Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2485654 C 2007/07/31

(11)(21) **2 485 654**

(12) **BREVET CANADIEN
CANADIAN PATENT**

(13) **C**

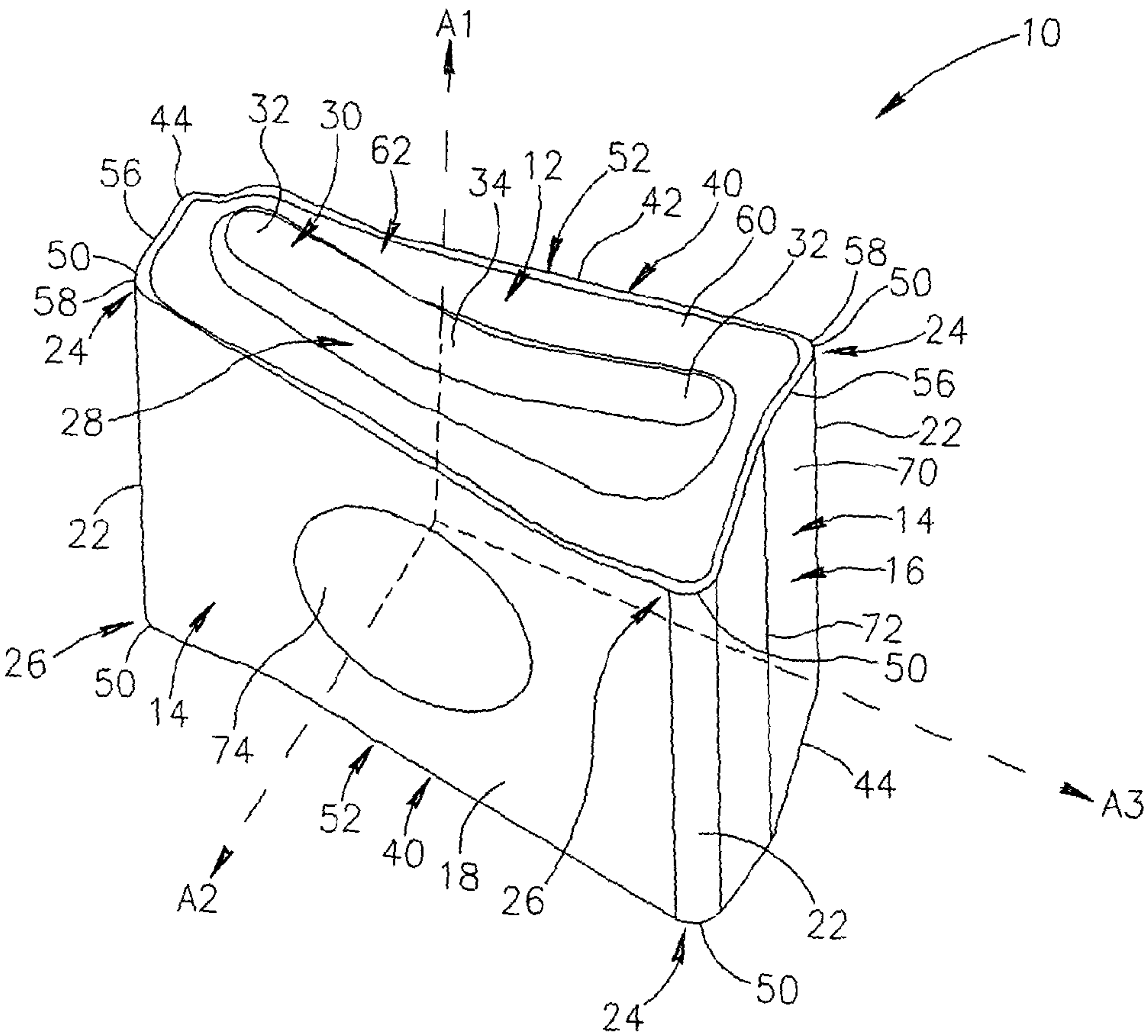
(86) Date de dépôt PCT/PCT Filing Date: 2003/05/27
(87) Date publication PCT/PCT Publication Date: 2003/12/11
(45) Date de délivrance/Issue Date: 2007/07/31
(85) Entrée phase nationale/National Entry: 2004/11/10
(86) N° demande PCT/PCT Application No.: IL 2003/000440
(87) N° publication PCT/PCT Publication No.: 2003/101655
(30) Priorités/Priorities: 2002/06/04 (IL150012); 2002/12/04 (IL153252)

(51) Cl.Int./Int.Cl. *B23C 5/22* (2006.01)
(72) Inventeurs/Inventors:
SATRAN, AMIR, IL;
DAGAN, DANNY, IL

(73) Propriétaire/Owner:
ISCAR LTD., IL

(74) Agent: DIMOCK STRATTON LLP

(54) Titre : PLAQUETTE DE COUPE TANGENTIELLE ET FRAISE
(54) Title: TANGENTIAL CUTTING INSERT AND MILLING CUTTER



(57) Abrégé/Abstract:
A tangential cutting insert (10) having two identical opposing end surfaces (12) with two identical opposing major side surfaces (18) and two identical opposing minor side surfaces (16) extending between them. Each end surface has a peripheral edge (40)

(57) Abrégé(suite)/Abstract(continued):
containing cutting edges and four corners (24, 26) of which two are lowered and two are raised. Each end surface is provided with at least one projecting abutment member (28) having a projecting abutment surface (30), wherein in a side view of either major side surface, the at least one projecting abutment surface is concave.

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 December 2003 (11.12.2003)

PCT

(10) International Publication Number
WO 03/101655 A1

(51) International Patent Classification⁷: **B23C 5/22**

(21) International Application Number: PCT/IL03/00440

(22) International Filing Date: 27 May 2003 (27.05.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
150012 4 June 2002 (04.06.2002) IL
153252 4 December 2002 (04.12.2002) IL

(71) Applicant *(for all designated States except US)*: **ISCAR LTD.** [IL/IL]; P.O. Box 11, 24959 Tefen (IL).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **SATRAN, Amir** [IL/IL]; 6 Moran Street, 25147 Kfar Vradim (IL). **DAGAN, Danny** [IL/IL]; 100/8 Hertzel Street, 22445 Nahariya (IL).

(74) Agent: ISCAR LTD.; Patent Department, P.O. Box 11, 24959 Tefen (IL).

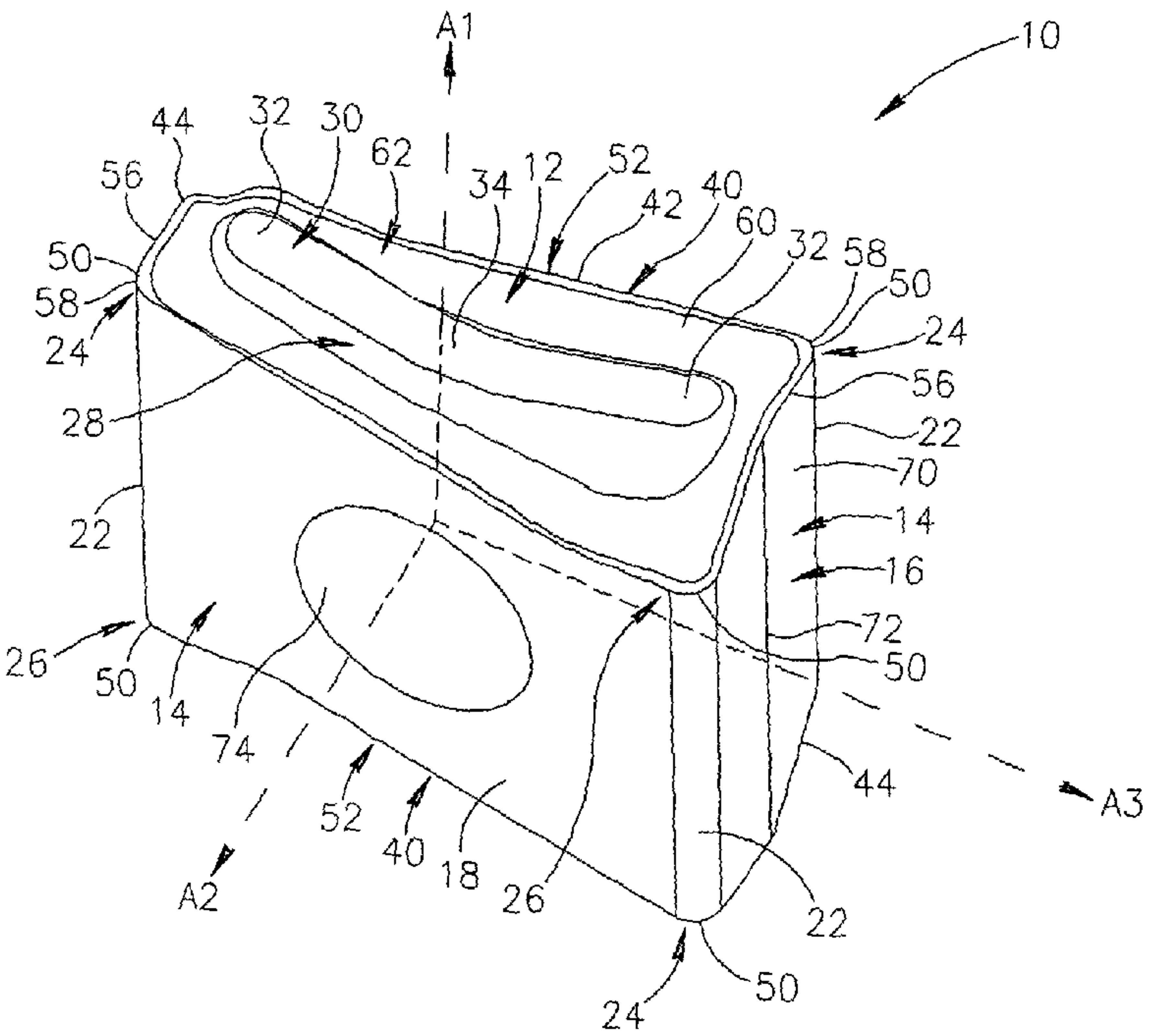
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: TANGENTIAL CUTTING INSERT AND MILLING CUTTER



(57) Abstract: A tangential cutting insert (10) having two identical opposing end surfaces (12) with two identical opposing major side surfaces (18) and two identical opposing minor side surfaces (16) extending between them. Each end surface has a peripheral edge (40) containing cutting edges and four corners (24, 26) of which two are lowered and two are raised. Each end surface is provided with at least one projecting abutment member (28) having a projecting abutment surface (30), wherein in a side view of either major side surface, the at least one projecting abutment surface is concave.

WO 03/101655 A1

TANGENTIAL CUTTING INSERT AND MILLING CUTTER

FIELD OF THE INVENTION

The present invention relates to a tangential indexable cutting insert and a milling cutter for use in metal cutting processes in general and for milling a square shoulder in a workpiece in particular.

BACKGROUND OF THE INVENTION

Tangential cutting inserts, also known as on-edge, or lay down, cutting inserts, are oriented in an insert holder in such a manner that during a cutting operation on a workpiece the cutting forces are directed along a major (thicker) dimension of the cutting insert. An advantage of such an arrangement being that the cutting insert can withstand greater cutting forces than when oriented in such a manner that the cutting forces are directed along a minor (thinner) dimension of the cutting insert.

There is disclosed in EP 0 769 341 a face milling cutter employing a double-sided indexable tangential cutting insert having a prismoidal shape with two opposed generally rectangular rake surfaces connected by side surfaces. The cutting insert has a basic "negative" geometry and therefore in order to provide the necessary clearance between the cutting insert and the workpiece, when mounted in a face-mill, the cutting insert is oriented with a negative axial rake angle. However, negative axial rake angles are disadvantageous, e.g., they have been found to be deficient in cutting efficiency for applications involving difficult to machine materials.

There is disclosed in WO 96/35536 a double-sided indexable tangential cutting insert which when mounted in a face-mill has a positive axial rake angle, even when the necessary clearance between the cutting insert and the workpiece is provided. This cutting inserts presents two peripheral cutting edges for a right-hand face mill and two peripheral cutting edges for a left-hand face mill.

A double-sided indexable tangential cutting insert for a boring tool head is disclosed in US 5,333,972. The insert is provided at each end with a protruding flat island. Each long cutting edge is inclined at an angle of 3° relative to the protruding flat island, defining an "insert axial rake angle". Rearward of each cutting edge is a descending land surface that merges with an increasing incident angle surface to form a chip breaker groove. Each increasing incident angle surface extends from its associated descending land surface to an adjacent island, at either the top or the bottom of the cutting insert. The cutting insert is left or right handed. It is manufactured to be right-handed and, when flipped around, is left-handed. It will be appreciated that the magnitude of the insert axial rake angle is limited for practical reasons. Any increase in the insert axial rake angle will result in an increase in the "vertical" extent of the increasing incident angle surface (see Fig. 3 of US 5,333,972) that will have an adverse effect on chip development and evacuation.

It is an object of the present invention to provide a double-sided indexable tangential cutting insert that substantially overcomes the above-mentioned problems.

It is a further object of the present invention to provide a double-sided indexable tangential cutting insert having four main cutting edges, for a given direction of rotation of the milling cutter, each main cutting edge having a positive axial rake angle when mounted as an operative cutting edge in a milling cutter.

It is yet a further object of the present invention to provide a double-sided indexable tangential cutting insert capable of milling a square shoulder in a workpiece.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a tangential cutting insert, for use in a milling cutter, comprising:

two identical opposing end surfaces having 180° rotational symmetry about a first axis **A1** passing therethrough,

a peripheral side surface extending between the two opposing end surfaces, and

a peripheral edge formed at the intersection of each end surface and the peripheral side surface, at least two sections of each peripheral edge constituting cutting edges,

the peripheral side surface comprising:

two identical opposing major side surfaces having 180° rotational symmetry about a second axis **A2** passing therethrough, the second axis **A2** being perpendicular to the first axis **A1**;

two identical opposing minor side surfaces having 180° rotational symmetry about a third axis **A3** passing therethrough, the third axis **A3** being perpendicular to the first axis **A1** and the second axis **A2**;

a minor plane **P1** defined by the first axis **A1** and the second axis **A2**;

a major plane **P2** defined by the first axis **A1** and the third axis **A3**;

a median plane **M** being defined by the second axis **A2** and the third axis **A3**;

each end surface having four corners, two lowered corners and two raised corners, the lowered corners being closer to the median plane **M** than the raised corners;

each end surface being provided with at least one projecting abutment member having a projecting abutment surface, wherein in a side view of either major side surface, the projecting abutment surface lies on a concave surface.

Preferably, in a side view of either major side surface, the projecting abutment surface is generally V-shaped.

In accordance with a first embodiment of the present invention, in an end-view of the cutting insert the projecting abutment surface is generally rectangular in shape having two parallel long edges extending between two short edges, the long edges making an angle of **β** with the major plane **P2**.

In accordance with a specific application of the first embodiment, **β** = 2°.

If desired, the projecting abutment surface comprises three flat portions, two outer flat portions with an inner flat portion therebetween, each outer flat portion extending from a respective short edge to the inner flat portion.

In accordance with a first embodiment of the present invention, in an end-view of the cutting insert two median lines are defined, one for each outer flat portion, the median lines do not overlap and do not lie on a common straight line.

Preferably, the two median lines are parallel.

Further preferably, the two median lines are parallel to the major side surfaces.

In accordance with a second embodiment of the present invention, in an end view of the cutting insert the at least one projecting abutment member has an elongated S-shape.

In accordance with a third embodiment of the present invention, each end surface is provided with two projecting abutment members.

Preferably, the two projecting abutment members are located on opposite sides of the minor plane **P1**.

Further peferably, a major portion of a first of the two projecting abutment members is located on a first side of the major plane **P2** and a major portion of a second of the two projecting abutment members is located on a second side of the major plane **P2**.

If desired, each minor side surface is divided into two minor side sub-surfaces by the major plane along a join where the major plane intersects the minor side surface, each minor side sub-surface extending away from the join at an angle **α** with respect to a plane passing through the join and parallel to the minor plane **P1**.

In accordance with the present invention, each minor side surface merges with an adjacent major side surface at a corner side surface, wherein each corner side surface extends between a given raised corner of one of the two opposing end surfaces and a given lowered corner of the other of one of the two opposing end surfaces.

In accordance with the present invention, each cutting edge comprises a major cutting edge, a minor cutting edge and a corner cutting edge, therebetween.

In accordance with the present invention, major, corner, and minor edges are formed at the intersection of the major, corner and minor side surfaces, respectively with an adjacent end surface.

In accordance with the present invention, each corner cutting edge is associated with a given raised corner.

Generally, each major cutting edge extends along substantially the whole length of an associated major edge.

Generally, each minor cutting edge extends along at least half of the length of an associated minor edge.

In accordance with the present invention, the cutting insert further comprises an insert through bore extending between the major side surfaces and having a bore axis **B** coinciding with the second axis **A2**.

Generally, a first major dimension **D1**, measured between the end surfaces, is greater than a minor dimension **D2** measured between the major side surfaces.

Further generally, a second major dimension **D3**, measured between the minor side surfaces, is greater than the minor dimension **D2**.

There is also provided in accordance with the present invention, a milling cutter comprising:

at least one cutting insert in accordance with claim 1; and

a cutter body having at least one insert pocket in which the at least one cutting insert is retained, the at least one insert pocket comprising adjacent side and rear walls generally transverse to a base, the rear wall being generally convex; the side wall being provided with an axial location surface that abuts a given minor side surface of the at least one cutting insert at a given axial abutment region; the rear wall being provided with two tangential location surfaces, located on either side of a central region of the rear wall, a first of the two tangential location surfaces abuts a first tangential abutment surface located on the at least one cutting insert, a second of the two tangential location surfaces abuts a second tangential abutment surface located on the at least one cutting insert.

In accordance with the present invention, the given axial abutment region is located on a forward region of a radially outer minor side sub-surface, the forward region being distal the rear wall of the insert pocket.

Further in accordance with the present invention, the lower and upper tangential abutment surfaces are located on opposite sides of the minor plane **P1**.

In accordance with the first and second embodiments, each end surface of the at least one cutting insert is provided with one projecting abutment member and the first and second tangential abutment surfaces are located on the one projecting abutment member.

In accordance with the third embodiment, each end surface of the at least one cutting insert is provided with two projecting abutment member and the first tangential abutment surface is located on one of the two projecting abutment members, and the second tangential abutment surfaces is located on the other one of the projecting abutment member.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding, the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a cutting insert in accordance with a first embodiment of the present invention;

Fig. 2 is a first side view of the cutting insert in Fig. 1;

Fig. 3 is an end view of the cutting insert shown in Fig. 1;

Fig. 4 is a second side view of the cutting insert shown in Fig. 1;

Fig. 5 is a cross-sectional view of the cutting insert shown in Fig. 1 taken along the line V-V in Fig. 4;

Fig. 5 is a cross-sectional view of the cutting insert shown in Fig. 1 taken along the line V-V in Fig. 4;

Fig. 6A is an enlarged scale partial cross section of the cutting insert shown in Fig. 1 taken along the line VIA-VIA in Fig. 3;

Fig. 6B is an enlarged scale partial cross section of the cutting insert shown in Fig. 1 taken along the line VIB-VIB in Fig. 3;

Fig. 6C is an enlarged scale partial cross section of the cutting insert shown in Fig. 1 taken along the line VIC-VIC in Fig. 3;

Fig. 7 is a perspective view of the cutting insert in accordance with the present invention with a ground primary relief surface;

Fig. 8 is a perspective view of a milling cutter in accordance with the present invention;

Fig. 9 is a perspective view of a portion of the cutter body of the milling cutter in accordance with the present invention, showing in detail an insert pocket;

Fig. 10 is an end view of a cutting insert in accordance with a second embodiment of the present invention;

Fig. 11 is a side view of a cutting insert in accordance with the second embodiment of the present invention;

Fig. 12A is an enlarged scale partial cross section of the cutting insert in accordance with the second embodiment taken along the line XIIA-XIIA in Fig. 10;

Fig. 12B is an enlarged scale partial cross section of the cutting insert in accordance with the second embodiment taken along the line XIIB-XIIB in Fig. 10;

Fig. 12C is an enlarged scale partial cross section of the cutting insert in accordance with the second embodiment taken along the line XIIB-XIIB in Fig. 10;

Fig. 13 is a perspective view of a cutting insert in accordance with a third embodiment of the present invention;

Fig. 14 is a side view of the cutting insert shown in Fig. 13;

Fig. 15 is an end view of the cutting insert shown in Fig. 13;

Fig. 16A is an enlarged scale partial cross section of the cutting insert shown in Fig. 13 taken along the line XVIA-XVIA in Fig. 15;

Fig. 16B is an enlarged scale partial cross section of the cutting insert shown in Fig. 13 taken along the line XVIB-XVIB in Fig. 15; and

Fig. 16C is an enlarged scale partial cross section of the cutting insert shown in Fig. 13 taken along the line XVIC-XVIC in Fig. 15.

DETAILED DESCRIPTION OF THE INVENTION

Attention is first drawn to Figs. 1 to 6C, showing a cutting insert **10** in accordance with a first embodiment of the present invention. The cutting insert **10** is tangential and indexable. The cutting insert **10** is typically manufactured by form-pressing and sintering carbide powders. The cutting insert **10** is generally rectangular in an end view and has two identical opposing end surfaces **12**. Each end surface **12** has 180° rotational symmetry about a first axis **A1** passing through the two end surfaces **12**.

A peripheral side surface **14** extends between the two opposing end surfaces **12** and comprises two opposed identical minor side surfaces **16**, two opposed identical major side surfaces **18**, and four opposed corner side surfaces **22**. Adjacent minor and major side surfaces **16**, **18** merge at a common corner side surface **22**. The two identical opposing major side surfaces **18** each have 180° rotational symmetry about a second axis **A2** passing through the opposing major side surfaces **18**. The second axis **A2** is perpendicular to the first axis **A1**. Similarly, the two identical opposing minor side surfaces **16** each have 180° rotational symmetry about a third axis **A3** passing through the opposing minor side surfaces **16**. The third axis **A3** is perpendicular to the first axis **A1** and to the second axis **A2**. A minor plane **P1** defined by the first axis **A1** and the second axis **A2**, a major plane **P2** defined by the first axis **A1** and the third axis **A3** and a median plane **M** is defined by the second axis **A2** and the third axis **A3**.

Each end surface **12** has four corners, two lowered corners **24** and two raised corners **26**. The lowered corners **26** being closer to the median plane **M** than the raised corners **24**. Each corner side surface **22** extends between a given raised corner **26** of one of the two opposing end surfaces **12** and a given lowered corner **26** of the other of one of the two opposing end surfaces **12**. Each end surface **12** is provided with a projecting abutment member **28** having a projecting abutment surface **30**, wherein in a side view of either major side surface **18**, the projecting abutment member **28** is generally concave in form. The projecting abutment surface **30** comprises three generally flat portions, two outer portions **32** with an inner portion **34** therebetween. Therefore, in a side view of either major side surface **18**, each projecting abutment surface **30** lies on a concave surface **S** which is generally V-shaped in form.

Referring to Fig. 3, it can be seen that in an end-view of the cutting insert **10** the projecting abutment surface **30** is generally rectangular in shape having two parallel long edges **36** extending between two short edges **38**. Therefore, each outer flat portion **32** of the projecting abutment surface **30**, extends from a respective short edge **38** to the inner flat portion **34**.

A peripheral edge **40** is formed at the intersection of each end surface **12** and the peripheral side surface **14**. For each end surface **12**, the peripheral edge **40** comprises two major edges **42**, formed by the intersection of the major side surfaces **18** with the end surface **12**; two minor edges **44**, formed by the intersection of the minor side surfaces **16** with the end surface **12**; and two corner edges **42**, formed by the intersection of the corner side surfaces **22** with the end surface **12**.

At least two sections of each peripheral edge **40** the cutting insert **10** constitute cutting edges **52**. Each cutting edge **52** comprises a major cutting edge **54**, extending along substantially the whole length of its associated major edge **42**; a minor cutting edge **56**, extending along at least half of the length of its associated minor edge **44**; and a corner cutting edge **58**, associated with a raised corner **24** and at which the major and minor cutting edges **54**, **56** merge. Adjacent each cutting edge **52** in the end surfaces **12** is a rake surface **60** along which chips, removed from a workpiece during a milling operation, flow. Between the rake surface **60** and the projecting abutment member **28** there is a chip groove **62**. The portion of the projecting abutment member **28** adjacent the chip forming groove **62** constitutes a chip deflector **64**.

Referring to Fig. 3, it is seen that each minor side surface **16** is divided into two minor side sub-surfaces **70** by a join **72** where the major plane **P2** intersects the minor side surface **16**. Each minor side sub-surface **70** extends away from the join **72** at an angle **α** with respect to a plane **P3** passing through the join **72** and parallel to the minor plane **P1**. In accordance with a specific application this angle is approximately 1.5°. The cutting insert is provided with a through bore **74** extending between the major side surfaces **18** and having a bore axis **B** coinciding with the second axis **A2**.

As will become apparent below, with reference to the milling cutter in accordance with the present invention, the section of the major cutting edge **54** adjacent the raised corner **24** constitutes a leading end **66** of the major cutting edge **54** whereas, the section of the major cutting edge **54** adjacent the lowered corner **26** constitutes a trailing end **68** of the major cutting edge **54**. As can be seen in Fig. 4, in a side view of the cutting insert **10**, the projecting abutment member **28** in the region of the leading end of the major cutting edge **54** and up to and a little beyond the region of the minor plane **P1**, does not protrude by much above the major cutting edge **54**. As a consequence, chips in this region are completely formed during a milling process. However, in the region of the trailing end **68** of the major cutting edge **54**, the chip deflector **64** protrudes much further than it does in the region of the leading end **66**, which can disturb the development of the chips. In order to reduce the influence of the protruding chip deflector **64** in the region of the trailing end **68**, the chip deflector **64** is designed to be more distant from the major cutting edge **54** in the region of the trailing end **68** than it is in the region of the leading end **66**. Consequently, as can be seen in Fig. 3, in an end-view of the cutting insert **10** in accordance with the first embodiment of the present invention the long edges **36** of the projecting abutment member **28** are oriented at a small angle **β** with respect to the major plane **P2**. In accordance with a specific application this angle is 2°. Although the shape of the major cutting edge **54** is shown in Fig. 4 to be generally straight in a side view, apart from section adjacent the trailing end **68**, the major cutting edge **54** can have any desired shape. Further with reference to Fig. 4, it can be seen that in a side view of the major side surface **18**, the major cutting edge **54** generally slopes downwardly from the raised corner **24** to the lowered corner **26**. With reference to Fig. 2, it can be seen that in a side view of the minor side surface **16**, the minor edge **44** is clearly divided into two sections, a first section **46** extending from the raised corner **24** to approximately the major plane **P2** and a second section **48** extending from the major plane to the lowered corner **26**. The first section **46** is approximately straight and is perpendicular to the major side surface **18** in a side view, see Fig. 2, and is oriented at the angle **α** with respect to a plane **P3** in an end view, see Fig. 3. The second section **48** extends from approximately the major plane **P2** slopingly towards the lowered corner **26** in an end view, see Fig. 2, and is oriented at the angle **α** with respect to a plane **P3** in an end view, see Fig. 3. It is the first section **46** of the minor edge **44** that forms the minor cutting edge **56**.

Attention is now drawn to Fig. 7, showing the cutting insert **10** in accordance with the present invention, in which the major side surface comprises a primary relief surface **76** adjacent the major cutting edge **54** and a secondary relief surface **78** adjacent the primary relief surface **76**. This arrangement gives more flexibility in the design of the major cutting edge **54** and is particularly important when designing the major cutting edge **54** to mill a true 90° shoulder in a workpiece. The primary relief surface **76** can have a constant relief angle along the major cutting edge **54**, or a variable relief angle along the major cutting edge **54**.

Attention is now drawn to Fig. 8, showing a milling cutter **80** with an axis of rotation **R**, having a cutter body **82** provided with a plurality of insert pockets **84**. In each insert pocket **84** a cutting insert **10** in accordance with the present invention is clamped by means of a clamping screw (not shown). The axial rake angle will generally be in the range of 5° to 20°. As can be seen, each cutting insert is seated so that there will be a clearance between a workpiece (not shown) and the cutting insert's minor side surface **16** adjacent the milling cutter's face **86**. The structure of the insert pocket **84** is shown in detail in Fig. 9. The insert pocket **84** comprises adjacent side and rear walls **88, 90** generally transverse to a base **92**. The rear wall **90** is generally convex and the side wall **88** is provided with an axial location surface **94** for abutting a given minor side surface **16** of the cutting insert **10** at an axial abutment region **96**. The rear wall **90** is provided with two tangential location surfaces, a upper tangential location surface **98**, adjacent the pocket side wall **88** and a lower tangential location surface **100** adjacent the milling cutter's face **86**. The two tangential location surfaces **98**, **100** project outwardly from the rear wall **90** and are located on either side of a central region **102** of the rear wall **90**, which is correspondingly recessed relative to the tangential location surfaces **98, 100**. The upper tangential location surface **98** abuts an upper tangential abutment surface **104** located on the projecting abutment surface **30** of the cutting insert **10**. The lower tangential location surface **100** abuts a lower tangential abutment surface **106** located on the projecting abutment surface **30**. Clearly, the terms "lower" and "upper" used here with respect to the projecting abutment surface **30** are used only when the cutting insert **10** is mounted in the milling cutter **80**, and with respect to the orientation shown in Figs. 8 and 9. Similarly, with respect to Figs. 8 and 9, the axial abutment region **96** is located on a forward region **108** of a radially outer minor side sub-surface **110**, the forward region being distal the rear wall of the insert pocket **90**. As can be seen in Fig. 3, the two tangential abutment surfaces **104, 106** on each projecting abutment surface **30** are located on opposite sides of the minor plane. As can be seen in Fig. 2, each minor side sub-surface **70** is provided with one axial abutment region **96** adjacent a lowered corner **26**. The base **92** of the insert pocket **84** is provided with a threaded bore **112** for receiving a clamping screw in order to secure the cutting insert **10** in the insert pocket **84**. When the cutting insert **10** is secured in the insert pocket **84**, a radially inner major side surface **20** will abut the base **92** of the insert pocket **84**. Preferably, the major side surfaces **18** of the cutting insert **10** are ground. Further preferably, the minor side sub-surfaces **70** are ground. With these surfaces ground, good positioning of the cutting insert **10** in the insert pocket **84** is ensured.

Attention is now directed to Figs. 10 to 12C showing a cutting insert **10'** in accordance with a second embodiment of the present invention. The cutting insert **10'** in accordance with the second embodiment is almost identical to the cutting insert **10** in accordance with the first embodiment. The main difference between the two cutting inserts is in the shape of the projecting abutment member **28, 28'**. As can be seen from comparing Figs. 4 and 11, in both embodiments the projecting abutment members **28, 28'** are concave in shape in a side view of the cutting insert **10, 10'**, that is, each projecting abutment surface **30, 30'** lies on a concave surface **S** which is generally V-shaped in form in a side view of the cutting insert **10, 10'**. The difference between the two projecting abutment members **28, 28'** being in their shape in an end view. Like the projecting abutment member **28** of the cutting insert **10** in accordance with the first embodiment, the projecting abutment member **28'** of the cutting insert **10'** in accordance with the second embodiment has a projecting abutment surface **30'** comprising three generally flat portions, two outer flat portions **32'** with an inner flat portion **34'** therebetween. However, unlike the cutting insert **10** in accordance with the first embodiment, the shape of the projecting abutment member **28'** in an end view of the cutting insert **10'** in accordance with the second embodiment is not straight. As can be seen in Fig. 10, in an end view of the cutting insert **10'** each of the two outer flat portions **32'** has a median line **L1, L2** that is parallel to, but offset from, the major plane **P2'**. One median line **L1** being offset to one side of the major plane **P2'** and the other median line **L2** being offset to the other side of the major plane **P2'**, with the inner flat portion **34'** being transverse to the major plane **P2'**. Clearly then, in an end view of the cutting insert **10'**, the median lines **L1, L2** of the two flat outer portions **32'** are parallel, non-adjacent, and spaced apart from each other. In other words, the median lines **L1, L2** of the two flat outer portions **32'** are parallel, do not overlap and do not lie on a common straight line. As a consequence of this structure, the distance between the chip deflector **64'** and the adjacent major cutting edge **54'** remains constant along each outer flat portion **32'**. This is advantageous in regions where the chip deflector **64'** is high above the adjacent major cutting edge **54'** as shown on the right hand side in Fig. 12A.

As already stated, the cutting inserts **10**, **10'** in accordance with the first and second embodiments are almost identical. In particular, being tangential inserts each cutting insert **10**, **10'** has a first major dimension **D1**, measured between the end surfaces **12**, **12'** that is greater than a minor dimension **D2** measured between the major side surfaces **18**, **18'**. A second major dimension **D3**, measured between the minor surfaces **16**, **16'** is also greater than the minor dimension **D2**.

The cutting insert **10'** in accordance with the second embodiment is clamped in the milling cutter **80** in a similar way to which the cutting insert **10** in accordance with the first embodiment is clamped in the milling cutter **80**. That is, the upper tangential location surface **98** of the insert pocket **84** abuts an upper tangential abutment surface **104'** located on the projecting abutment surface **30'** of the cutting insert **10'** and the lower tangential location surface **100** of the insert pocket **84** abuts a lower tangential abutment surface **106'** located on the projecting abutment surface **30'**. In both the first and second embodiments the upper tangential abutment surface **104**, **104'** and the lower tangential abutment surface **106**, **106'** are generally flush with the projecting abutment surface **30**, **30'**.

As can be seen in Fig. 10, in an end view of the cutting insert **10'** in accordance with the second embodiment, the projecting abutment member **28'** has an elongated, or stretched out, "S-shape". However, as described above, the cutting insert **10'** in accordance with the second embodiment is clamped in the milling cutter **80** in a similar way to which the cutting insert **10** in accordance with the first embodiment is clamped in the milling cutter **80**. Clearly, other variations in the shape of the projecting abutment member **28** are acceptable in accordance with the present invention, provided that in a side view, as in Figs. 4 and 11, the projecting abutment members **28**, **28'** are concave. This, is due to fact that the projecting abutment members **28**, **28'** are designed to reduce the disturbance caused to the development of the chips during a milling operation, and the rear wall **90** of the insert pocket **84** is designed correspondingly convex with two protruding abutment members **104, 106, 104', 106'** in order to support the concave projecting abutment surface **30, 30'**.

Attention is now directed to Figs. 13 to 16C showing a cutting insert **10"** in accordance with a third embodiment of the present invention. The cutting insert **10"** in accordance with the third embodiment is almost identical to the cutting inserts **10, 10"** in accordance with the first and second embodiments. The difference between the cutting insert **10"** in accordance with the third embodiment and the cutting inserts **10, 10'** in accordance with the first and second embodiments is in the structure of the projecting abutment member. In accordance with the third embodiment, each end surface **12"** of the cutting insert **10"** is provided with two projecting abutment members **28"A, 28"C** separated by a central recessed region **28"B**. Each projecting abutment member **28"A, 28"C** has a projecting abutment surface **30A, 30C**, wherein in a side view of either major side surface **18"** of the cutting insert **10"** the projecting abutment surfaces **30A, 30C** at each end surface **12"** lie on a concave surface **S** which is generally **V**-shaped in form.

The two projecting abutment members **28"A, 28"C** are located on opposite sides of the minor plane **P1** of the cutting insert **10"**. As seen in Fig. 15, a major portion of one of the projecting abutment members **28"A** is located on one side of the major plane **P2** of the cutting insert **10"**, whereas a major portion of the other one of the projecting abutment members **28"C** is located on the other side of the major plane **P2**.

The cutting insert **10"** in accordance with the third embodiment is clamped in the milling cutter **80** in a similar way to which the cutting inserts **10, 10'** in accordance with the first and second embodiments are clamped in the milling cutter **80**. That is, the upper tangential location surface **98** of the insert pocket **84** abuts an upper tangential abutment surface **104"** located on one of the projecting abutment surfaces **30A** of the cutting insert **10"** and the lower tangential location surface **100** of the insert pocket **84** abuts a lower tangential abutment surface **106"** located on the other one of the projecting abutment surfaces **30C**. The upper and lower tangential abutment surfaces **104"**, **106"** are generally flush with their respective projecting abutment surfaces **30A**, **30C**.

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.

What is claimed is:

1. A tangential cutting insert comprising:

two identical opposing end surfaces having 180° rotational symmetry about a first axis A1 passing therethrough,

a peripheral side surface extending between the two opposing end surfaces, and

a peripheral edge formed at the intersection of each end surface and the peripheral side surface, at least two sections of each peripheral edge constituting cutting edges,

the peripheral side surface comprising:

two identical opposing major side surfaces having 180° rotational symmetry about a second axis A2 passing therethrough, the second axis A2 being perpendicular to the first axis A1;

two identical opposing minor side surfaces having 180° rotational symmetry about a third axis A3 passing therethrough, the third axis A3 being perpendicular to the first axis A1 and the second axis A2;

a minor plane P1 defined by the first axis A1 and the second axis A2;

a major plane P2 defined by the first axis A1 and the third axis A3;

a median plane M being defined by the second axis A2 and the third axis A3;

each end surface having four corners, two lowered corners and two raised corners, the lowered corners being closer to the median plane M than the raised corners;

each end surface being provided with at least one projecting abutment member having a projecting abutment surface, wherein in a side view of either major side surface, the projecting abutment surface lies on a concave surface.

2. The cutting insert according to claim 1, wherein in a side view of either major side surface, the projecting abutment surface is generally V-shaped.

3. The cutting insert according to claim 1, wherein in an end-view of the cutting insert the at least one projecting abutment surface is generally rectangular in shape having two parallel long edges extending between two short edges, the long edges making an angle of β with the major plane P2.

4. The cutting insert according to claim 3, wherein β=2°.

5. The cutting insert according to claim 2, wherein the projecting abutment surface comprises three flat portions, two outer flat portions with an inner flat portion therebetween, each outer flat portion extending from a respective short edge to the inner flat portion.

6. The cutting insert according to claim 5, wherein in an end view of the cutting insert two median lines L1, L2 are defined, one for each outer flat portion, the median lines L1, L2 do not overlap and do not lie on a common straight line.

7. The cutting insert according to claim 6, wherein the two median lines L1, L2 are parallel.

8. The cutting insert according to claim 7, wherein the two median lines L1, L2 are parallel to the major side surfaces.

9. The cutting insert according to claim 1, wherein in an end view of the cutting insert the at least one projecting abutment member has an elongated S-shape.

10. The cutting insert according to claim 1, wherein each end surface is provided with two projecting abutment members.

11. The cutting insert according to claim 10, wherein the two projecting abutment members are located on opposite sides of the minor plane P1.

12. The cutting insert according to claim 11, wherein a major portion of a first of the two projecting abutment members is located on a first side of the major plane P2

and a major portion of a second of the two projecting abutment members is located on a second side of the major plane P2.

13. The cutting insert according to claim 1, wherein each minor side surface is divided into two minor side sub-surfaces by the major plane P2 along a join where the major plane P2 intersects the minor side surface, each minor side sub-surface extending away from the join at an angle α with respect to a plane passing through the join and parallel to the minor plane P1.

14. The cutting insert according to claim 1, wherein each minor side surface merges with an adjacent major side surface at a corner side surface, wherein each corner side surface extends between a given raised corner of one of the two opposing end surfaces and a given lowered corner of the other of one of the two opposing end surfaces.

15. The cutting insert according to claim 1, wherein each cutting edge comprises a major cutting edge, a minor cutting edge and a corner cutting edge, therebetween.

16. The cutting insert according to claim 15, wherein major, corner, and minor cutting edges are formed at the intersection of the major, corner and minor side surfaces respectively, with an adjacent end surface.

17. The cutting insert according to claim 15, wherein each corner cutting edge is associated with a given raised corner.

18. The cutting insert according to claim 16, wherein each major cutting edge extends along substantially the whole length of an associated major edge.

19. The cutting insert according to claim 16, wherein each minor cutting edge extends along at least half of the length of an associated minor edge.

20. The cutting insert according to claim 1, further comprising an insert through bore extending between the major side surfaces and having a bore axis B coinciding with the second axis A2.

21. The cutting insert according to claim 1, wherein a first major dimension D1, measured between the end surfaces, is greater than a minor dimension D2 measured between the major side surfaces.

22. The cutting insert according to claim 21, wherein a second major dimension D3, measured between the minor side surfaces, is greater than the minor dimension D2.

23. A milling cutter comprising:

at least one cutting insert in accordance with claim 1; and

a cutter body having at least one insert pocket in which the at least one cutting insert is retained, the at least one insert pocket comprising adjacent side and rear walls generally transverse to a base, the rear wall being generally convex; the side wall being provided with an axial location surface that abuts a given minor side surface of the at least one cutting insert at a given axial abutment region; the rear wall being provided with two tangential location surfaces, located on either side of a central region of the rear wall, a first of the two tangential location surfaces abuts a first tangential abutment surface located on the at least one cutting insert, a second of the two tangential location surfaces abuts a second tangential abutment surface located on the at least one cutting insert.

24. The milling cutter according to claim 23, wherein the given axial abutment region is located on a forward region of a radially outer minor side sub-surface, the forward region being distal the rear wall of the insert pocket.

25. The milling cutter according to claim 23, wherein the lower and upper tangential abutment surfaces are located on opposite sides of the minor plane P1.

26. The milling cutter according to claim 23, wherein each end surface of the at least one cutting insert is provided with one projecting abutment member and the first and second tangential abutment surfaces are located on the one projecting abutment member.

27. The milling cutter according to claim 23, wherein each end surface of the at least one cutting insert is provided with two projecting abutment member and the first tangential abutment surface is located on one of the two projecting abutment members, and the second tangential abutment surfaces is located on the other one of the projecting abutment member.

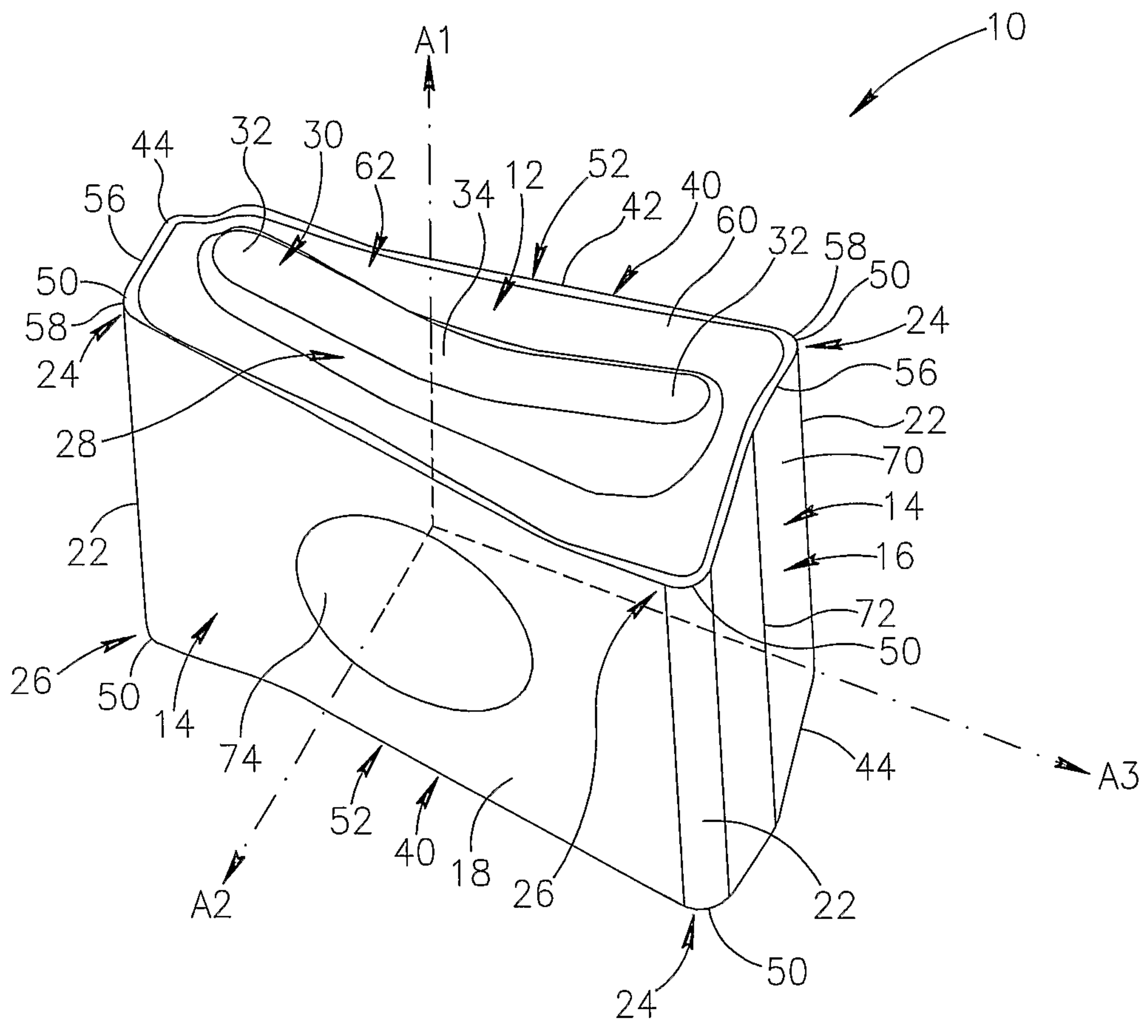

10
A1
44
32
30
62
34
12
52
40
42
60
32
58
50
56
50
58
24
24
56
28
22
70
14
16
22
72
50
26
50
14
74
52
40
18
26
22
44
A3
A2
24
50

FIG.1

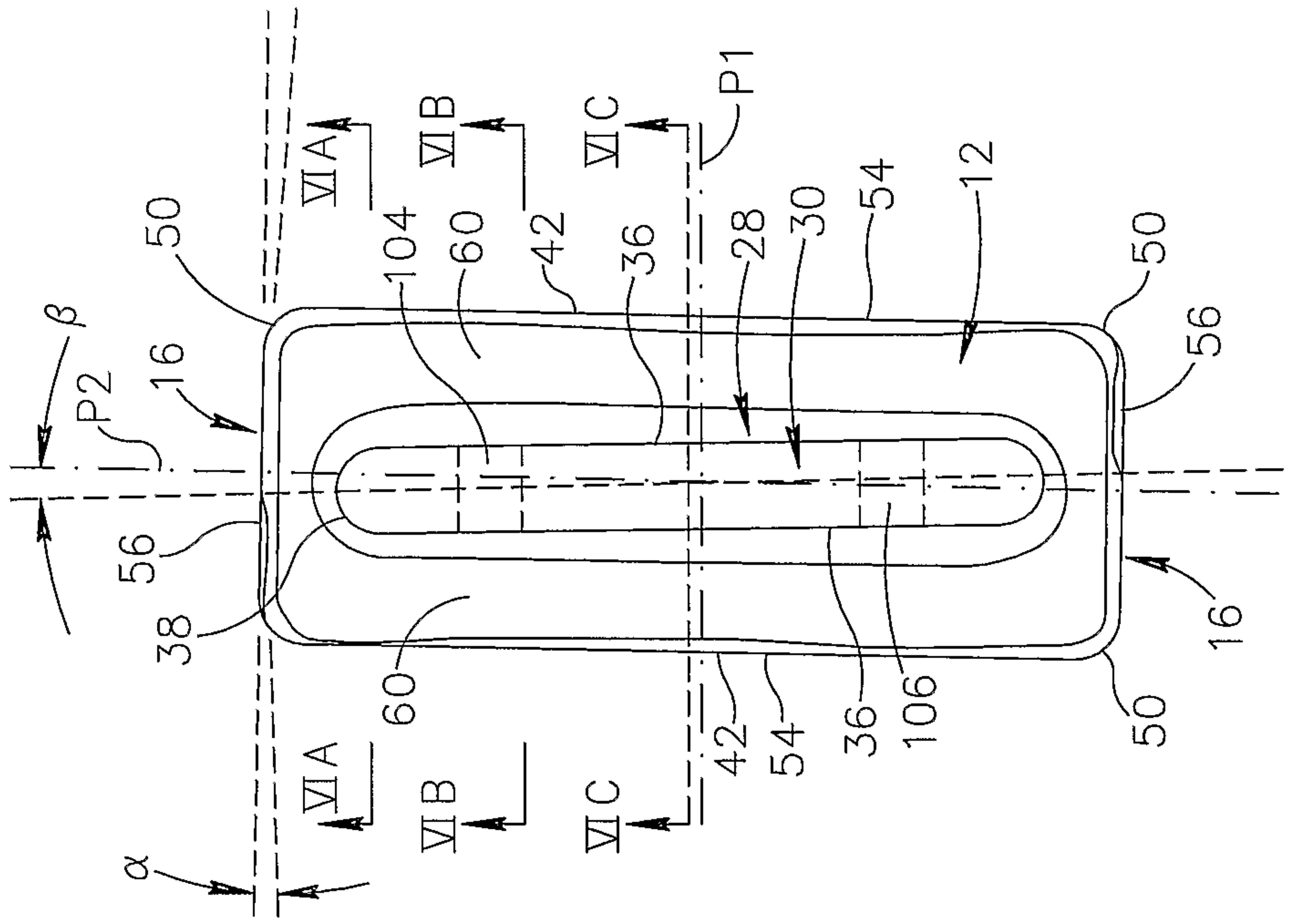


FIG.3

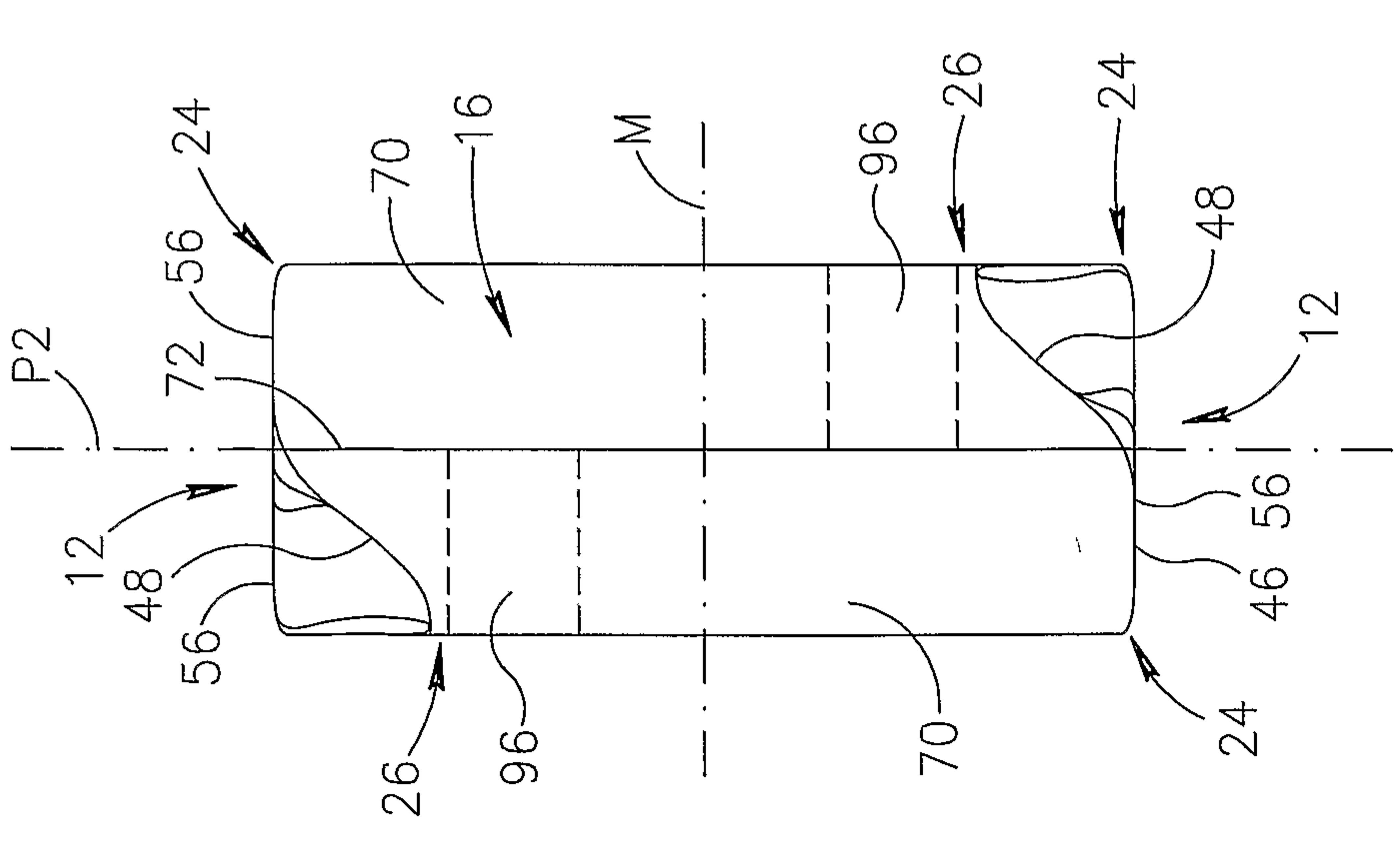


FIG.2

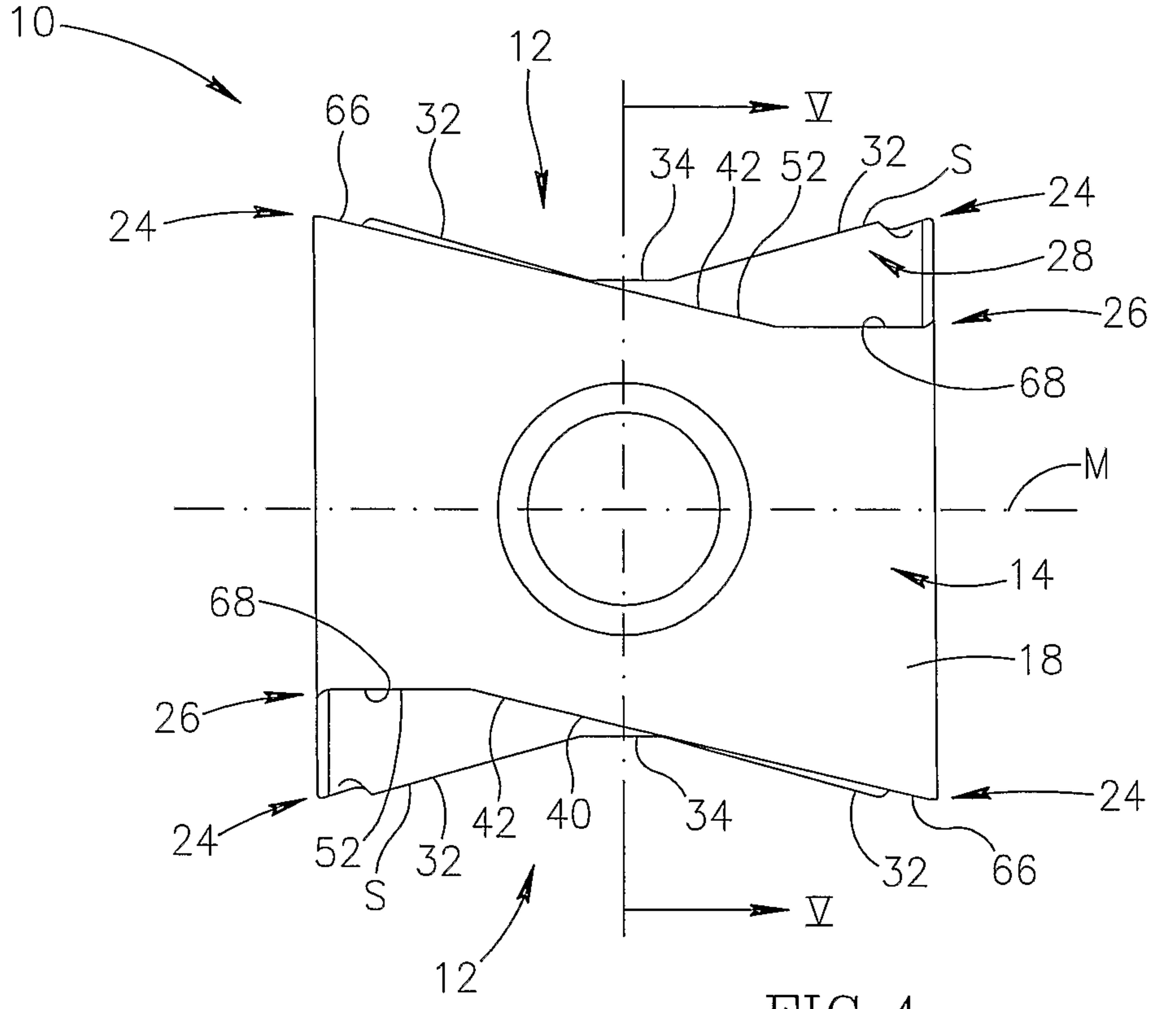

10
12
V
66
32
34
42
52
32
S
24
24
28
26
68
M
14
68
18
26
24
42
40
34
24
52
32
42
S
32
66
12
V

FIG.4

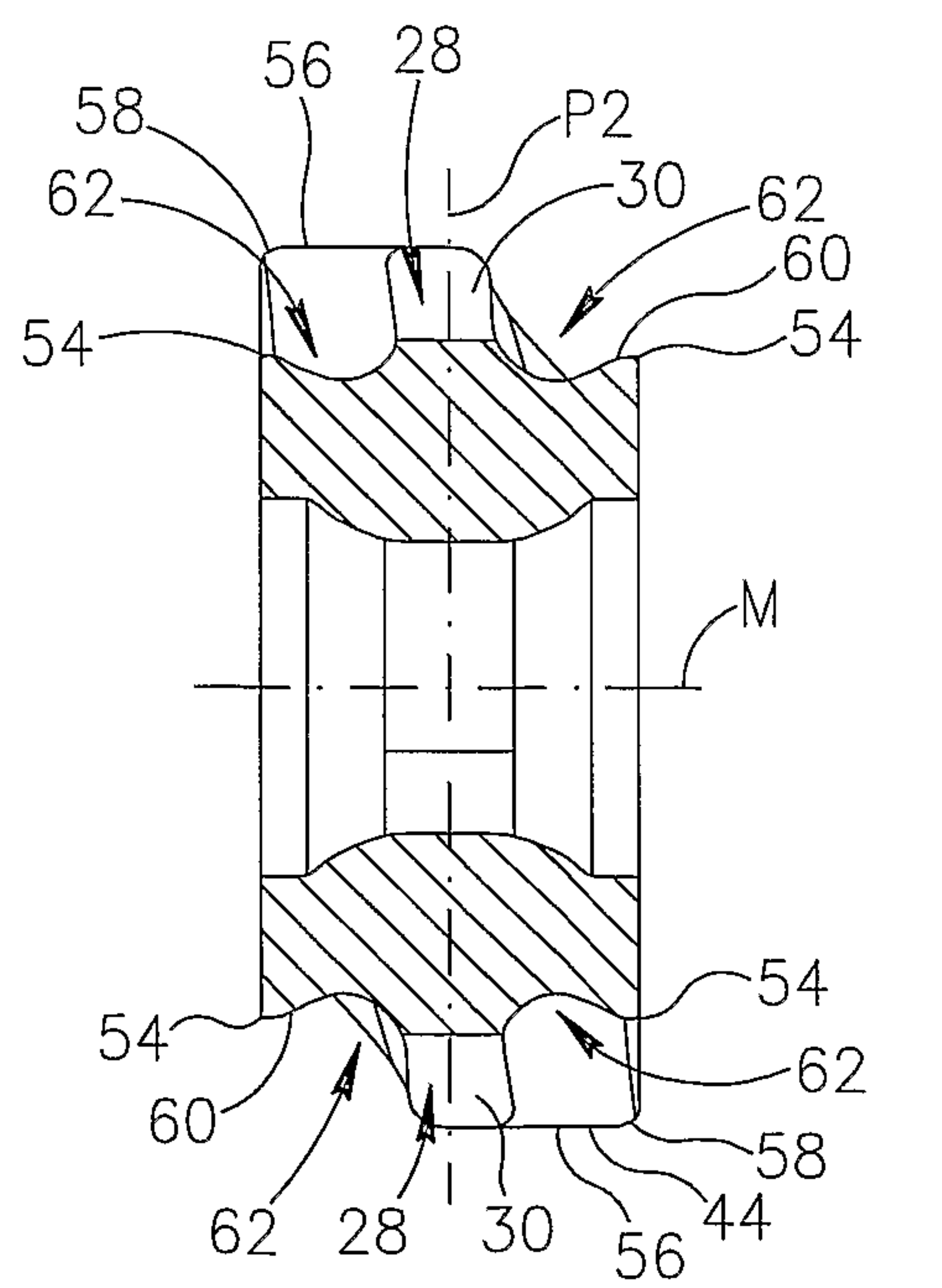

58
56
28
P2
30
62
62
60
54
54
M
54
54
62
60
62
28
30
56
44
58

FIG.5

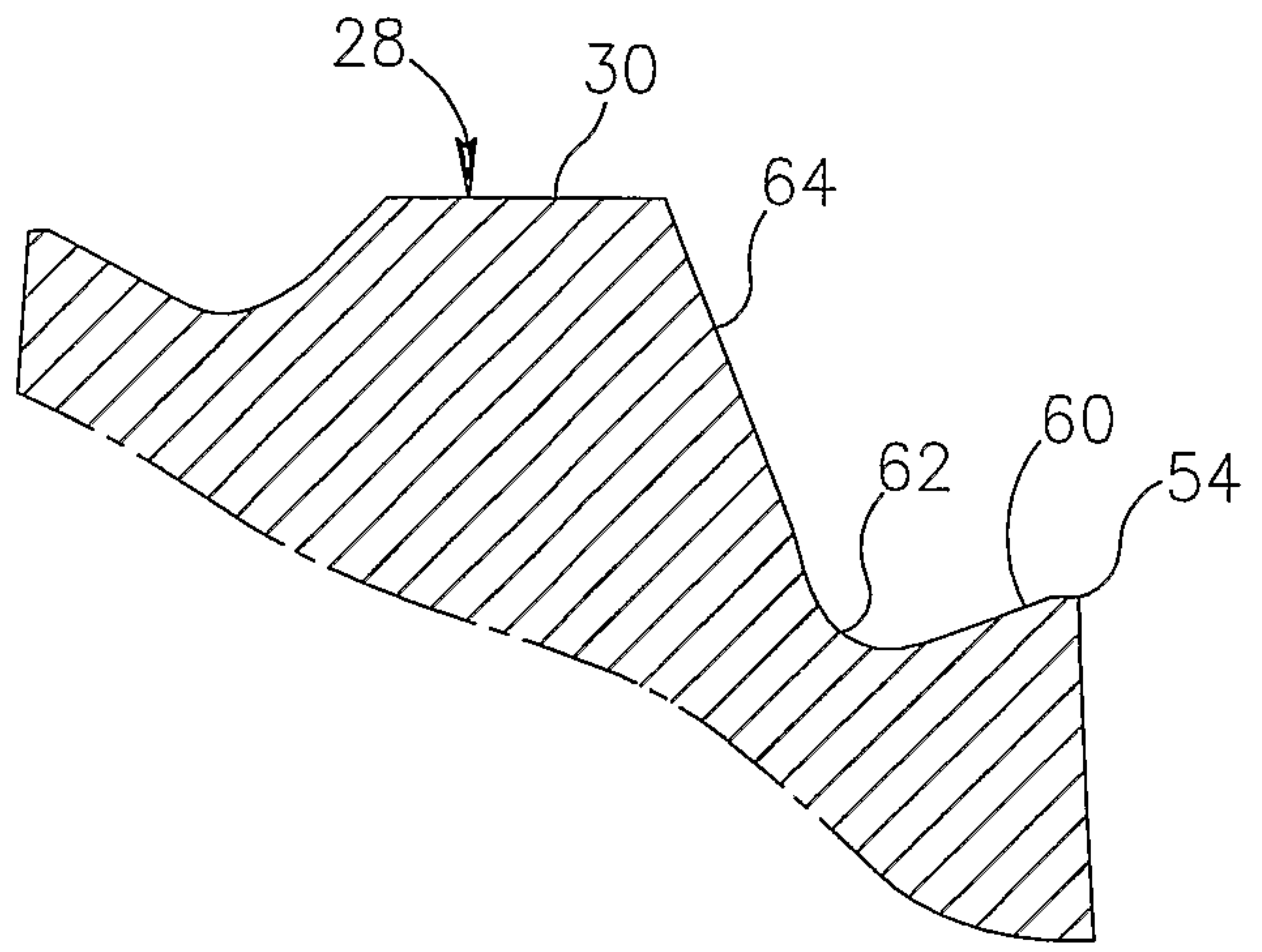


FIG.6A

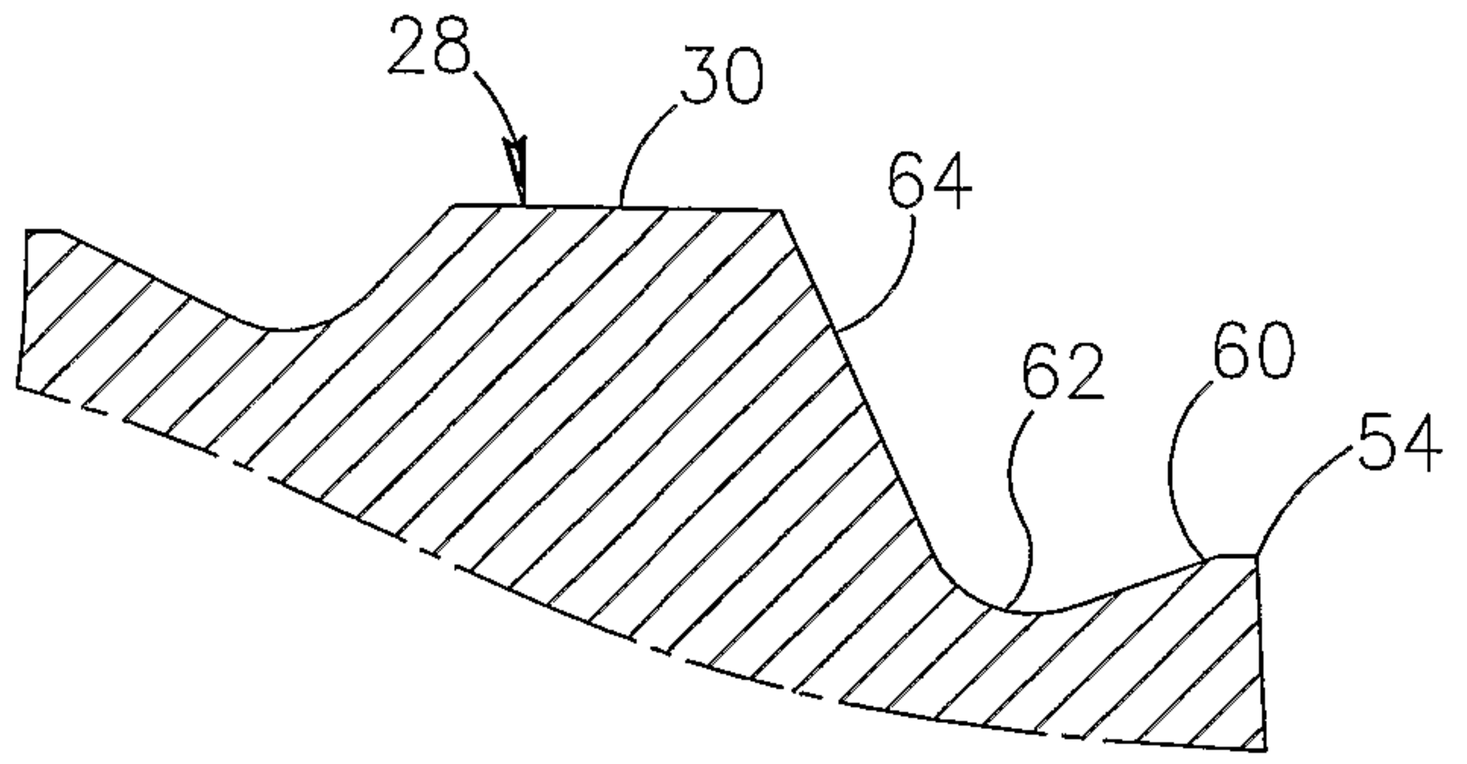


FIG.6B

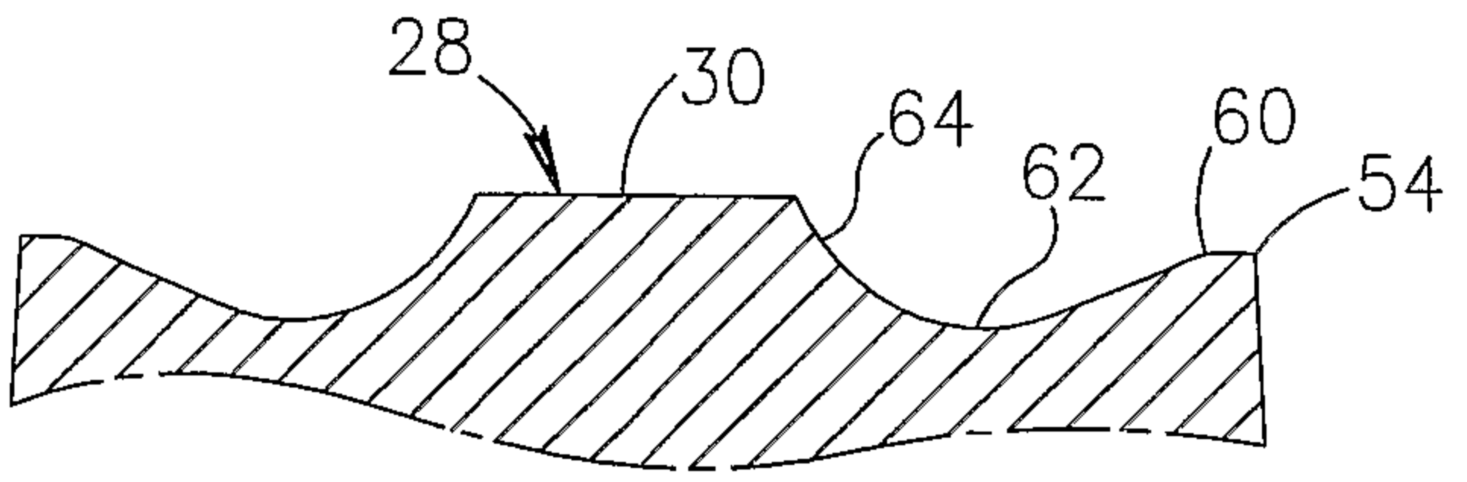


FIG.6C

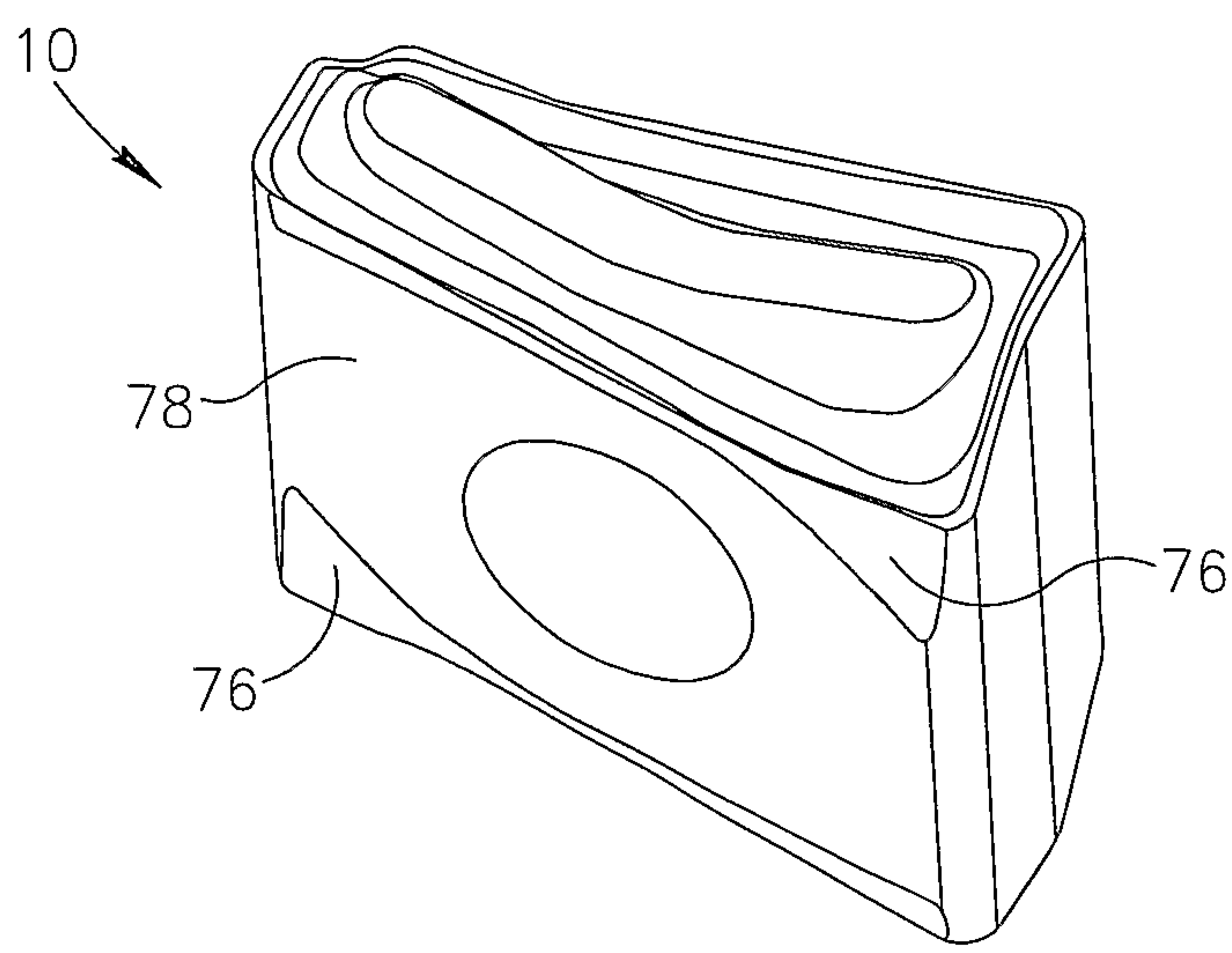


FIG.7

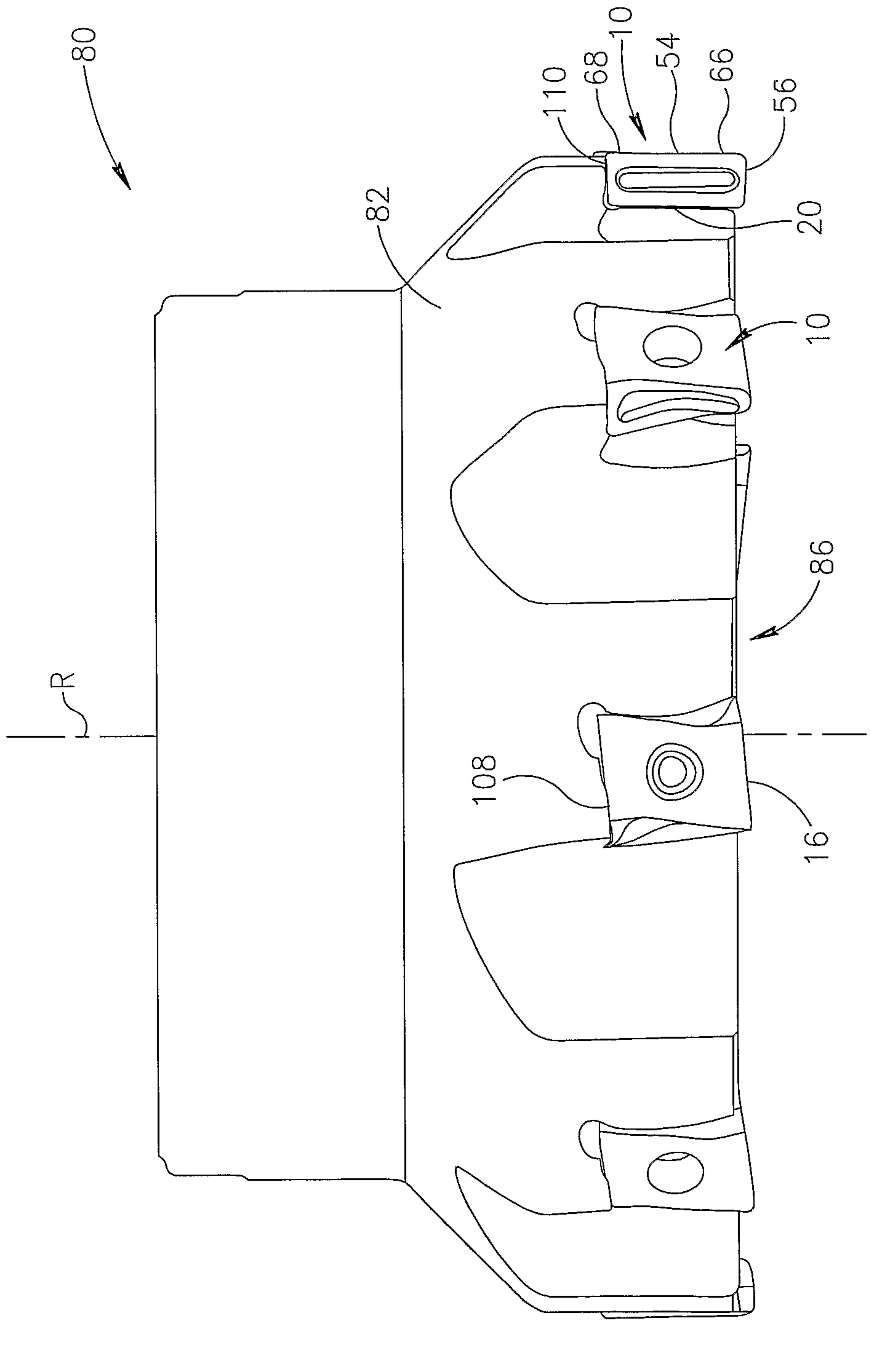


FIG.8

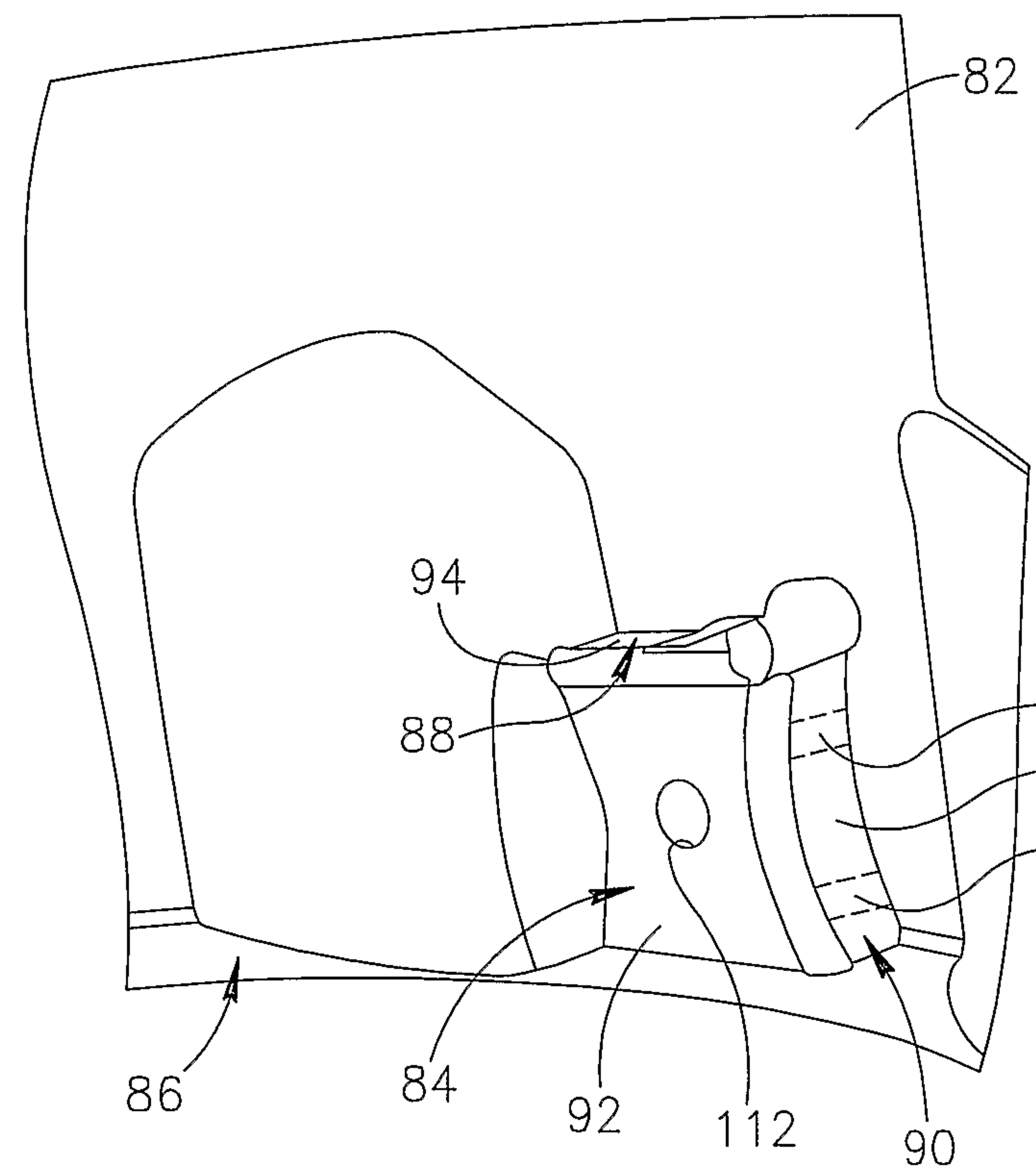


FIG.9

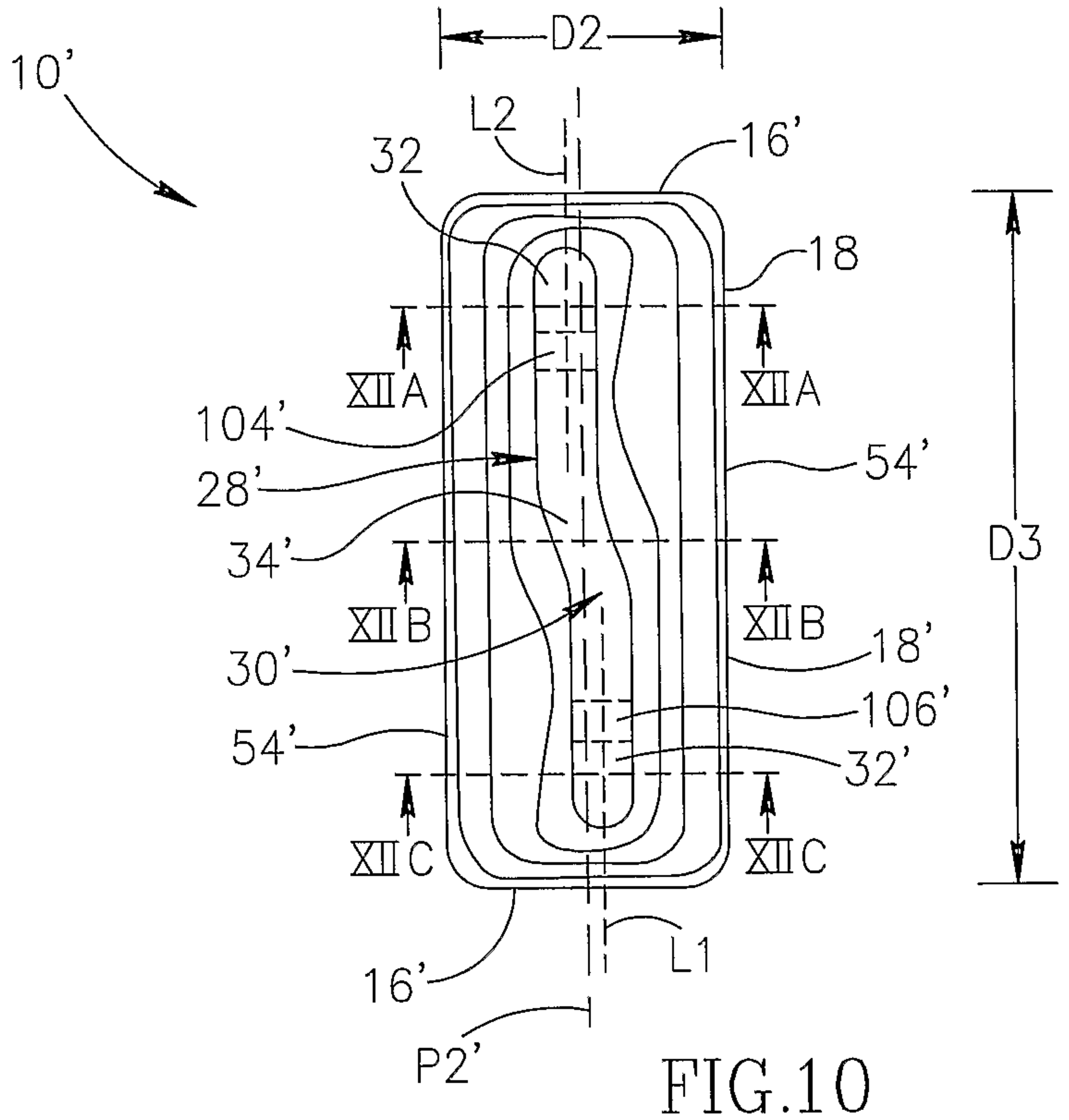

10'
D2
L2
32
16'
18
XII A
XII A
104'
28'
54'
34'
D3
XII B
XII B
30'
18'
106'
54'
32'
XII C
XII C
L1
16'
P2'

FIG.10

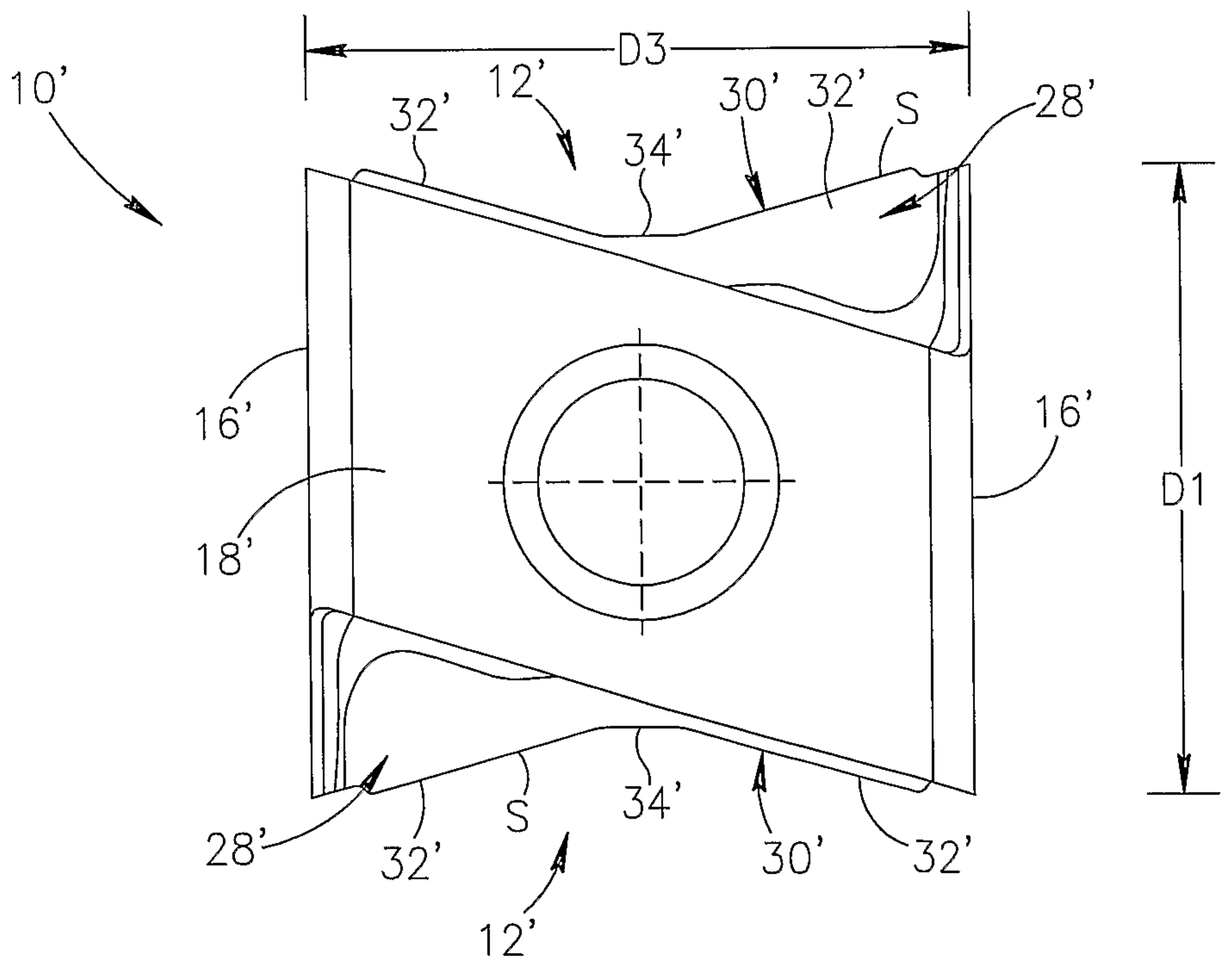

10'
D3
12'
32'
34'
30'
32'
S
28'
16'
16'
18'
D1
28'
32'
S
34'
30'
32'
12'

FIG.11

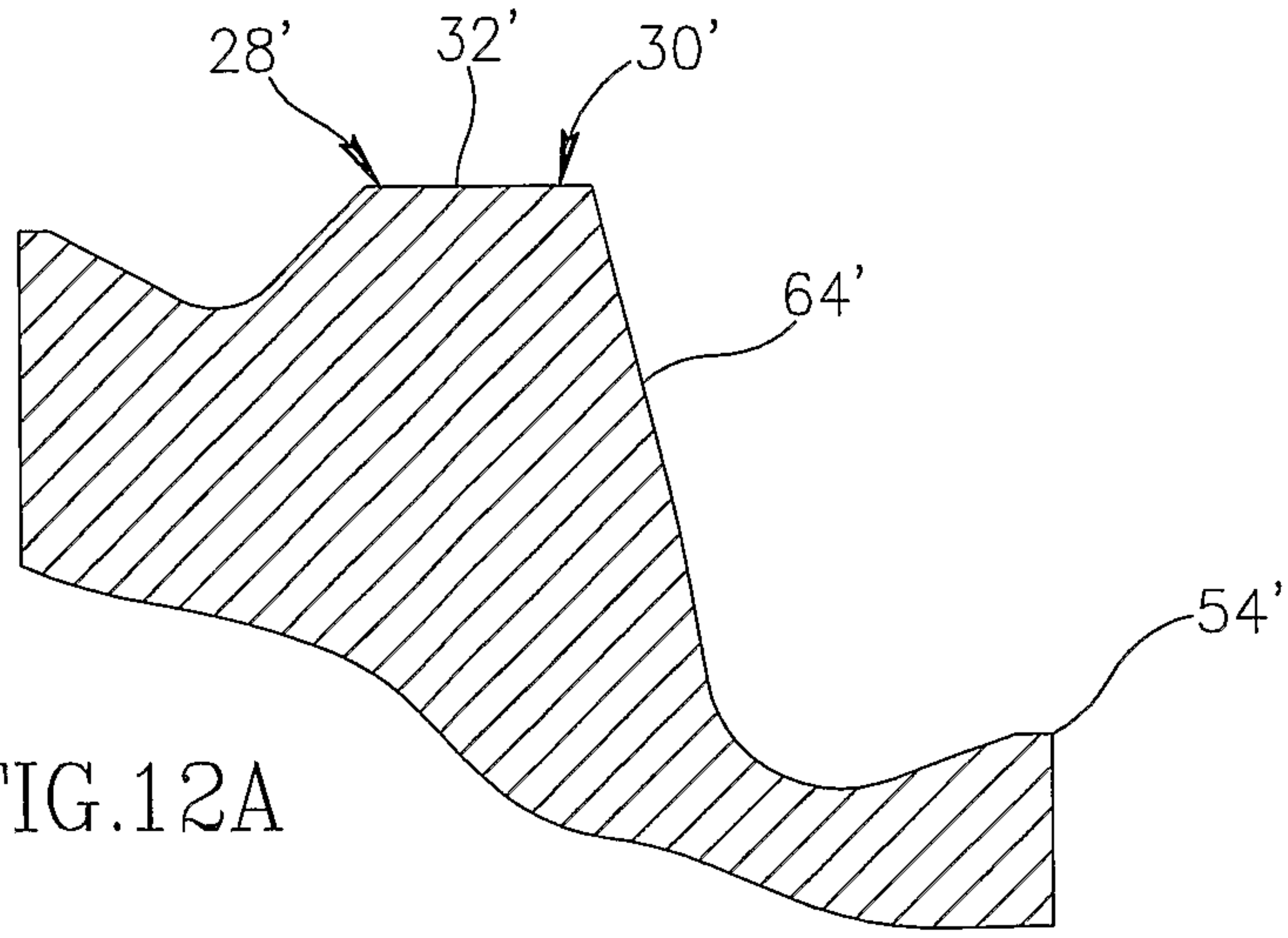


FIG.12A

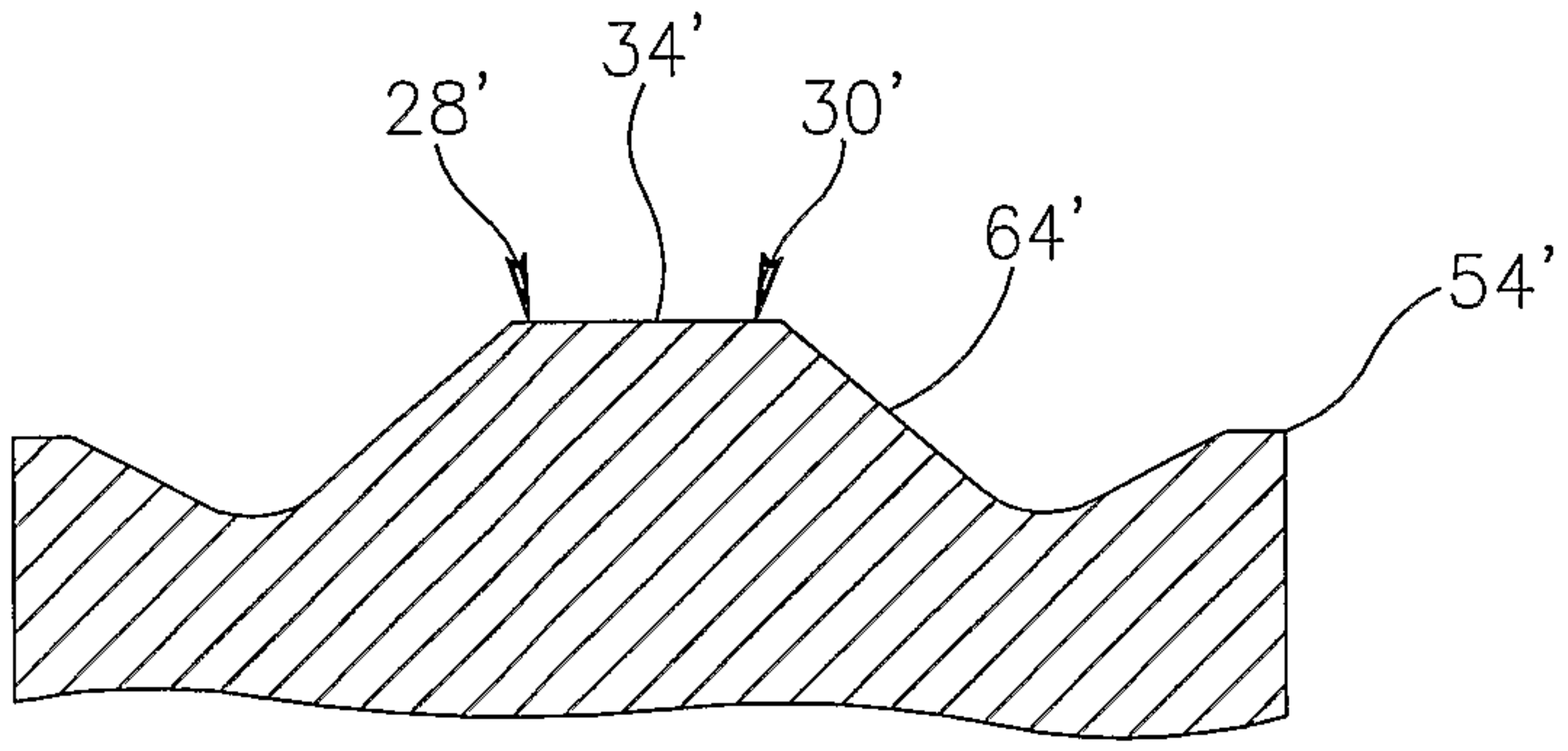


FIG.12B

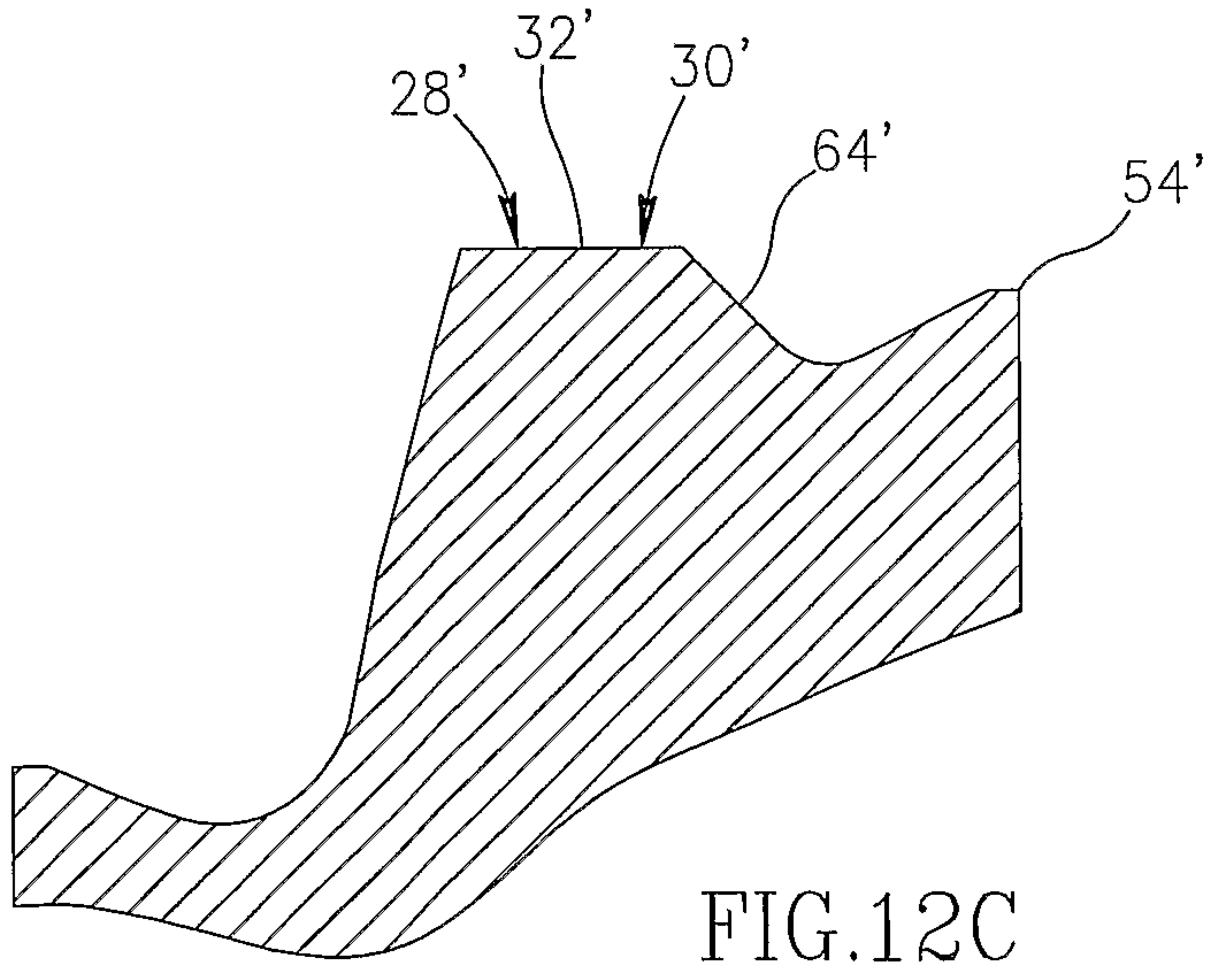


FIG.12C

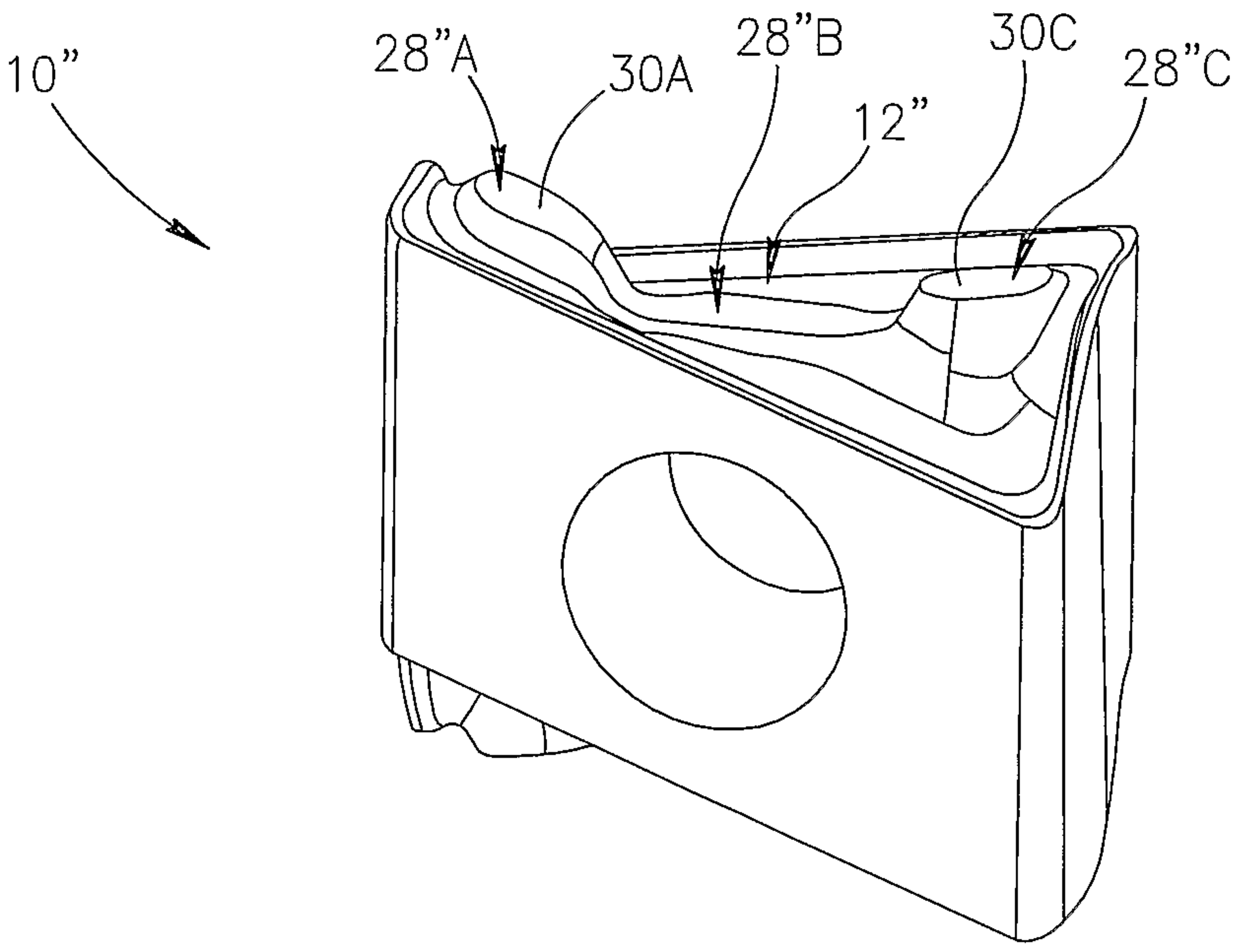


FIG.13

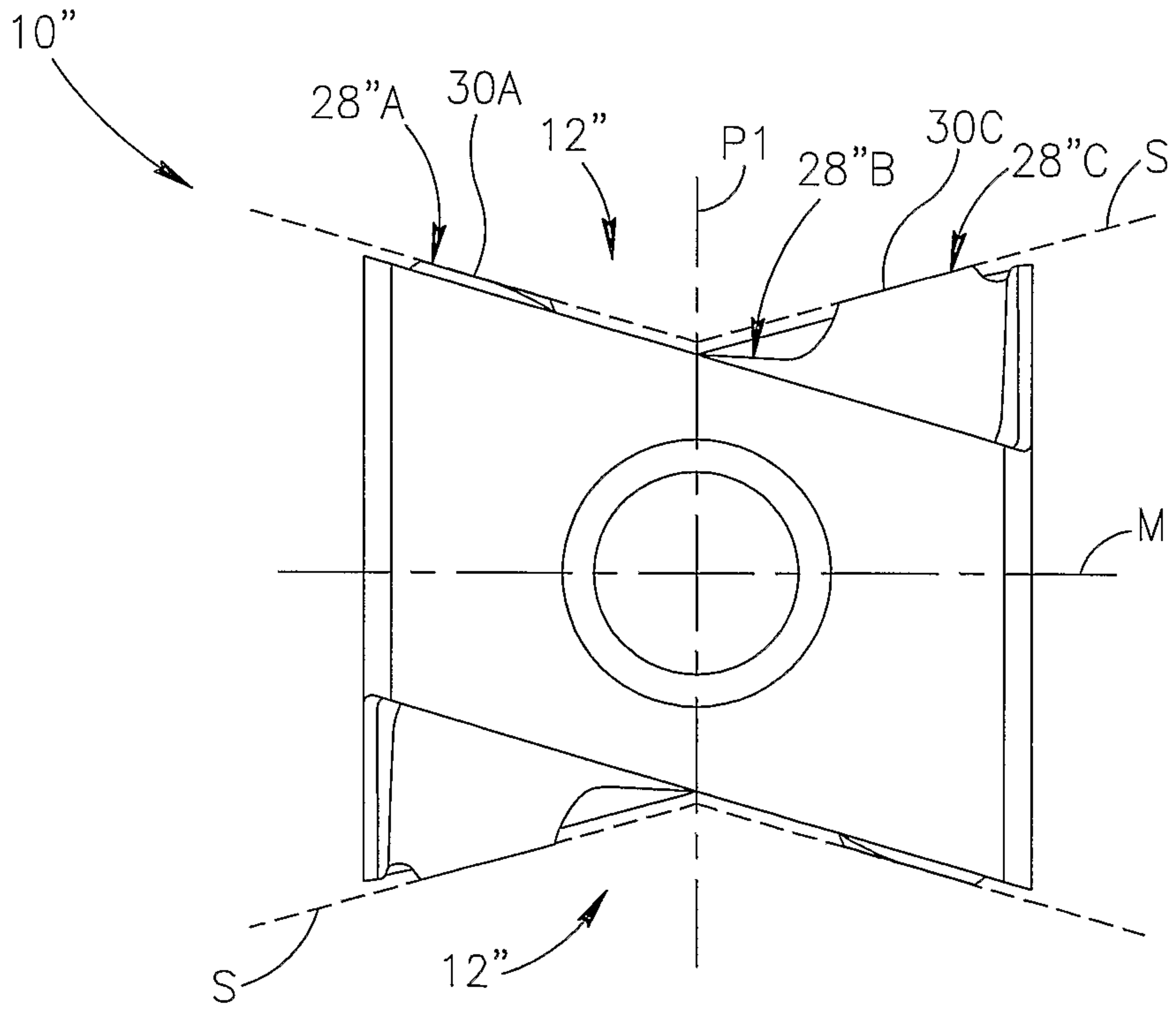


FIG.14

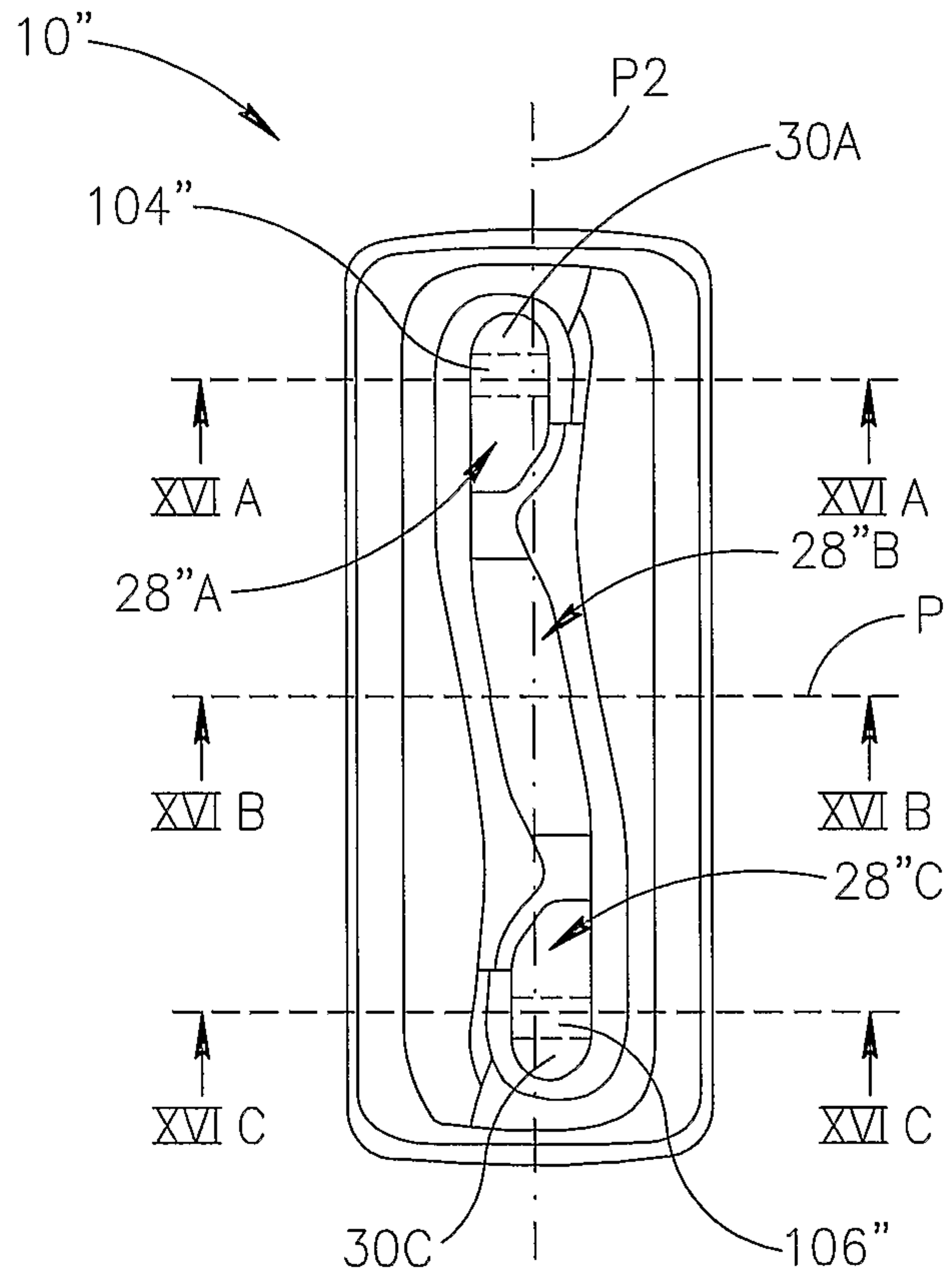

10"
P2
30A
104"
XVI A
XVI A
28"A
28"B
P1
XVI B
XVI B
28"C
XVI C
XVI C
30C
106"

FIG.15

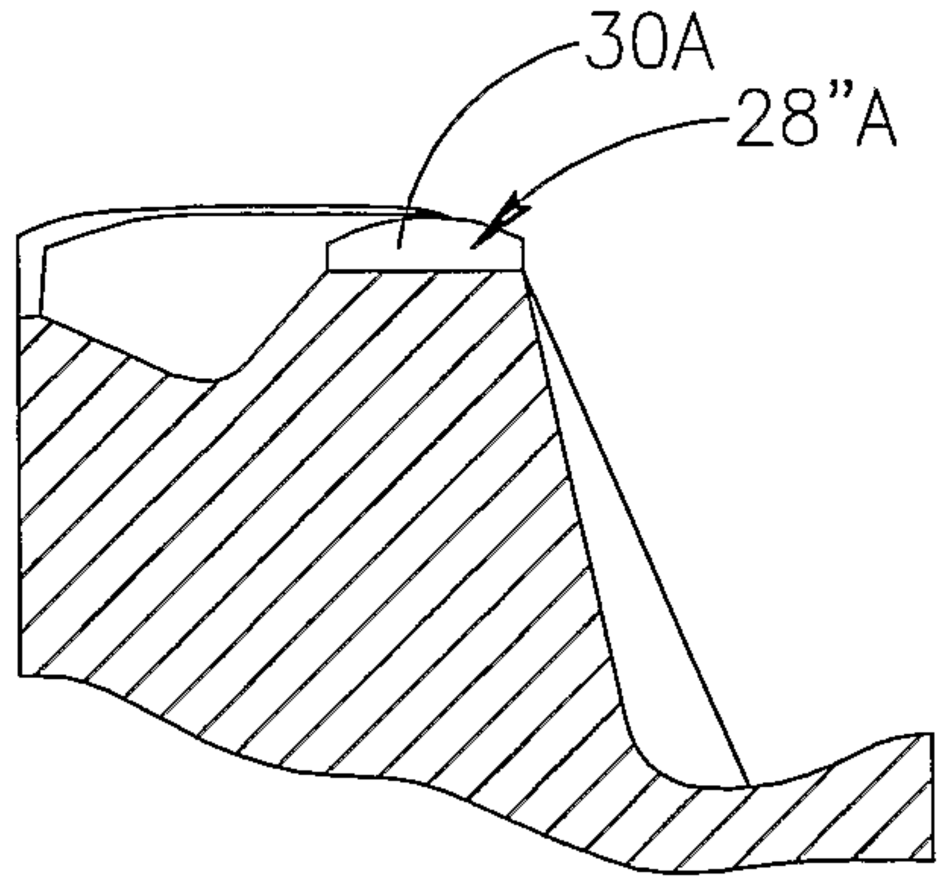


FIG.16A

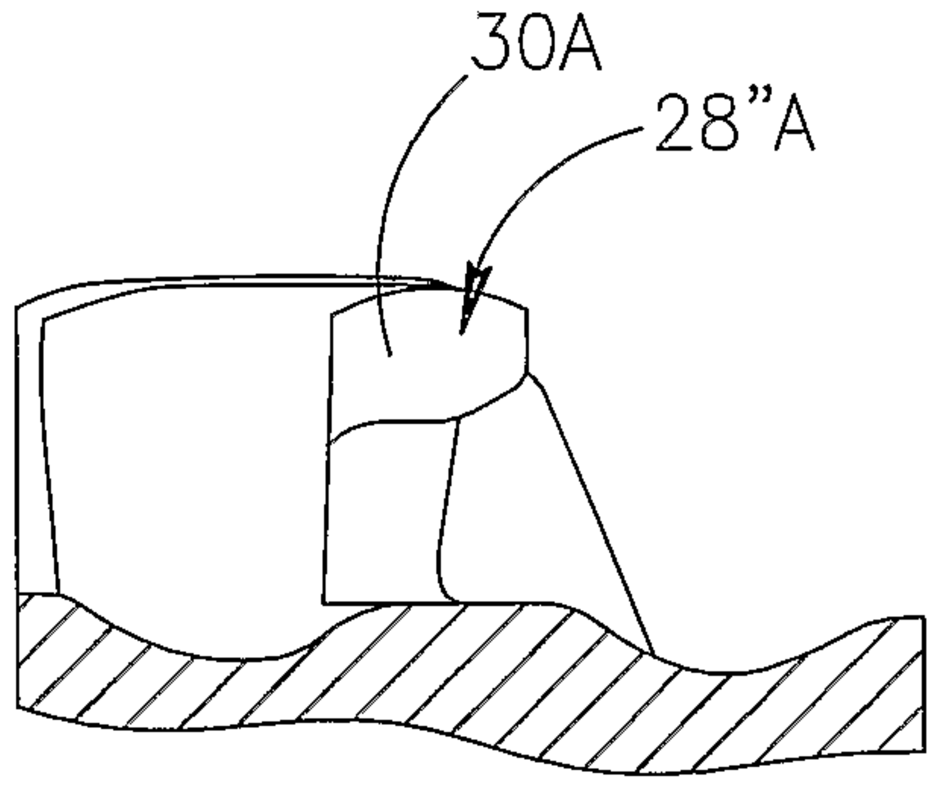


FIG.16B

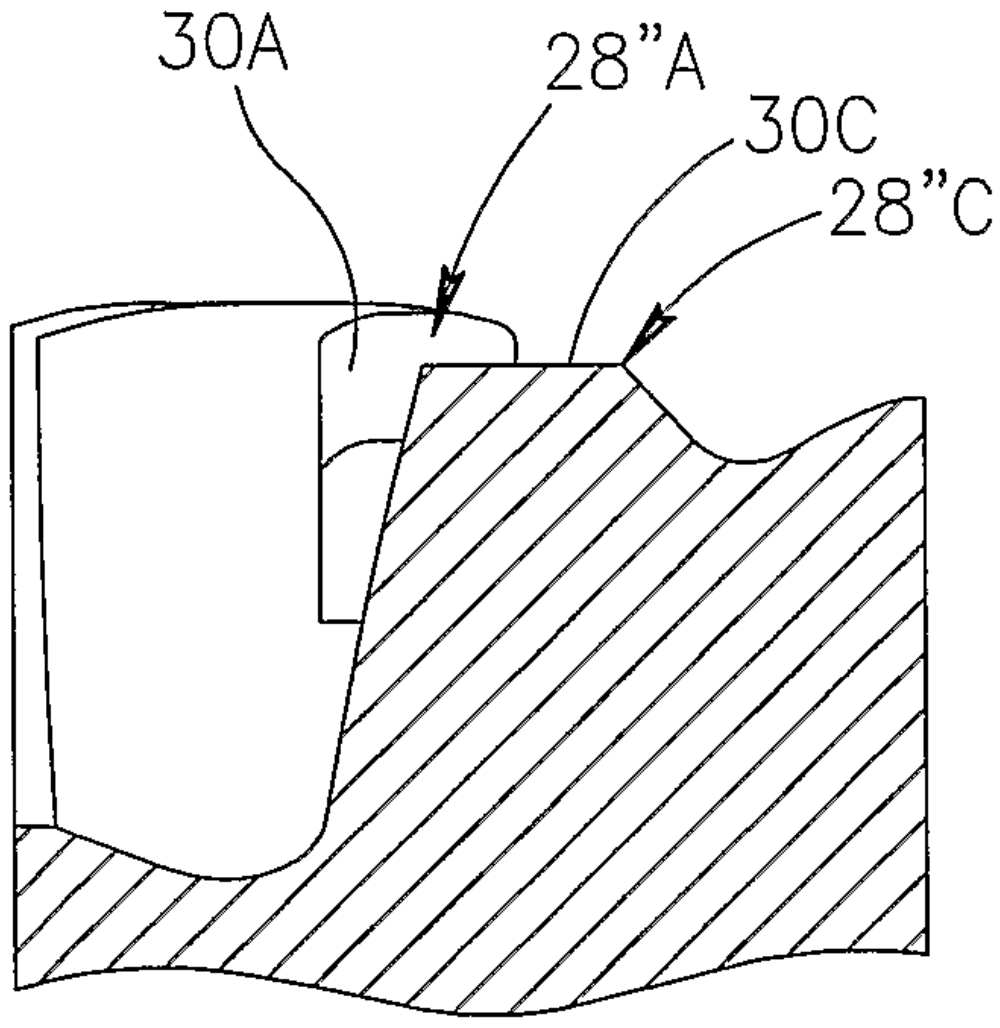
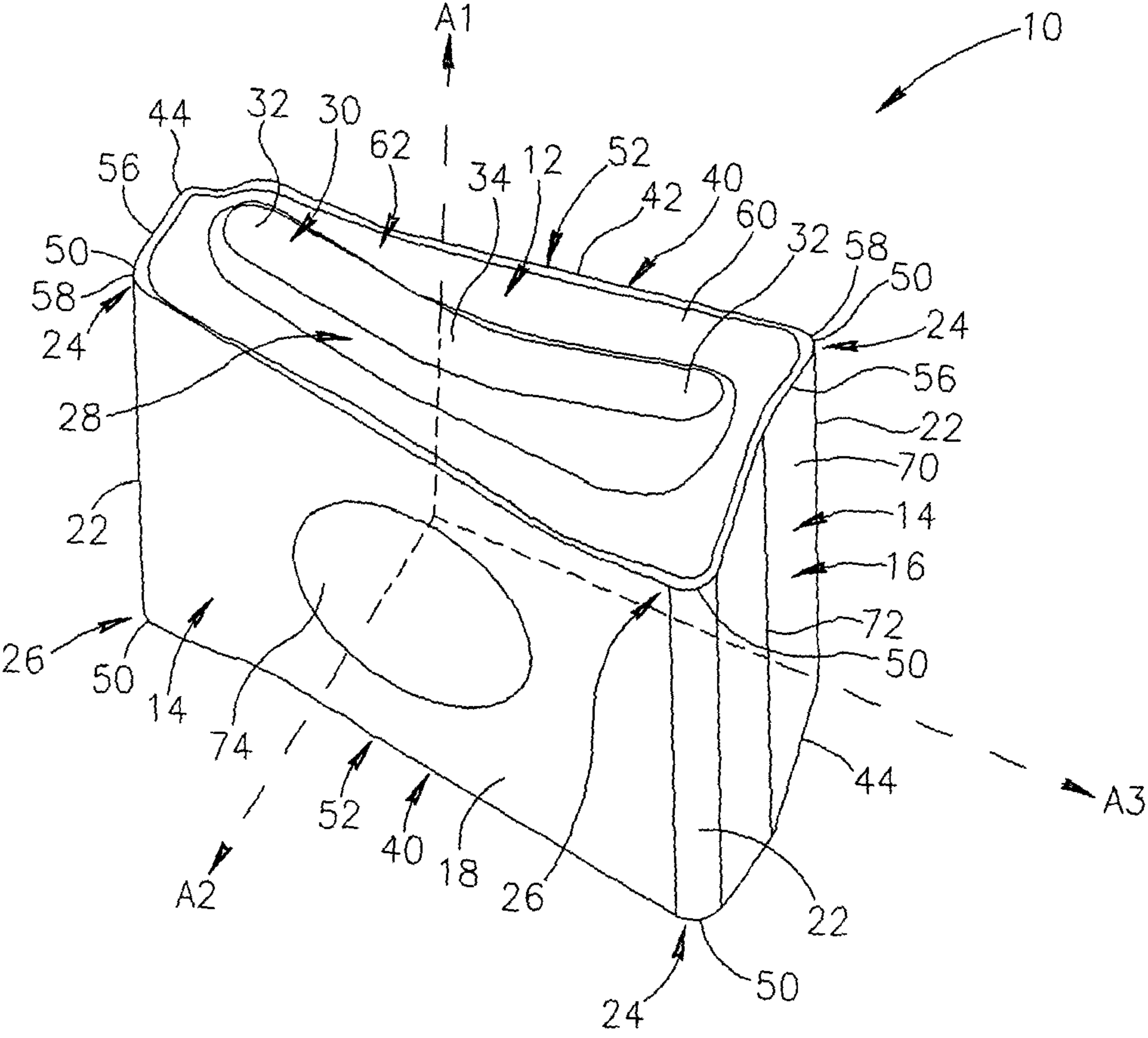


FIG.16C


A1
10
44
32
30
62
56
34
12
52
42
40
60
32
58
50
50
58
24
24
56
28
22
70
22
14
16
72
26
50
50
14
74
44
A3
52
40
18
26
22
A2
50
24