028] In accordance with the second embodiment of the present invention, the milling cutter **220** is assembled by placing the second adapter member **242** adjacent the second side surface **26** of the cutter body **22** with the protrusions **268** adjacent the slots **92.** The second adapter member **242** is urged towards the cutter body **22** until the second inner side wall **252** abuts the second side surface **26**. In this position each protrusion **268** is fully inside the slot **92** with the peripheral surfaces **274** in juxtaposition with the slot inner surface **94**.

[0029] All that remains is to urge the first adapter member **240** towards the partially assembled milling cutter **220**. This is done by placing the first adapter member **240** adjacent the first side surface **24** with the raised portion **280** located adjacent the aperture **88**. In this position the raised portion **280** is fully inside the aperture **88** with the outer surface **282** in juxtaposition with the aperture inner surface **90**, the first inner side wall **244** abuts the first side surface **24,** and the first drive keyway member **264** is aligned with the second drive keyway member **266,** thereby bringing the milling cutter **220** into an assembled state, that is forming the milling cutter **220**, as shown in Figs. 15 and 16.

[0030] The hub hole **232** receives a support shaft of a machine spindle for rotating the milling cutter **220**. Wherein, rotative motion is imparted to the hub **230** via a drive key of the support shaft which mates with drive keyway **234**. In turn, the hub **230** imparts rotative motion to the cutter body **22** via the coupling between the protrusions **268** and the slots **92**. The first and second adapter members **240, 242** of the milling cutter **220**, in accordance with the second embodiment of the present invention, are firmly secured to the milling cutter **220,** even without the support shaft of a machine spindle. Furthermore, the first and second adapter members **240,**

242 are easy to manufacture. In the same manner as in the first embodiment of the present invention, the assembly of the milling cutter **220** in accordance with the second embodiment can be carried in and out in any desired feasible order.

[0031] In some embodiments, each adapter member **42, 242** having the protrusions **68, 268** is integrally formed to have one-piece construction. In other embodiments, the protrusions **68, 268** may be affixed to their respective adapter members by a fastener, such as screw. Also, in some embodiments, at their radially outer ends **70, 270**, the protrusions **68, 268** form the radially outermost portion of the second adapter member **42, 242**.

[0032] It will be clear that a variation of the second embodiment of the present invention, suitable for use with a support shaft having a smaller diameter than that of the milling cutter **220** may be constructed in a manner similar to the variation of the first embodiment, thereby providing a milling cutter having a greater depth of cut than the depth of cut of the milling cutter **220**.

[0033] It will be appreciated that the present invention not only provides a particularly efficient and firm way of changing adapters in accordance with the diameter of the spindle support shaft, with the use of an integral device, but at the same time facilitates increasing the depth of cut of the milling cutter.

[0034] Although the present invention has been described to a certain degree of particularity, it should be understood that various alterations and modifications could be made without departing from the scope of the invention as hereinafter claimed.

CLAIMS

1. A milling cutter (20, 120, 220) having an axis of rotation (R) and comprising:

a generally disk-shaped cutter body (22), having two side surfaces (24, 26) and an outer peripheral surface (28) therebetween, the axis of rotation (R) being perpendicular to the side surfaces (24, 26);

a plurality of circumferentially spaced apart cutting portions (36) located around the outer peripheral surface (28) of the cutter body (22);

a central aperture (88) in the cutter body (22), having an aperture inner surface (90);

at least two radially directed slots (92) in the cutter body (22), each slot (92) having a slot inner surface (94) opening out to the central aperture (88);

two adapter members (40, 42, 240, 242) located on either side (24, 26) of the cutter body (22), each adapter member (40, 42, 240, 242) having an inner side wall (44, 52, 152, 244, 252) in abutment with respective side surfaces (24, 26) of the cutter body (22), the two adapter members (40, 42, 240, 242) each having a central hole (60, 260) and a drive keyway member (64, 66, 264, 266);

one adapter member (42, 242) having at least two protrusions (68, 268) formed on the inner side wall (52, 152, 252) thereof;

one adapter member (42, 240) having an axially extending circularly shaped raised portion (80, 180, 280) located on the inner side wall (52, 152, 244) thereof and being concentric with the central hole (60, 260) thereof, the raised portion (80, 180, 280) having an outer surface (82, 282) in juxtaposition with the aperture inner surface (90); and

each protrusion (68, 268) having a peripheral surface (74, 274) in juxtaposition with the slot inner surface (94).

2. The milling cutter according to claim 1, wherein the slots (92) are generally rectangular in shape.

3. The milling cutter according to claim 1, wherein the protrusions (68, 268) are generally rectangular in shape.

4. The milling cutter according to claim 1, wherein the raised portion is formed on a first adapter member (240) and the protrusions (68, 268) are formed on a second adapter member (42, 242).

5. The milling cutter according to claim 1, wherein the adapter member (42, 242) having the protrusions (68, 268) is integrally formed to have one-piece construction.

6. The milling cutter according to claim 1, wherein the protrusions (68, 268) form the radially outermost portion of the adapter member (42, 242) to which they belong.

7. The milling cutter according to claim 1, wherein:

the disk-shaped cutter body (22) has three slots (92), each slot having a slot inner surface (94);

the adapter member (42, 242) having protrusions is provided with three protrusions (68, 268), each protrusion having a peripheral surface (74, 274) in juxtaposition with a corresponding slot inner surface (94).

8. A method for constructing a milling cutter (20, 120, 220) comprising the steps of:

(i) providing a generally disk-shaped cutter body (22), having first and second side surfaces (24, 26) and a central aperture (88) and at least two radially directed slots (92), each slot having a slot inner surface (94) opening out to the central aperture (88);

(ii) providing first and second adapter members (40, 42, 240, 242), each adapter member comprising a central hole (60, 260), an inner side wall (44, 52, 152, 244, 252) and a drive keyway member (64, 66, 264, 266), the second adapter member (42, 242) having at least two protrusions (68, 268), each protrusion having a peripheral surface (74, 274) formed on the adapter inner side wall (52, 152, 252), and one of the first and second adapter members (42, 240) having an axially extending circularly shaped raised portion (80, 180, 280) concentric with the central hole (60, 260) thereof, the raised portion (80, 180, 280) having an outer surface (82, 282) and an inner surface (84, 284);

(iii) placing the second adapter member (42, 242) adjacent the second side surface (26) of the cutter body (22) with the protrusions (68, 268) located in the slots (92); and

(iv) placing the first adapter member (40, 240) adjacent the first side surface (24) of the cutter body (22), such that the inner side wall (44, 244) of the first adapter member abuts the first side surface (24), and the drive keyway member (64, 264) of the first adapter member is adjacent the drive keyway member (66, 266) of the second adapter member (42, 242);

wherein the raised portion (80, 180, 280) is located in the aperture (88) of the cutter body (22).

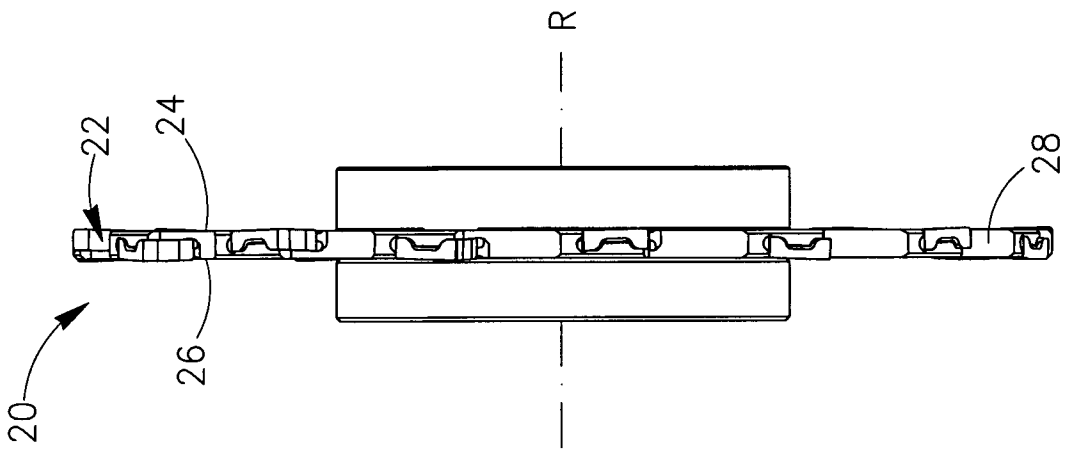

FIG.2

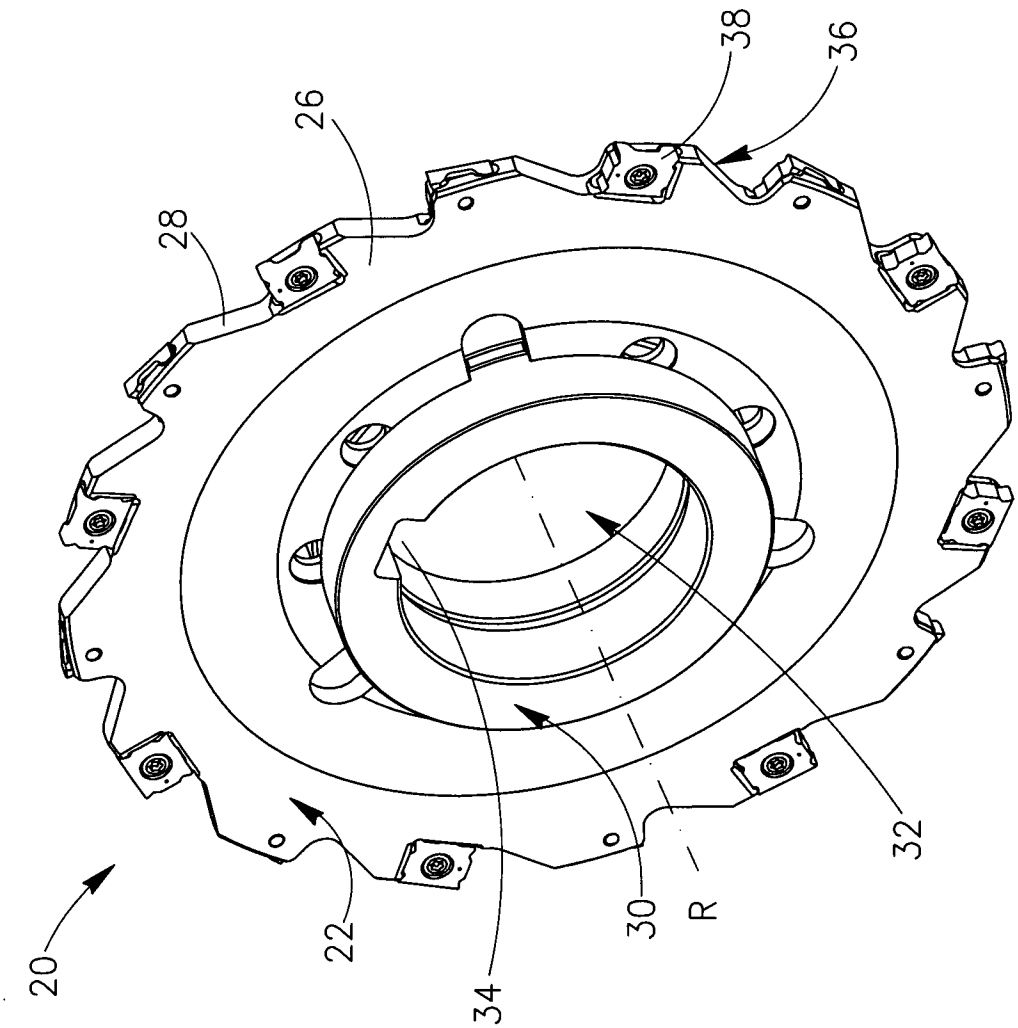

FIG.1

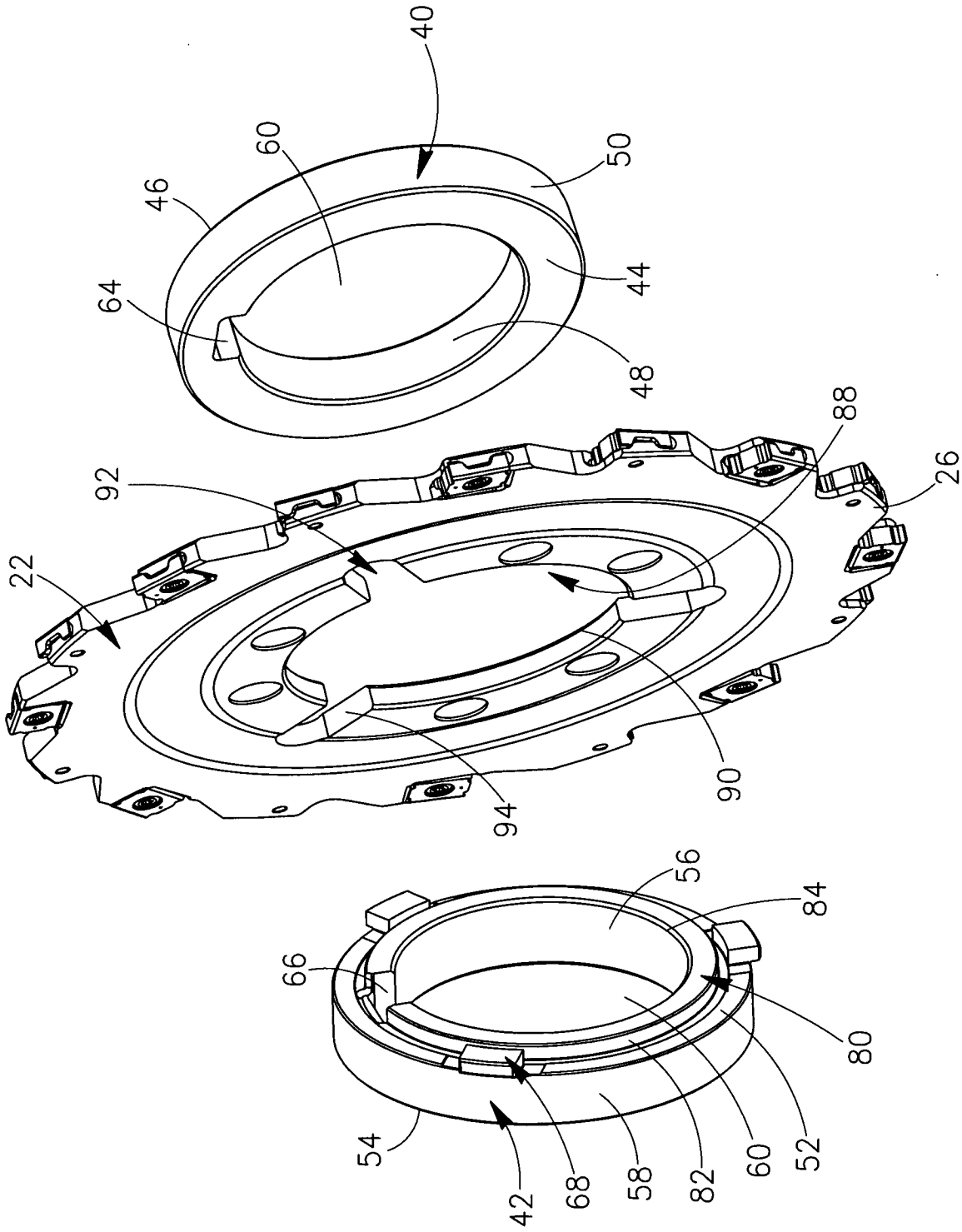

FIG.3

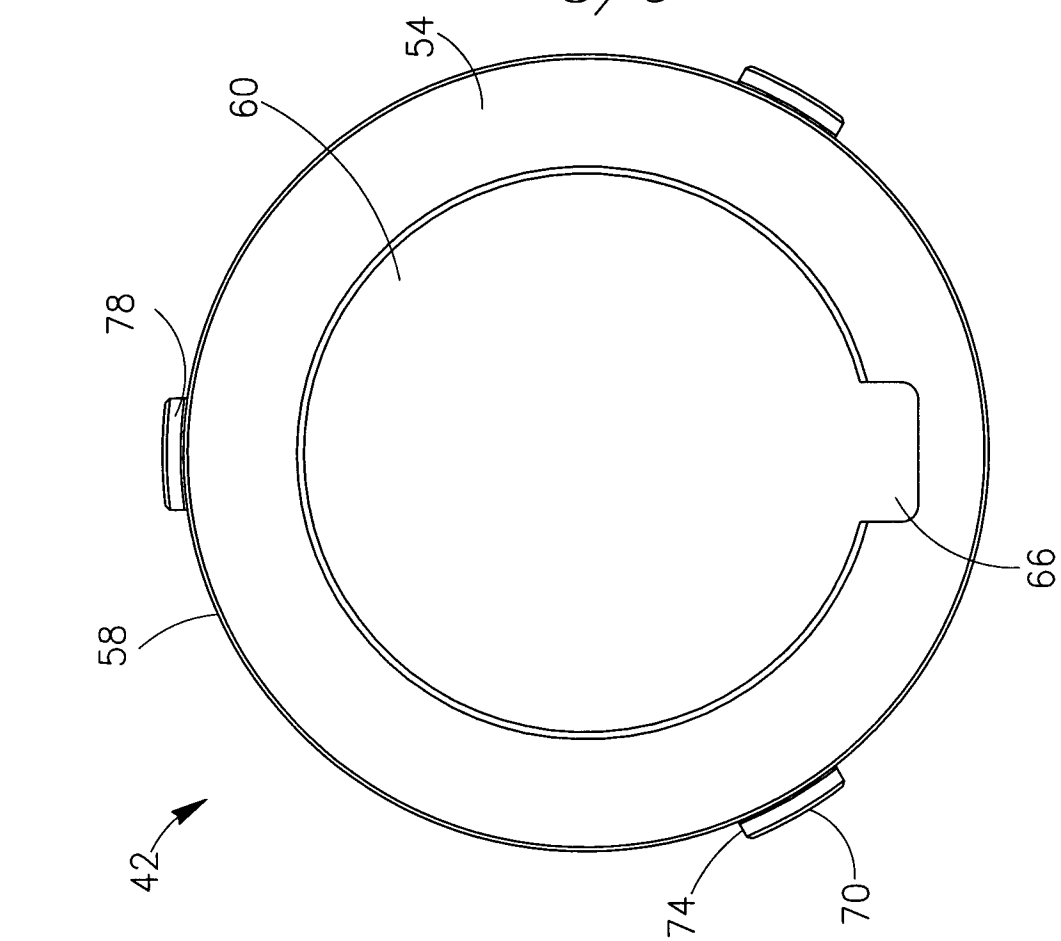

FIG.5

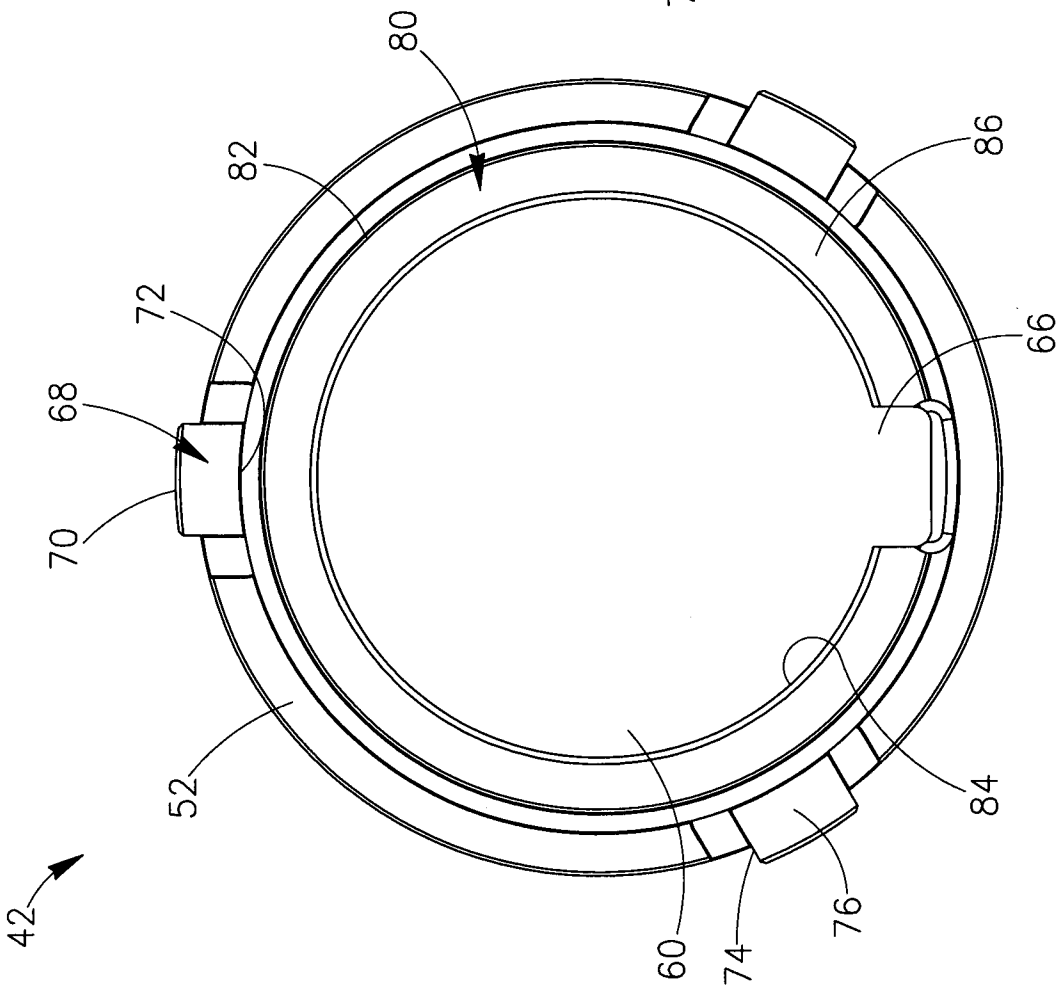

FIG.4

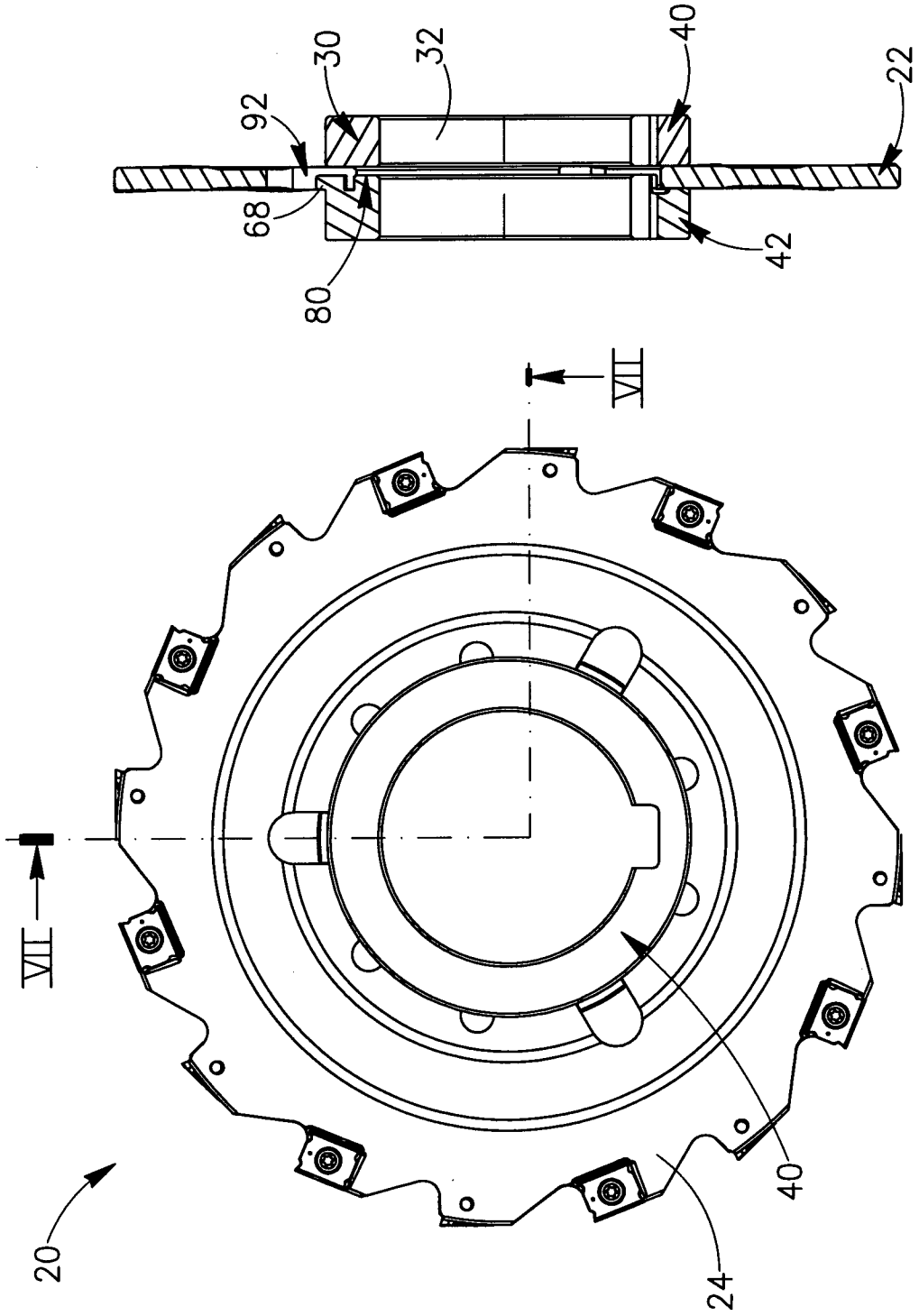

FIG.6

FIG.7

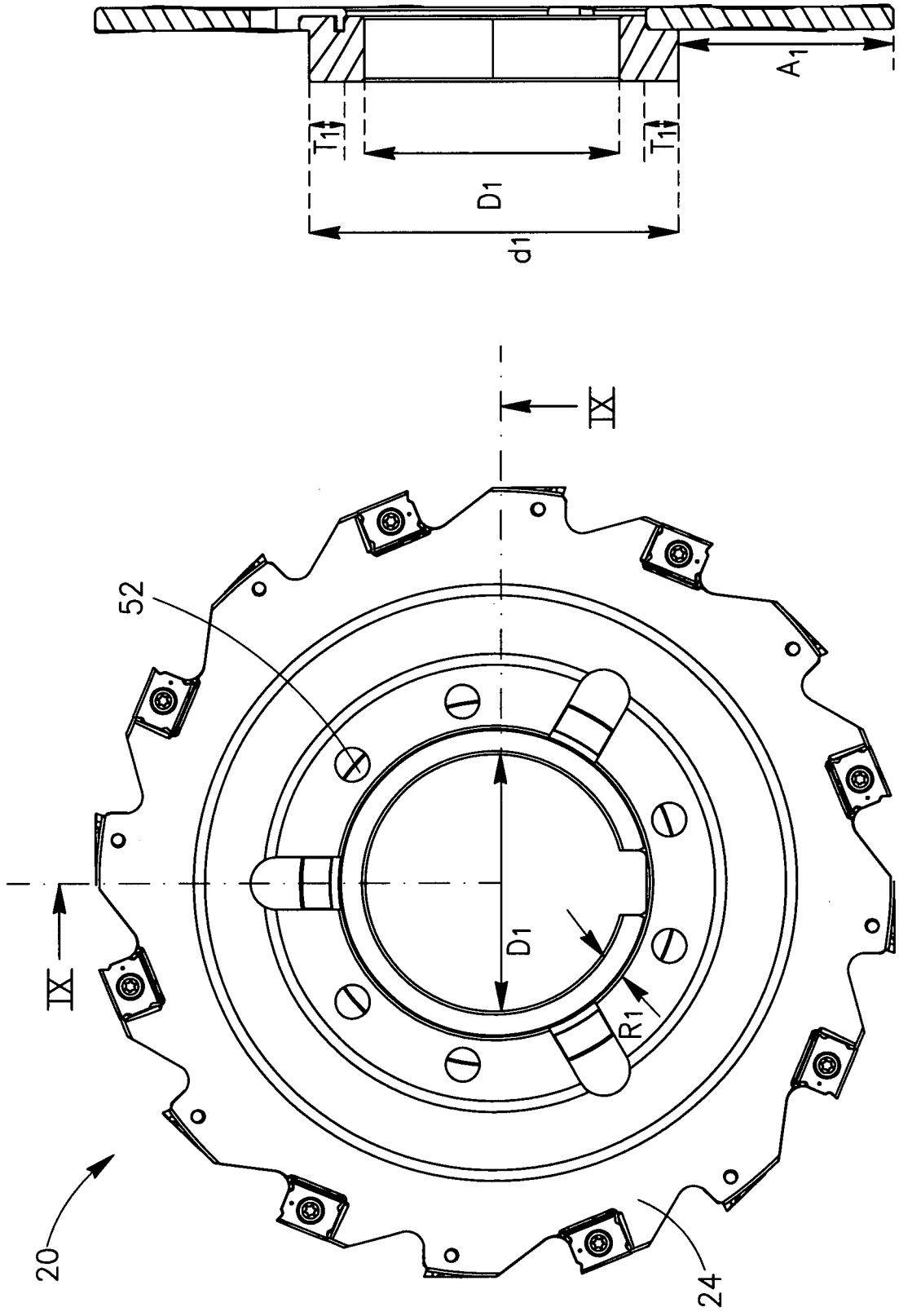

FIG.8

FIG.9

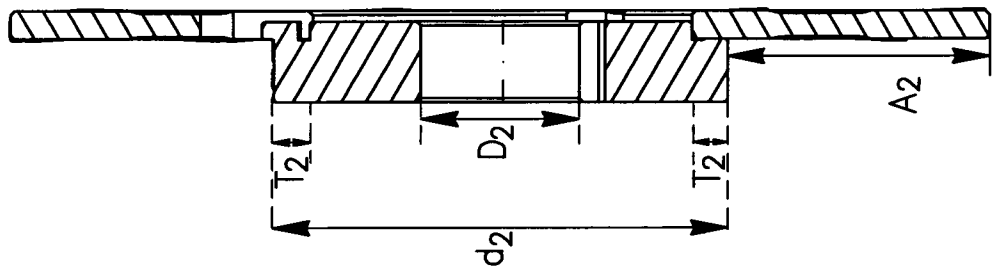

FIG.11

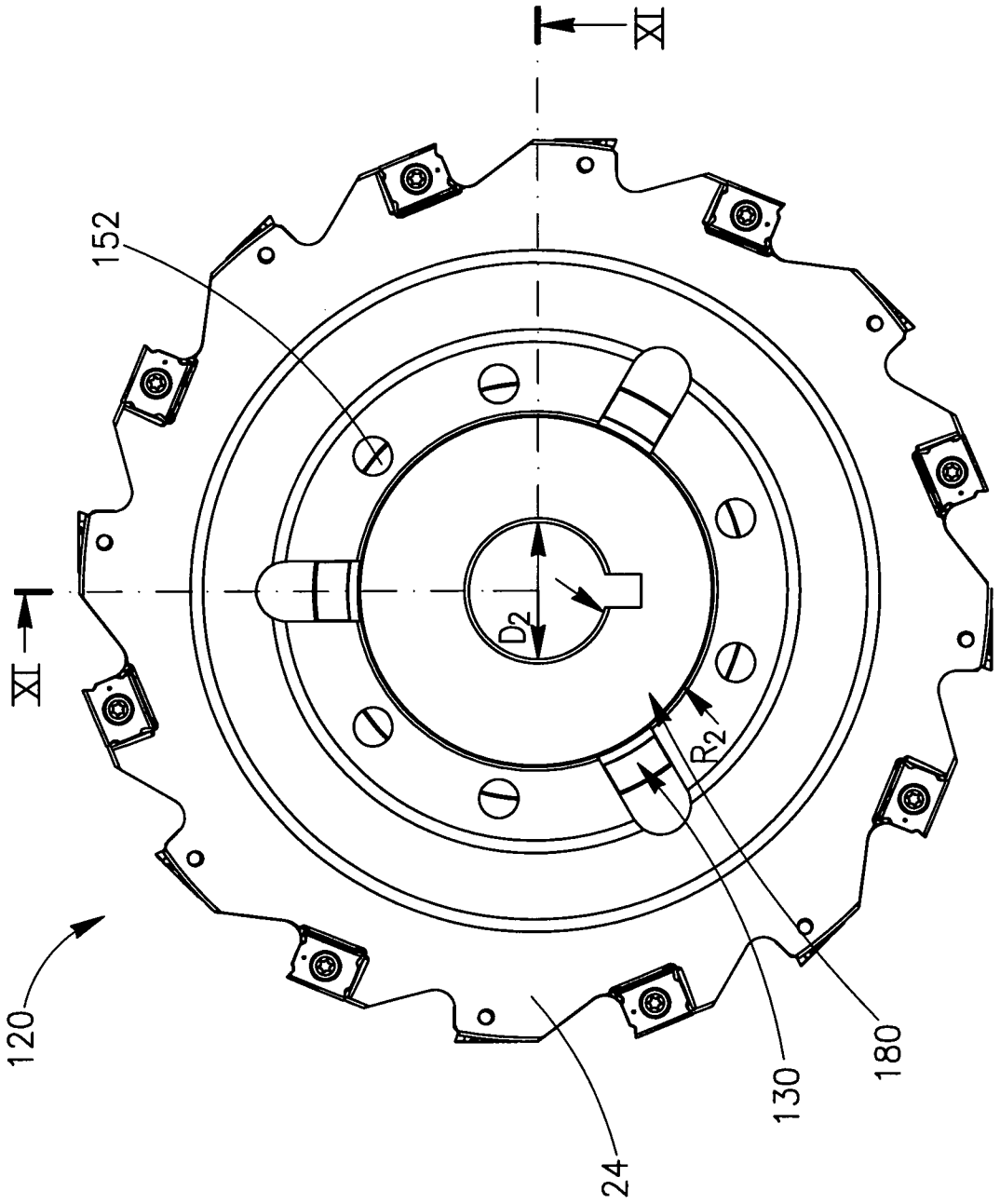

FIG.10

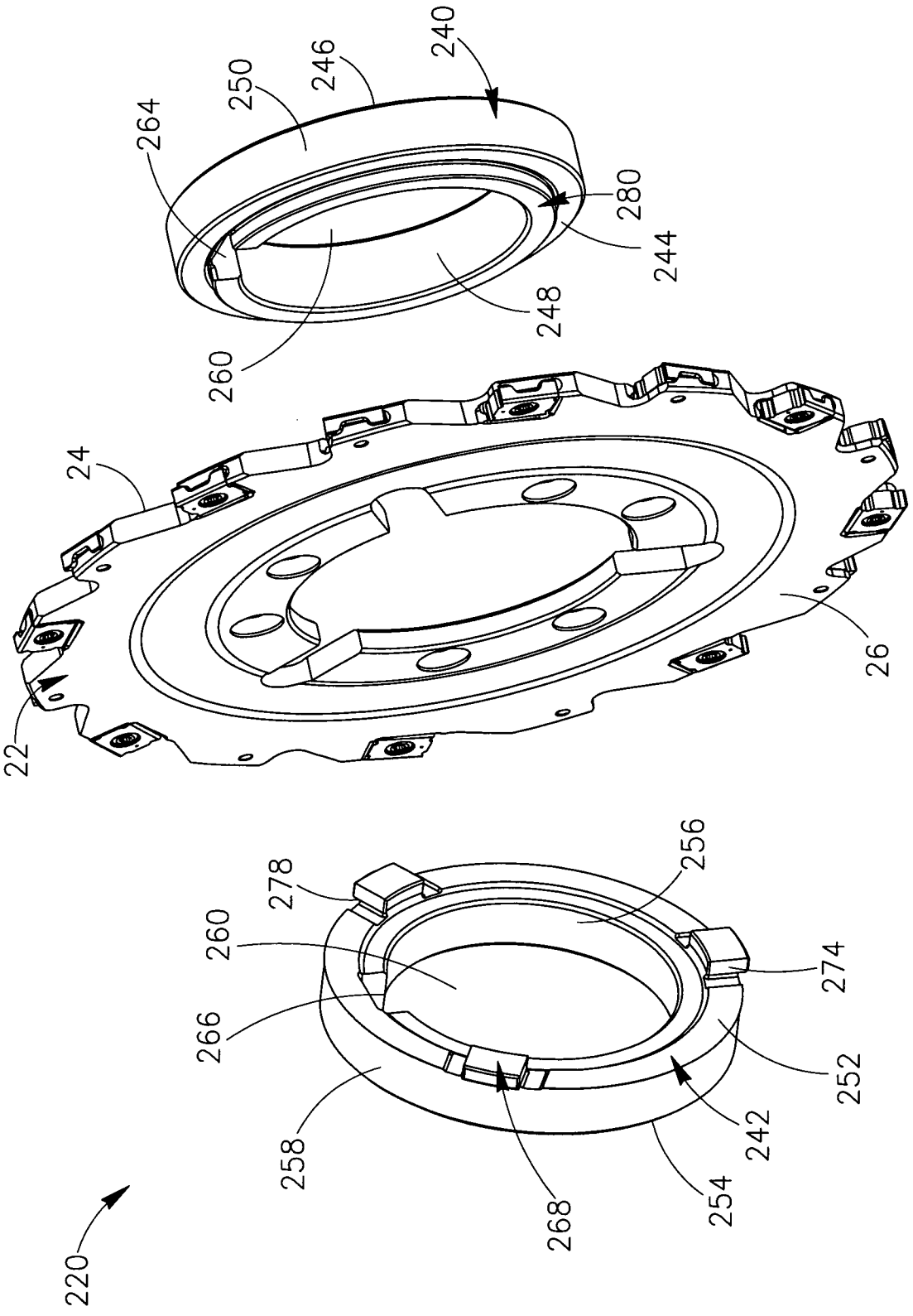
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FIG.12

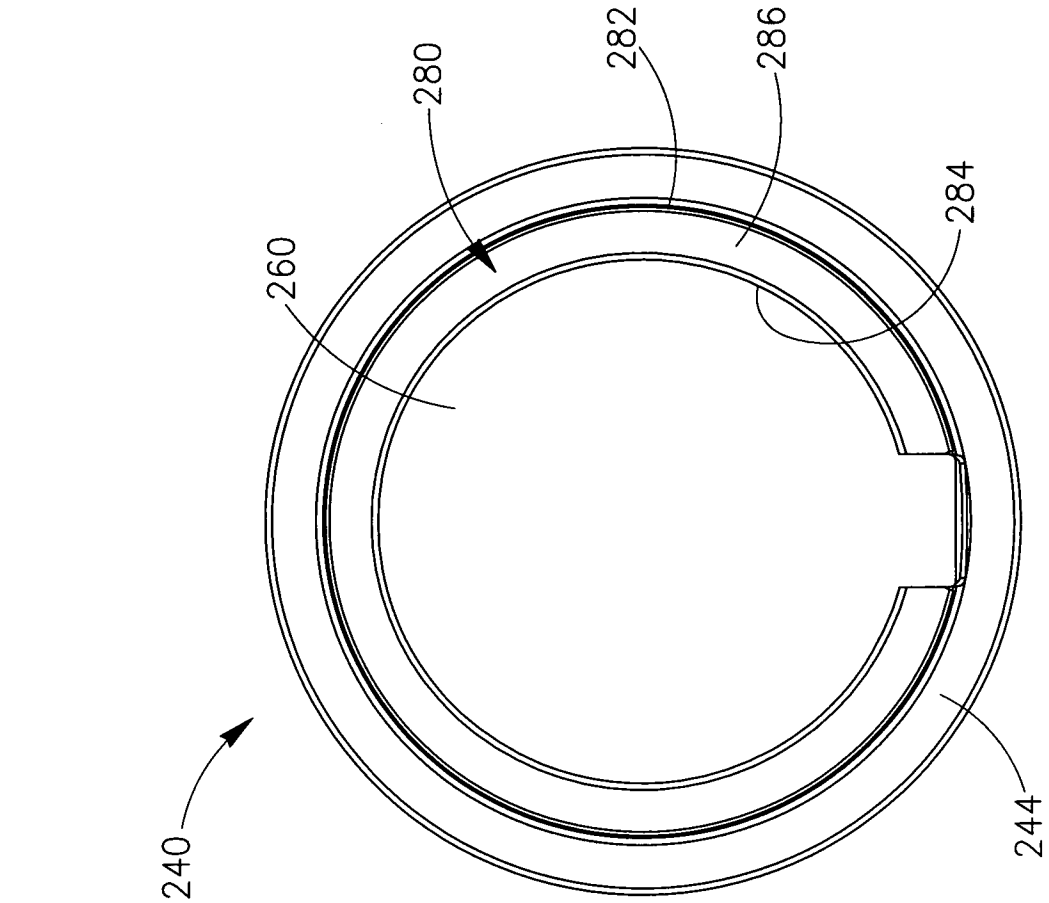

FIG.14

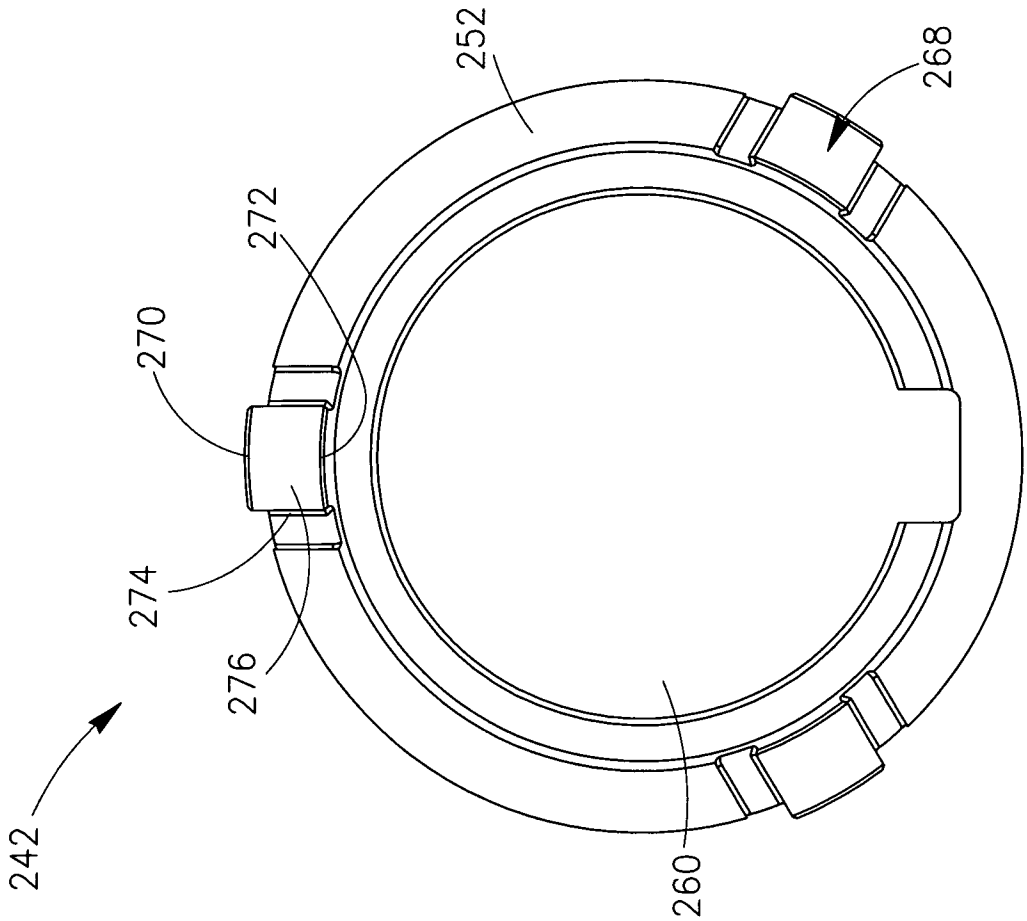

FIG.13

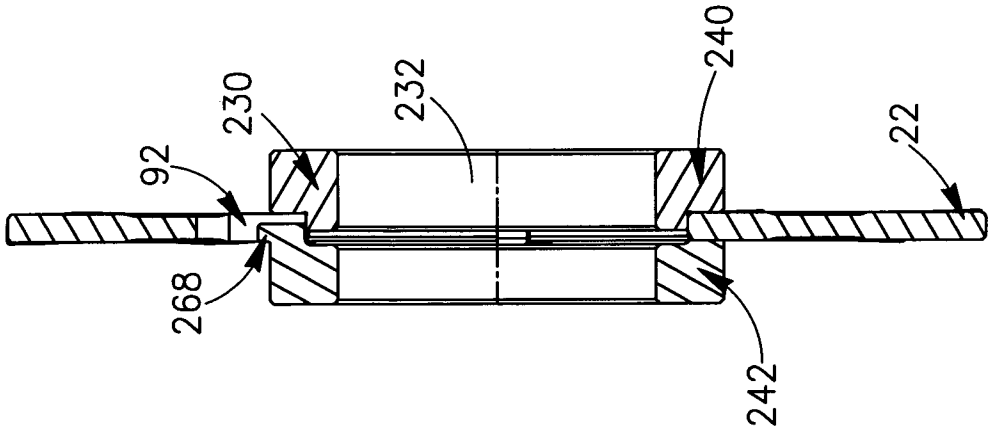

FIG.16

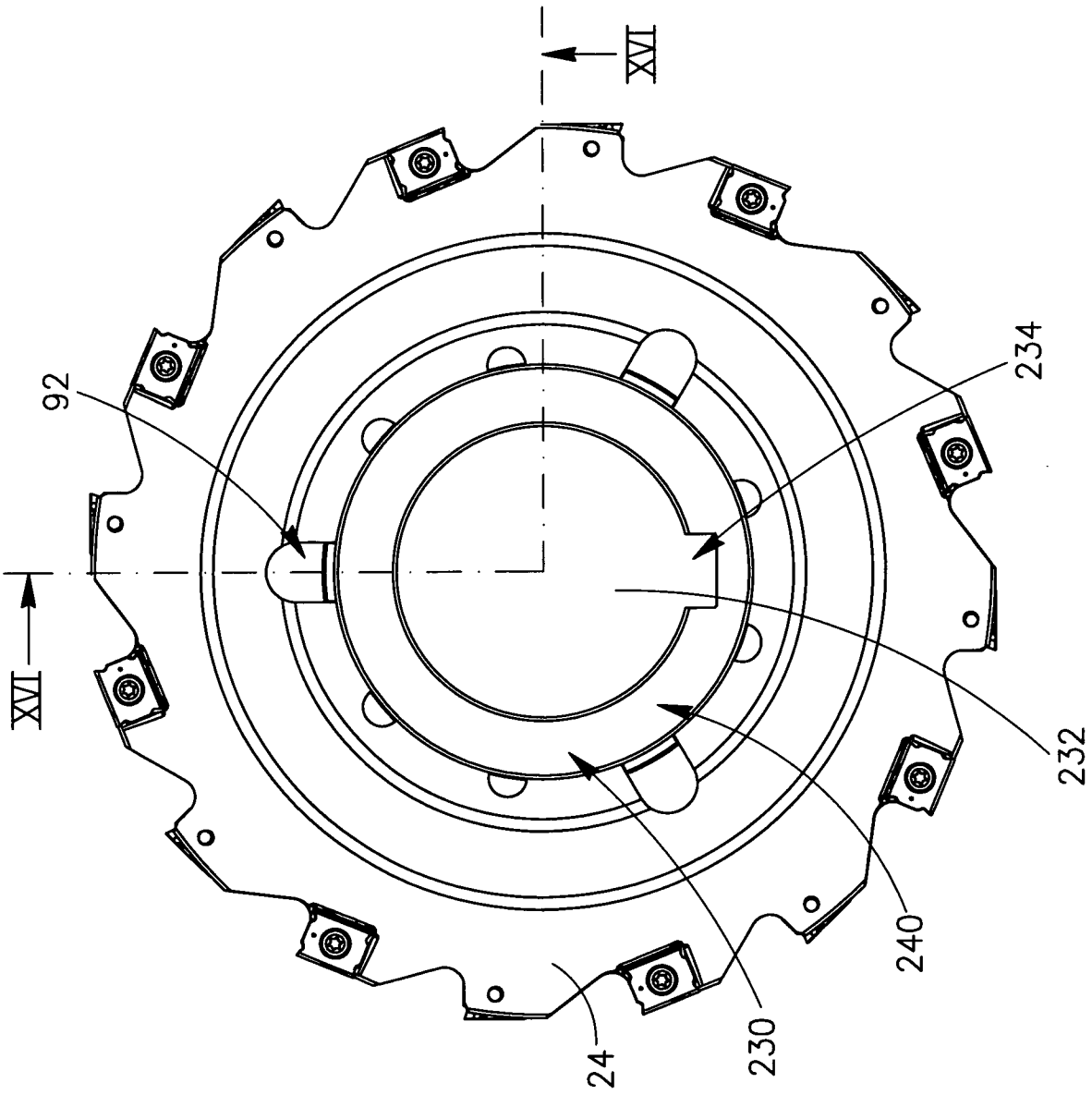

FIG.15

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2010/000815

A. CLASSIFICATION OF SUBJECT MATTER
INV. B23C5/08 B23C5/26
ADD.

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)
B23C B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 112 013 B2 (SATRAN AMIR [IL] ET AL) 26 September 2006 (2006-09-26) cited in the application	1-3,5-8
A	column 3, line 53 - column 4, line 43; figures 1-3	4

A	DE 36 00 809 A1 (HICK EMIL) 30 July 1987 (1987-07-30) column 1, lines 43-51; figure 1	1-8

A	US 1 337 313 A (GROENE WILLIAM F) 20 April 1920 (1920-04-20) figure 2	1-8

A	FR 1 163 729 A (M. LIS ZDZISLAW) 30 September 1958 (1958-09-30) figures 1,2	1-8

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 January 2011	02/02/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rilliard, Arnaud

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2010/000815

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 556 376 A (BSA TOOLS LTD; WILLIAM OGILVIE) 1 October 1943 (1943-10-01) figures 1-5	1-8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IL2010/000815

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