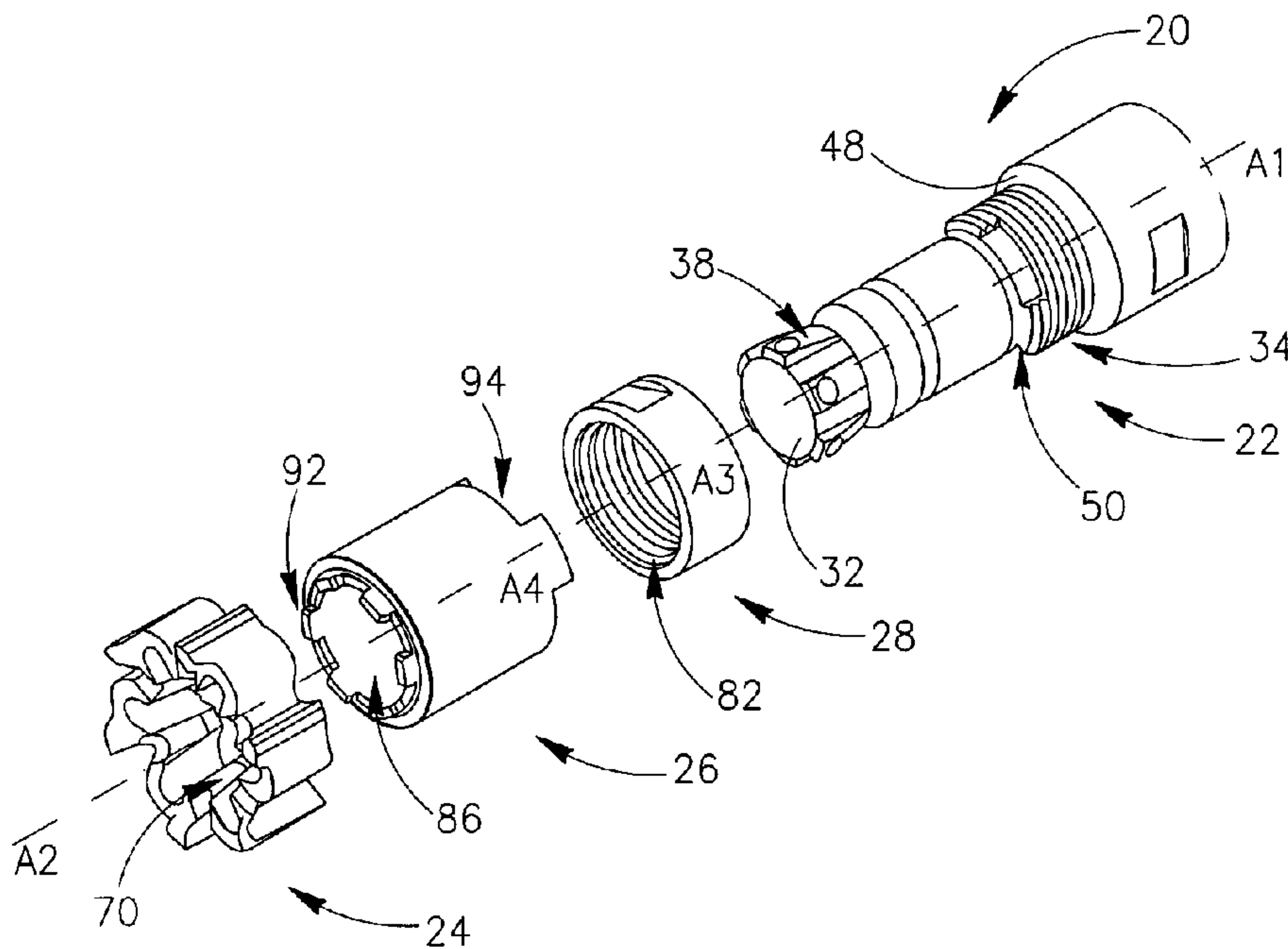




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(57) **Abrégé/Abstract:**

A rotary cutting tool (20) for reaming operations, including a generally cylindrically shaped tool shank (22) with a longitudinal axis (A1) having a plurality of radially protruding and generally axially extending clamping wings (38), and a cylindrically shaped cutting head (24) having a central bore (58) and a plurality of axially extending cutting edges (62) with an outer cutting diameter (D). The central bore (58) has a plurality of circumferentially and alternately spaced bore sectors (70) and bore recesses (72), where each bore sector (70) has an outwardly inclined female clamping surface (74) in clamping contact with an outwardly inclined male clamping surface (40) of each clamping wing (38). A cylindrical shaped locking sleeve (26) and a cylindrical shaped clamping nut (28) assembled to the tool shank (22) provide a means to adjust the clamping contact forces and the cutting diameter (D) of the cutting head (24), and also enable removal and replacement of the cutting head without removal of the locking sleeve (26) and clamping nut (28).

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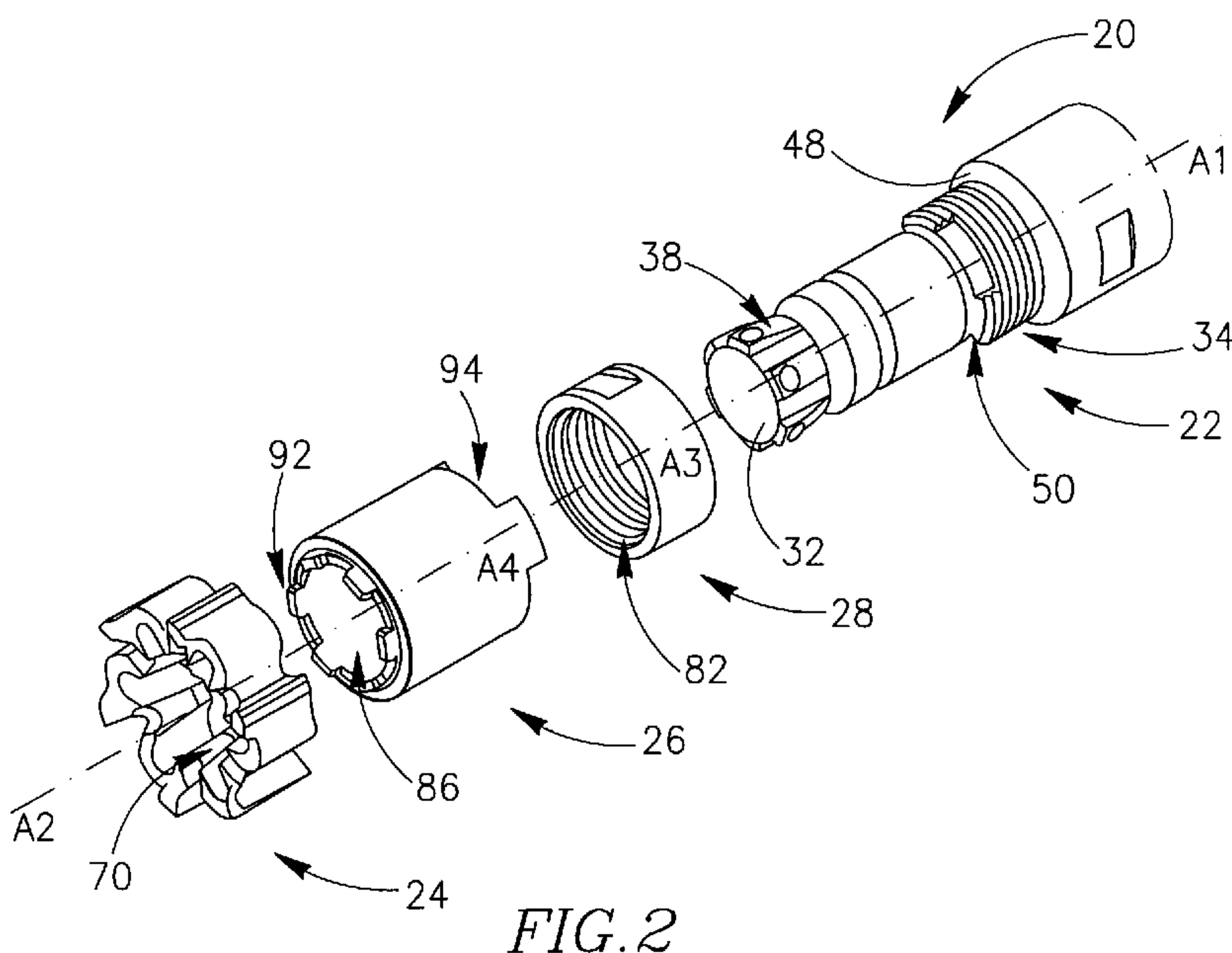
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(57) Abstract: A rotary cutting tool (20) for reaming operations, including a generally cylindrically shaped tool shank (22) with a longitudinal axis (A1) having a plurality of radially protruding and generally axially extending clamping wings (38), and a cylindrically shaped cutting head (24) having a central bore (58) and a plurality of axially extending cutting edges (62) with an outer cutting diameter (D). The central bore (58) has a plurality of circumferentially and alternately spaced bore sectors (70) and bore recesses (72), where each bore sector (70) has an outwardly inclined female clamping surface (74) in clamping contact with an outwardly inclined male clamping surface (40) of each clamping wing (38). A cylindrical shaped locking sleeve (26) and a cylindrical shaped clamping nut (28) assembled to the tool shank (22) provide a means to adjust the clamping contact forces and the cutting diameter (D) of the cutting head (24), and also enable removal and replacement of the cutting head without removal of the locking sleeve (26) and clamping nut (28).

ROTARY CUTTING TOOL

FIELD OF THE INVENTION

The present invention relates to a rotary cutting tool for use in metal cutting processes in general, and for reaming operations in particular.

5 BACKGROUND OF THE INVENTION

Within the field of rotary cutting tools for reaming operations of a metal workpiece, the rotary cutting tools may be configured in many different ways.

US 4,705,435 discloses an adjustable reamer with a cutter head integral to the shank with coolant outlet channels directing coolant fluid to the leading edges. A conical
10 head of a conical screw engaged within the threaded shank expands the cutter head.

US 5,163,790 discloses an adjustable reamer with an interchangeable cutting head and a coolant feed supplying the cutter head from outside nozzles, having a clamping bolt with a conical head screwed into the reamer shank securing and expanding the cutting
head.

15 US 7,004,692 discloses a reamer having a tool shank, a screw member remaining within the tool shank during normal operations, and a replaceable cutting head having a fixed cutting diameter. Coolant channels within the screw member direct coolant fluid to the cutting edges of the cutting head.

It is an object of the present invention to provide an improved rotary cutting tool.

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SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a rotary cutting tool comprising a tool shank, a cutting head, a locking sleeve and a clamping nut:

the tool shank comprising a longitudinal axis extending in a forward to rearward direction having a cutting head receiving portion adjacent a tool shank forward end surface and a male threaded portion rearward of the cutting head receiving portion,

the cutting head receiving portion comprising a plurality of radially protruding and generally axially extending clamping wings, each clamping wing having a male clamping surface outwardly inclined in the forward direction;

the cutting head comprising a central bore having a central bore axis coaxial with the longitudinal axis and a peripheral outer surface having a plurality of cutting edges, with an outer cutting diameter, axially extending between a cutting head rearward end surface and a cutting head forward end surface,

the central bore comprising a plurality of generally axially extending bore sectors, each bore sector having a female clamping surface outwardly inclined in a direction towards the cutting head forward end surface;

the locking sleeve having a cylindrical shape with a through bore between a locking sleeve rearward end surface and a locking sleeve forward end surface; and

the clamping nut having a threaded bore between a clamping nut forward and rearward end surface,

wherein the threaded bore of the clamping nut is in threaded engagement with the male threaded portion of the tool shank, the locking sleeve rearward end surface is in clamping contact with the clamping nut forward end surface, the locking sleeve forward end surface is in clamping contact with the cutting head rearward end surface, and the plurality of female clamping surfaces are in clamping contact with the plurality of male clamping surfaces,

and wherein the clamping contact forces and the cutting diameter can be increased and decreased by adjusting the rotational position of the clamping nut, and the cutting head can be removed and replaced following rotation of the clamping nut without removing either the locking sleeve or the clamping nut from the tool shank.

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 chain-dash lines represent cut-off boundaries for partial views of a member and in which:

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Fig. 1 is a perspective view of a rotary cutting tool in accordance with the present invention;

Fig. 2 is an exploded perspective view of the rotary cutting tool shown in Fig. 1;

10 **Fig. 3** is a longitudinal side view of a tool shank in accordance with the present invention;

Fig. 4 is a forward end view of the tool shank shown in Fig. 3;

Fig. 5 is a forward end view of a cutting head in accordance with the present invention;

15 **Fig. 6** is a cross-sectional view of the cutting head shown in Fig. 5 taken along the line VI-VI;

Fig. 7 is a forward end view of a locking sleeve in accordance with the present invention;

Fig. 8 is a cross-sectional view of the locking sleeve shown in Fig. 7 taken along the line VIII-VIII;

20 **Fig. 9** is a longitudinal cross-sectional side view of the rotary cutting tool shown in Fig. 1;

Fig. 10 is a cross-sectional view of the rotary cutting tool shown in Fig. 9 taken along the line X-X; and

Fig. 11 is a forward end view of the rotary cutting tool shown in Fig. 9.

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DETAILED DESCRIPTION OF THE INVENTION

Attention is first drawn to Figs. 1 and 2, showing a rotary cutting tool **20** in accordance with the present invention. The rotary cutting tool **20** is in the form of an

expandable reamer including a tool shank **22**, a cutting head **24**, a locking sleeve **26** and a clamping nut **28**. The tool shank **22**, locking sleeve **26** and clamping nut **28** are typically manufactured from machined steel, and the cutting head **24** of the present invention may be manufactured by form pressing and sintering a carbide powder such as Tungsten
5 Carbide.

The tool shank **22**, as shown Figs. 3 and 4, is generally cylindrically shaped with a longitudinal axis **A1** extending in a forward to rearward direction **F**, **R**, having a cutting head receiving portion **30** adjacent a tool shank forward end surface **32** and a male threaded portion **34** rearward of the cutting head receiving portion **30**.

10 The cutting head receiving portion **30** has six generally planar cutting head receiving surfaces **36** circumferentially equally spaced about the longitudinal axis **A1** alternating with six radially protruding and generally axially extending clamping wings **38** circumferentially equally spaced about the longitudinal axis **A1**, where an imaginary circle **C** circumscribed in a plane perpendicular to the longitudinal axis **A1** through
15 twelve lines of intersection between the six cutting head receiving surfaces **36** and the six clamping wings **38** has a receiving surface first radius **R1**. In some embodiments of the present invention, the six cutting head receiving surfaces **36** may be parallel to the longitudinal axis **A1**. Each clamping wing **38** has a male clamping surface **40** outwardly inclined in the forward direction **F** intersecting a partially cylindrical outer wing surface
20 **42** adjacent the shank forward end surface **32** with a clamping wing second radius **R2**. The male clamping surface **40** forms an acute internal first inclination angle $\delta 1$ with the longitudinal axis **A1**.

It should be appreciated that throughout the detailed description and claims, an 'internal angle' refers to an angle between two features as measured internally, whereas an
25 'external angle' refers to an angle between two features as measured externally.

The six clamping wings **38** have a clamping wing first pitch angle $\alpha 1$ equal to 60° , where each clamping wing **38** includes circumferentially delimiting leading and trailing wing surfaces **44**, **46** transverse to the adjacent outer wing surface **42** having a clamping

wing first angular extent **E1** between a first wing edge **45** and a second wing edge **47**. The first wing edge **45** is formed at the intersection of the leading wing surface **44** and the outer wing surface **42**, and the second wing edge **47** is formed at the intersection of the trailing wing surface **46** and the outer wing surface **42**. The terms "leading surfaces" and "trailing surfaces" are used to indicate counter-clockwise rotation of the tool shank **22** during operation of the rotary cutting tool **20** when viewed in the direction of the tool shank forward end surface **32**.

For other embodiments of the present invention, the "leading surfaces" and the "trailing surfaces" may be reversed to indicate clockwise rotation of the tool shank **22** during operation of the rotary cutting tool **20** when viewed in the direction of the tool shank forward end surface **32**, where for these embodiments the direction of rotation of other elements of the rotary cutting tool **20** are correspondingly reversed.

The male threaded portion **34** rearward of the cutting head receiving portion **30** extends in the forward direction **F** from an annular base surface **48** and includes three axially extending locking protrusions **50** further extending in the forward direction **F**, each locking protrusion **50** having a forward locking protrusion surface **52**. The three locking protrusions **50** are circumferentially equally spaced with a locking protrusion second pitch angle α_2 equal to 120° , where each locking protrusion **50** includes radially extending and circumferentially delimiting first and second locking protrusion surfaces **54**, **56** having a locking protrusion second angular extent **E2**.

The cutting head **24**, as shown in Figs. 5 and 6, has a central bore **58** and a peripheral outer surface **60** including six cutting edges **62** extending axially between a cutting head rearward end surface **64** and a cutting head forward end surface **66** having an outer cutting diameter **D**. Each cutting edge **62** has an adjacent rake surface **68** transverse to the peripheral outer surface **60** and generally facing in a counter-clockwise direction when viewed in the direction of the cutting head forward surface **66**.

The central bore **58** has six circumferentially equally spaced and generally axially extending bore sectors **70** alternating with six circumferentially equally spaced and

axially extending bore recesses 72, the bore sectors 70 and bore recesses 72 each having a bore recess third pitch angle α_3 equal to the clamping wing first pitch angle α_1 ; 60°. Each bore sector 70 has a female clamping surface 74 outwardly inclined in a direction towards the cutting head forward end surface 66 intersecting an axially extending bore sector surface 76 adjacent the cutting head rearward end surface 64 with a bore sector third radius R3. The female clamping surface 74 forms an acute external second inclination angle δ_2 with a central bore axis A2. Each bore recess 72 includes circumferentially delimiting first and second bore recess surfaces 78, 80 transverse to the adjacent bore sector surface 76 having a bore recess third angular extent E3 between a first bore recess edge 79 and a second bore recess edge 81. The first bore recess edge 79 is formed at the intersection of the first bore recess surface 78 and its adjacent bore sector surface 76, and the second bore recess edge 81 is formed at the intersection of the second bore recess surface 80 and its own adjacent bore sector surface 76.

The clamping nut 28, as shown Figs. 2 and 9, has a cylindrical shape with a threaded bore 82 between a clamping nut forward end surface 84a and a clamping nut rearward end surface 84b, the clamping nut 28 having mirror symmetry about a central plane P perpendicular to a threaded bore axis A3.

The locking sleeve 26, as shown Figs. 7 and 8, has a cylindrical shape with a through bore 86 between a locking sleeve rearward end surface 88 and a locking sleeve forward end surface 90. The locking sleeve forward end surface 90 has six circumferentially equally spaced and axially extending alignment protrusions 92 with an alignment protrusion fourth pitch angle α_4 equal to the clamping wing first pitch angle α_1 ; 60°, and the locking sleeve rearward end surface 88 has three circumferentially equally spaced and axially extending locking slots 94 with a locking slot fifth pitch angle α_5 equal to the locking protrusion second pitch angle α_2 ; 120°.

Each alignment protrusion 92 includes circumferentially delimiting first and second alignment protrusion surfaces 96, 98 transverse to an adjacent through bore surface 87 having an alignment protrusion fourth angular extent E4 between a first

alignment protrusion edge **97** and a second alignment protrusion edge **99**. The first alignment protrusion edge **97** is formed at the intersection of the first alignment protrusion surface **96** and the through bore surface **87**, and the second alignment protrusion edge **99** is formed at the intersection of the second alignment protrusion surface **98** and the through bore surface **87**.

Each locking slot **94** includes circumferentially delimiting and radially extending first and second locking slot surfaces **100**, **102** having a locking slot fifth angular extent **E5**. Each locking slot **94** also includes a rearward locking slot surface **104** perpendicular to a through bore axis **A4**.

Attention is now drawn to Figs. 9 to 11 showing the rotary cutting tool **20**, where initial assembly is performed in the following four steps:-

In a first assembly step, the clamping nut **28** is positioned adjacent the tool shank forward end surface **32** with the threaded bore axis **A3** approximately co-axial with the longitudinal axis **A1**. Then, the tool shank **22** is inserted into the threaded bore **82** of the clamping nut **28** until the male threaded portion **34** engages the threaded bore **82**, and the clamping nut **28** is rotated in a counter-clockwise direction when viewed from the tool shank front surface **32** until the clamping nut rearward end surface **84b** is in contact with the annular base surface **48**.

In a second assembly step, the locking sleeve rearward end surface **88** is positioned adjacent the tool shank forward end surface **32** with the through bore axis **A4** approximately co-axial with the longitudinal axis **A1**. The tool shank **22** is then inserted into the through bore **86** of the locking sleeve **26** until the three locking protrusions **50** of the tool shank **22** are engaged with the three locking slots **94** of the locking sleeve **26** and each forward locking protrusion surface **52** is in contact with each rearward locking slot surface **104**. Then, the locking sleeve **26** is rotated in a counter-clockwise direction when viewed from the tool shank front end surface **32** until the three first locking slot surfaces **100** are in abutment with the three first locking protrusion surfaces **54** and the six

alignment protrusions **92** of the locking sleeve **26** are circumferentially aligned with the six clamping wings **38** of the tool shank **22**.

In a third assembly step, the cutting head rearward end surface **64** is initially positioned adjacent the tool shank forward end surface **32** with the central bore axis **A2** approximately co-axial with the longitudinal axis **A1**, and the cutting head **24** is rotationally oriented until the six bore recesses **72** are circumferentially aligned with the six clamping wings **38**. Then, the tool shank **22** is inserted into the central bore **58** of the cutting head **24** until the six alignment protrusions **92** of the locking sleeve **26** engage with the six bore recesses **72** of the cutting head **24** and the cutting head rearward end surface **64** is in contact with the locking sleeve forward end surface **90**, and the six bore sector surfaces **76** of the six bore sectors **70** of the cutting head **24** are rearward of the cutting head receiving portion **30** of the tool shank **22**. The locking sleeve **26** and the cutting head **24** are then simultaneously rotated in a clockwise direction when viewed from the tool shank front end surface **32** until the three second locking slot surfaces **102** of the locking sleeve **26** are in abutment with the three second locking protrusion surfaces **56** of the tool shank **22** and the six bore sectors **70** of the cutting head **24** are circumferentially aligned with the six clamping wings **38** of the tool shank **22**.

It should be appreciated in the third assembly step that in order to insert the tool shank **22** into the central bore **58** of the cutting head **24** and engage the six alignment protrusions **92** with the six bore recesses **72**, the bore recess third angular extent **E3** must be greater than the clamping wing first angular extent **E1**, ($E3 > E1$) and also greater than the alignment protrusion fourth angular extent **E4**, ($E3 > E4$), and the bore sector third radius **R3** must be greater than the receiving surface first radius **R1**, ($R3 > R1$).

It should also be appreciated during the third assembly step that the extent of angular rotation of the locking sleeve **26** from a position where the three first locking slot surfaces **100** are in abutment with the three first locking protrusion surfaces **54** to a position where the three second locking slot surfaces **102** are in abutment with the three second locking protrusion surfaces **56** is equal to the difference in angular extent between

the locking slot fifth angular extent **E5** and the locking protrusion second angular extent **E2**; **E5-E2**, and the simultaneous rotation of the cutting head **24** from a position where the six bore recesses **72** are circumferentially aligned with the six clamping wings **38** to a position where the six bore sectors **70** are circumferentially aligned with the six clamping wings **38** is equal to half the clamping wing pitch first angle α_1 ; $\alpha_1/2$, where **E5-E2** is equal to $\alpha_1/2$ and has a value of 30° .

In a fourth assembly step, the clamping nut **28** is rotated in a clockwise direction when viewed from the tool shank front end surface **32** until the clamping nut forward end surface **84a** is in clamping contact with the locking sleeve rearward end surface **88**, the locking sleeve forward end surface **90** is in clamping contact with the cutting head rearward end surface **64** and the female clamping surfaces **74** of the six bore sectors **70** are in clamping contact with the male clamping surfaces **40** of the six clamping wings **38**. The acute internal first inclination angle δ_1 of the male clamping surfaces **40** with the longitudinal axis **A1** is equal to the acute external second inclination angle δ_2 of the female clamping surfaces **74** with the central bore axis **A2**, within a manufacturing tolerance of 1° .

It should be appreciated in the fourth assembly step that in order to achieve clamping contact between the female clamping surfaces **74** of the six bore sectors **70** and the male clamping surfaces **40** of the six clamping wings **38**, the bore sector third radius **R3** must be less than the clamping wing second radius **R2**, ($R3 < R2$).

The rotary cutting tool **20** of the present invention may have a cutting head **24** constructed such that the cutting diameter **D** can be adjusted by increasing or decreasing the radial components of the clamping forces between the female clamping surfaces **74** of the six bore sectors **70** and the male clamping surfaces **40** of the six clamping wings **38**, and thus may be referred to as an expandable reamer. Rotation of the clamping nut **28** in a clockwise direction when viewed from the tool shank front end surface **32** increases the radial clamping forces and the cutting diameter **D**, and rotation of the clamping nut **28** in

a counter-clockwise direction when viewed from the tool shank front end surface **32** decreases the radial clamping forces and the cutting diameter **D**.

The rotary cutting tool **20** of the present invention may also be configured for directing coolant fluid to each of the six cutting edges **62** by including six minor diameter coolant bores **106** within the cutting head receiving portion **30** of the tool shank **22**, each
5 minor diameter coolant bore **106** radially extending from a major diameter coolant bore **108** co-axial with the longitudinal axis **A1** to the outer wing surface **42** of each clamping wing **38**.

It should be appreciated that the four assembly steps described above are required
10 for initial assembly of the rotary cutting tool **20** only, where following initial assembly the clamping nut **28** and locking sleeve **26** are not required to be removed when removing and replacing the cutting head **24**.

Removal and replacement of the cutting head **24** following normal operation of the rotary cutting tool **20** is performed in the following steps:

15 In a first cutting head replacement step, the clamping nut **28** is rotated in a counter-clockwise direction when viewed from the tool shank front surface **32** until the clamping nut rearward end surface **84b** is in contact with the annular base surface **48**.

In a second cutting head replacement step, the locking sleeve **26** and the cutting head **24** are simultaneously rotated in a counter-clockwise direction when viewed from
20 the tool shank front end surface **32** until the three first locking slot surfaces **100** are in abutment with the three first locking protrusion surfaces **54** and the six bore recesses **72** are circumferentially aligned with the six clamping wings **38**, after which the cutting head **24** can then be removed.

The third and fourth cutting head replacement steps are a repeat of the third and
25 fourth assembly steps described above for initial assembly of the rotary cutting tool **20**.

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 spirit or scope of the invention as hereinafter claimed.

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CLAIMS

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What is claimed is:

1. A rotary cutting tool (20) comprising a tool shank (22), a cutting head (24), a locking sleeve (26) and a clamping nut (28):

the tool shank (22) comprising a longitudinal axis (A1) extending in a forward to rearward direction (F, R) having a cutting head receiving portion (30) adjacent a tool shank forward end surface (32) and a male threaded portion (34) rearward of the cutting head receiving portion (30),

the cutting head receiving portion (30) comprising a plurality of radially protruding and generally axially extending clamping wings (38), each clamping wing (38) having a male clamping surface (40) outwardly inclined in the forward direction (F), and the male threaded portion (34) including a plurality of axially extending locking protrusions (50);

the cutting head (24) comprising a central bore (58) having a central bore axis (A2) coaxial with the longitudinal axis (A1) and a peripheral outer surface (60) having a plurality of cutting edges (62), with an outer cutting diameter D, axially extending between a cutting head rearward end surface (64) and a cutting head forward end surface (66),

the central bore (58) comprising a plurality of generally axially extending bore sectors (70) and a plurality of axially extending bore recesses (72), each bore sector (70) having a female clamping surface (74) outwardly inclined in a direction towards the cutting head forward end surface (66);

the locking sleeve (26) having a cylindrical shape with a through bore (86) between a locking sleeve rearward end surface (88) and a locking sleeve forward end surface (90), the locking sleeve forward end surface (90) having a plurality of alignment protrusions (92) and the locking sleeve rearward end surface (88) having a plurality of locking slots (94); and

the clamping nut (28) having a threaded bore (82) between a clamping nut forward and rearward end surface (84a, 84b),

wherein the threaded bore (82) of the clamping nut (28) is in threaded engagement with the male threaded portion (34) of the tool shank (22), the locking sleeve rearward end surface (88) is in clamping contact with the clamping nut forward end surface (84a), the locking sleeve forward end surface (90) is in clamping contact with the cutting head rearward end surface (64), and the plurality of female clamping surfaces (74) are in clamping contact with the plurality of male clamping surfaces (40),

wherein the clamping contact forces and the cutting diameter D can be increased and decreased by adjusting the rotational position of the clamping nut (28), and the cutting head (24) can be removed and replaced following rotation of the clamping nut (28) without removing either the locking sleeve (26) or the clamping nut (28) from the tool shank (22),

and wherein the plurality of locking protrusions (50) are engaged with the plurality of locking slots (94) and the plurality of alignment protrusions (92) are engaged with the plurality of bore recesses (72).

2. The rotary cutting tool (20) according to claim 1, wherein the plurality of clamping wings (38), the plurality of bore recesses (72) and the plurality of alignment protrusions (92) are circumferentially equally spaced having a clamping wing first pitch angle α_1 , a bore recess third pitch angle α_3 and an alignment protrusion fourth pitch angle α_4 , respectively,

and wherein the first pitch angle α_1 , the third pitch angle α_3 and the fourth pitch angle α_4 are equal.

3. The rotary cutting tool (20) according to claim 2, wherein the plurality of locking protrusions (50) and locking slots (94) are circumferentially equally spaced having a

locking protrusion second pitch angle α_2 and a locking slot fifth pitch angle α_5 , respectively,

and wherein the second pitch angle α_2 and the fifth pitch angle α_5 are equal.

4. The rotary cutting tool (20) according to claim 2, wherein:

each of the plurality of locking slots (94) comprises circumferentially delimiting and radially extending first and second locking slot surfaces (100, 102) having a locking slot fifth angular extent E_5 , and

each of the plurality of locking protrusions (50) comprises circumferentially delimiting and radially extending first and second locking protrusion surfaces (54, 56) having a locking protrusion second angular extent E_2 ,

and wherein:

the fifth angular extent E_5 is greater than the second angular extent E_2 , and

the difference in angular extent between the second angular extent E_2 and the fifth angular extent E_5 ; $E_5 - E_2$ is equal to half of the first pitch angle α_1 ; $\alpha_1/2$.

5. The rotary cutting tool (20) according to claim 3, comprising six clamping wings (38), six bore recesses (72) and six alignment protrusions (92), having first pitch angles α_1 , third pitch angles α_3 and fourth pitch angles α_4 , respectively, equal to 60° ,

and comprising three locking protrusions (50) and three locking slots (94), having second pitch angles α_2 and fifth pitch angles α_5 , respectively, equal to 120° .

6. The rotary cutting tool (20) according to claim 1, wherein:

each of the plurality of clamping wings (38) includes a partially cylindrical extending outer wing surface (42) adjacent the tool shank forward end surface (32) having a clamping wing second radius R_2 , and

each of the plurality of bore sectors (70) includes an axially extending bore sector surface (76) adjacent the cutting head rearward end surface (64) having a bore sector third radius R_3 ,

and wherein the second radius R2 is greater than the third radius R3.

7. The rotary cutting tool (20) according to claim 6, wherein:
the cutting head receiving portion (30) has a plurality of generally planar cutting head receiving surfaces (36) circumferentially equally spaced about the longitudinal axis (A1) alternating with the plurality of clamping wings (38), and
an imaginary circle (C) circumscribed through lines of intersection between the plurality of cutting head receiving surfaces (36) and the plurality of clamping wings (38) has a receiving surface first radius R1,
and wherein the third radius R3 is greater than the first radius R1.
8. The rotary cutting tool (20) according to claim 6, wherein:
each of the plurality of bore recesses (72) comprises circumferentially delimiting first and second bore recess surfaces (78, 80) transverse to the adjacent bore sector surface (76) having a bore recess third angular extent E3,
each of the plurality of clamping wings (38) comprises circumferentially delimiting leading and trailing wing surfaces (44, 46) transverse to the adjacent outer wing surface (42) having a clamping wing first angular extent E1, and
each of the plurality of alignment protrusions (92) comprises circumferentially delimiting first and second alignment protrusion surfaces (96, 98) transverse to the adjacent through bore surface (86) having an alignment protrusion fourth angular extent E4,
and wherein the third angular extent E3 is greater than the first angular extent E1, and the third angular extent E3 is greater than the fourth angular extent E4.
9. The rotary cutting tool (20) according to claim 6, wherein a minor diameter coolant bore (106) radially extends from a major diameter coolant bore (108) co-axial with the longitudinal axis (A1) to the outer wing surface (42) of each clamping wing (38).

10. The rotary cutting tool (20) according to claim 1, wherein an acute internal first inclination angle δ_1 formed between the plurality of male clamping surfaces (40) and the longitudinal axis (A1) is substantially equal to an acute external second inclination angle δ_2 formed between the plurality of female clamping surfaces (74) and the central bore axis (A2).
11. The rotary cutting tool (20) according to claim 1, wherein the rotary cutting tool (20) is an expandable reamer.
12. The rotary cutting tool (20) according to claim 1 wherein the cutting head (24) is manufactured from cemented carbide.
13. A method of assembling the rotary cutting tool (20) of claim 1, comprising:
positioning the threaded bore (82) of the clamping nut (28) approximately co-axially with the longitudinal axis (A1) before engaging the male threaded portion (34) of the tool shank (22) with the threaded bore (82) and rotating the clamping nut (28) in a counter-clockwise direction when viewed from the tool shank front end surface (32),
positioning the through bore (86) of the locking sleeve (26) co-axially with the longitudinal axis (A1) before engaging the plurality of locking protrusions (50) with the plurality of locking slots (94) and rotating the locking sleeve (26) in a counter-clockwise direction when viewed from the tool shank front end surface (32) until the plurality of alignment protrusions (92) are circumferentially aligned with the plurality of clamping wings (38),
positioning the central bore (58) of the cutting head (24) co-axially with the longitudinal axis (A1) before engaging the plurality of bore recesses (72) with the plurality of clamping wings (38) and the plurality of alignment protrusions (92), and rotating the cutting head (24) in a clockwise direction when viewed from the tool shank front end surface (32) until the plurality of bore sectors (70) are aligned with the plurality of clamping wings (38),

and

rotating the clamping nut (28) in a clockwise direction when viewed from the tool shank front end surface (32) until clamping contact is made between:

the clamping nut forward end surface (84a) and the locking sleeve rearward end surface (88),

the locking sleeve forward end surface (90) and the cutting head rearward end surface (64), and

the plurality of female clamping surfaces (74) and the plurality of male clamping surfaces (40).

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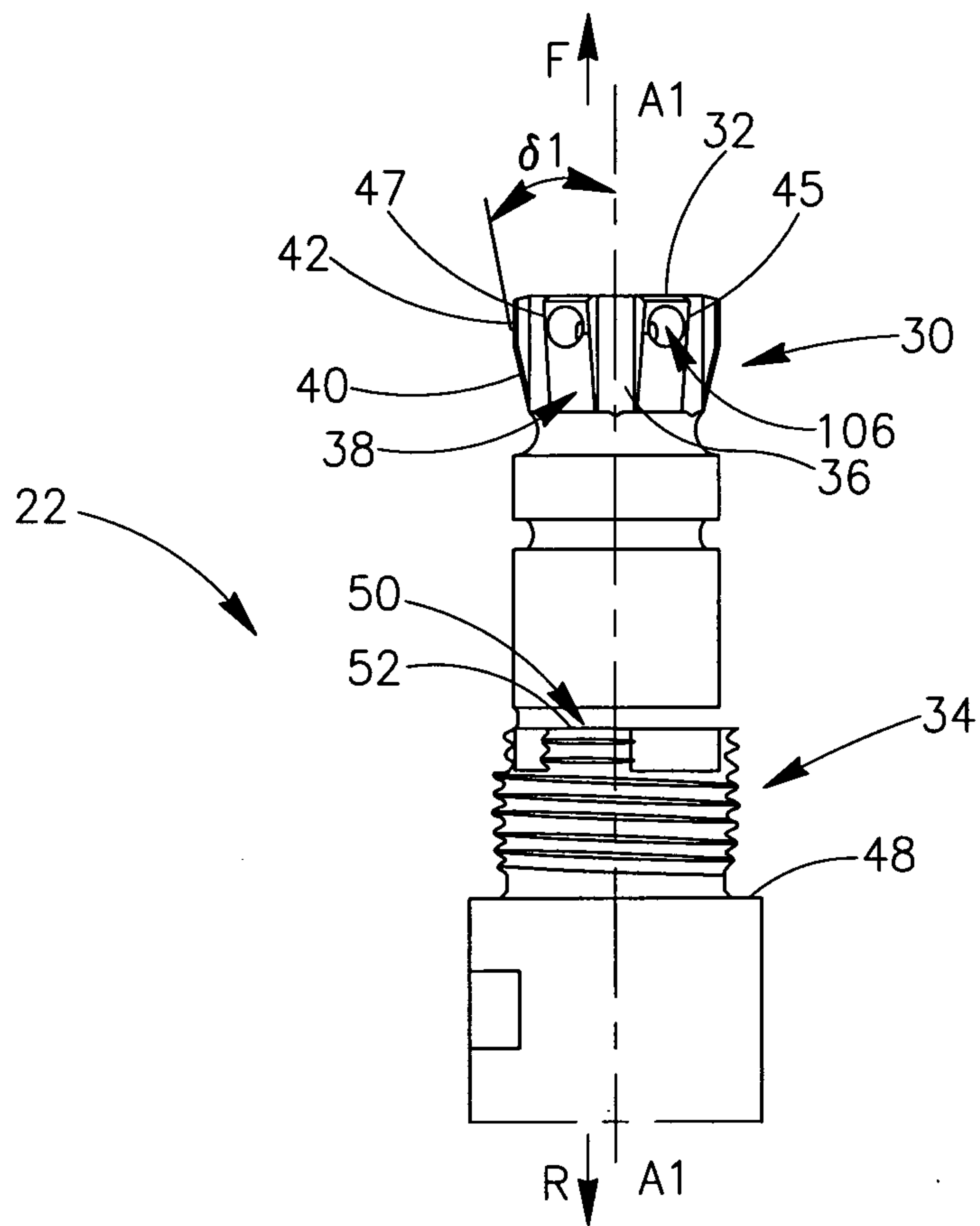


FIG. 3

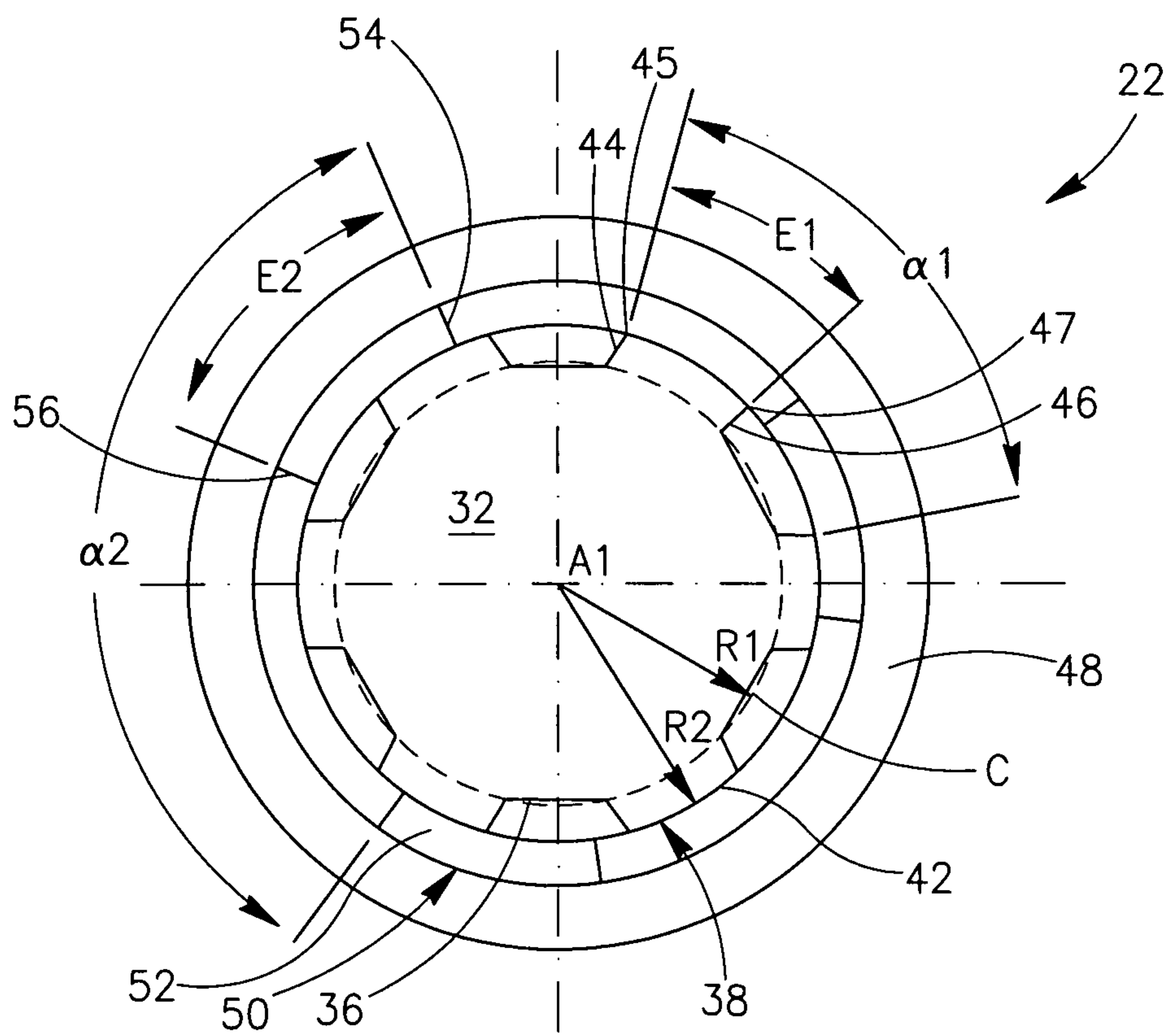


FIG. 4

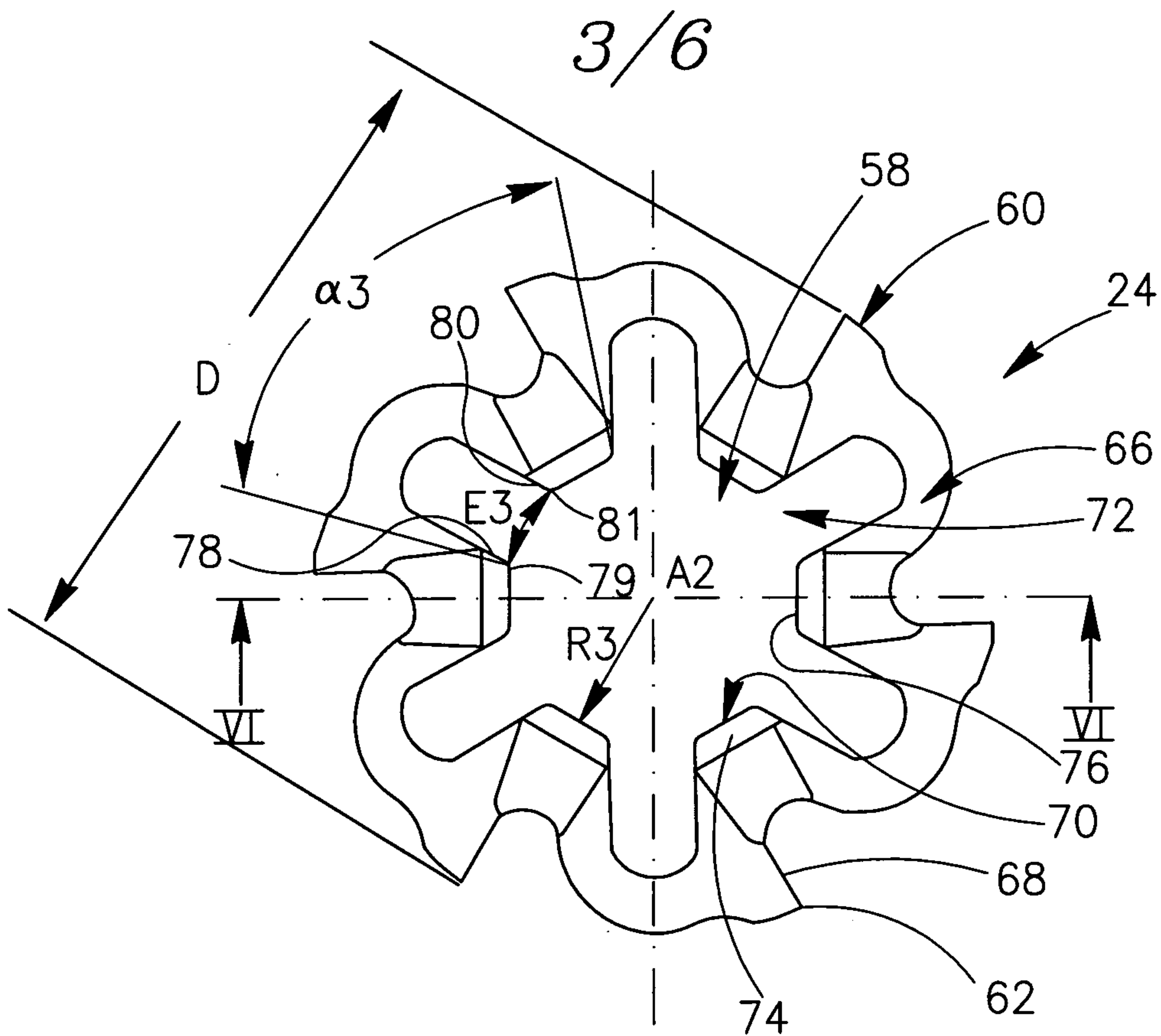


FIG. 5

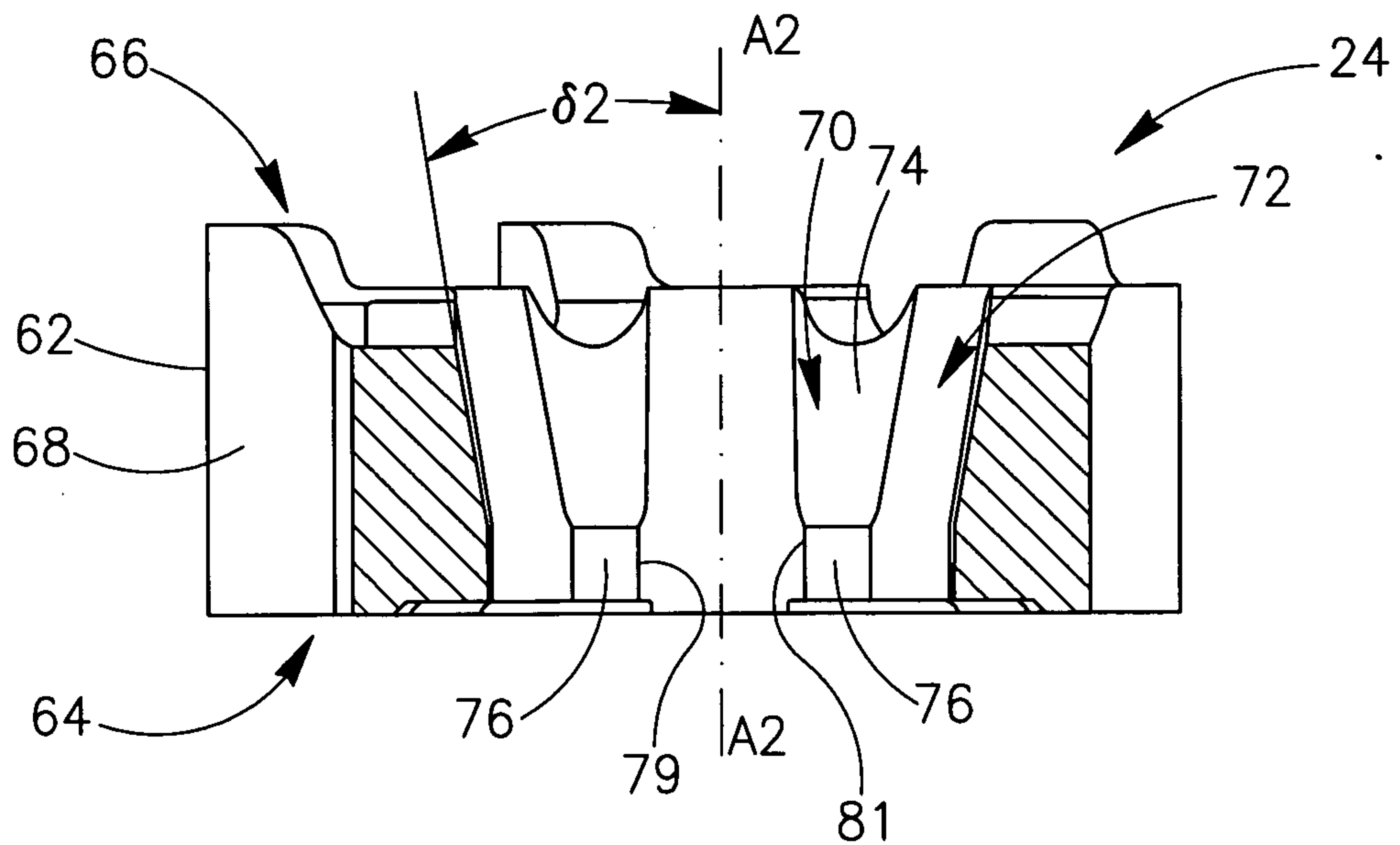


FIG. 6

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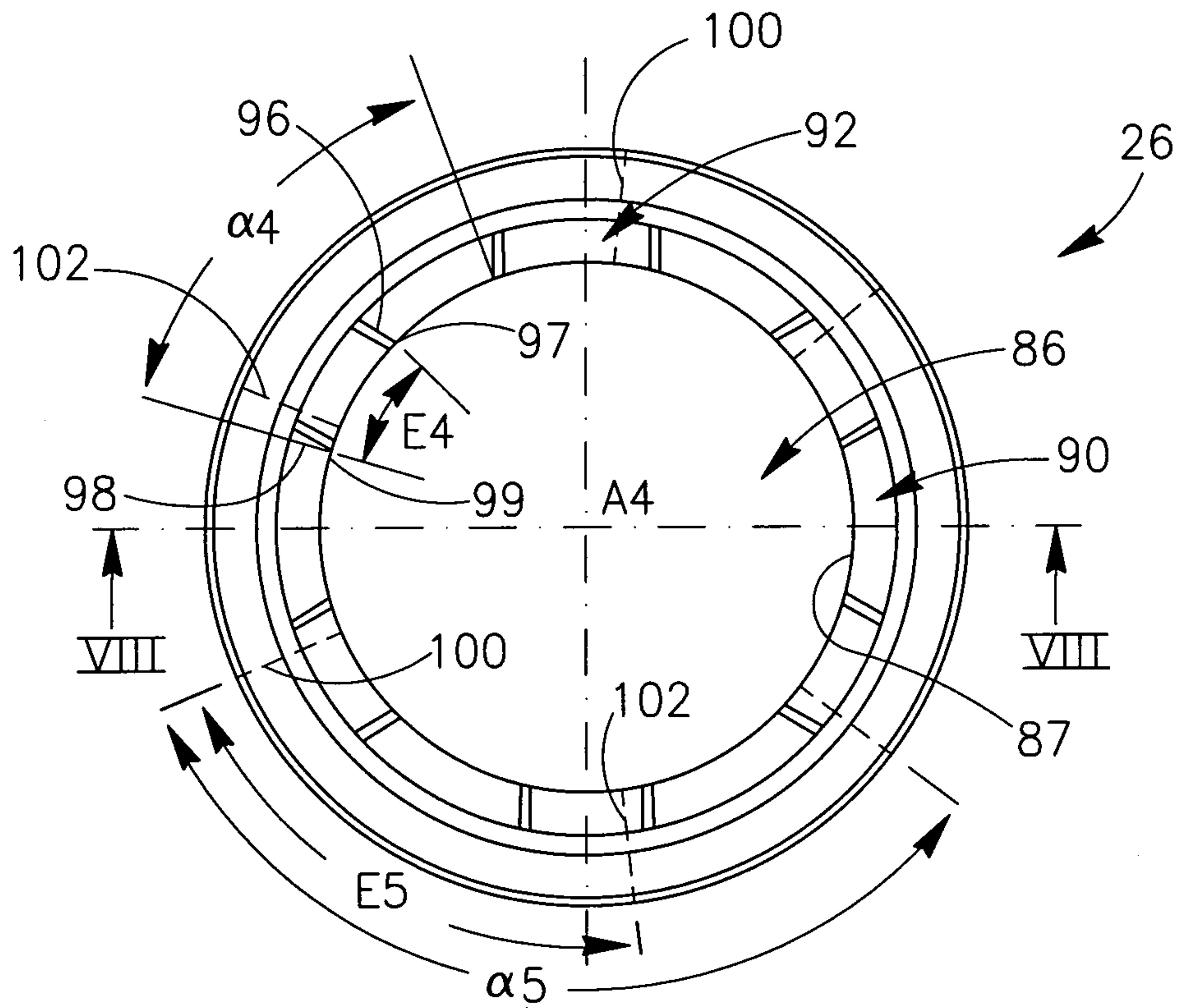


FIG. 7

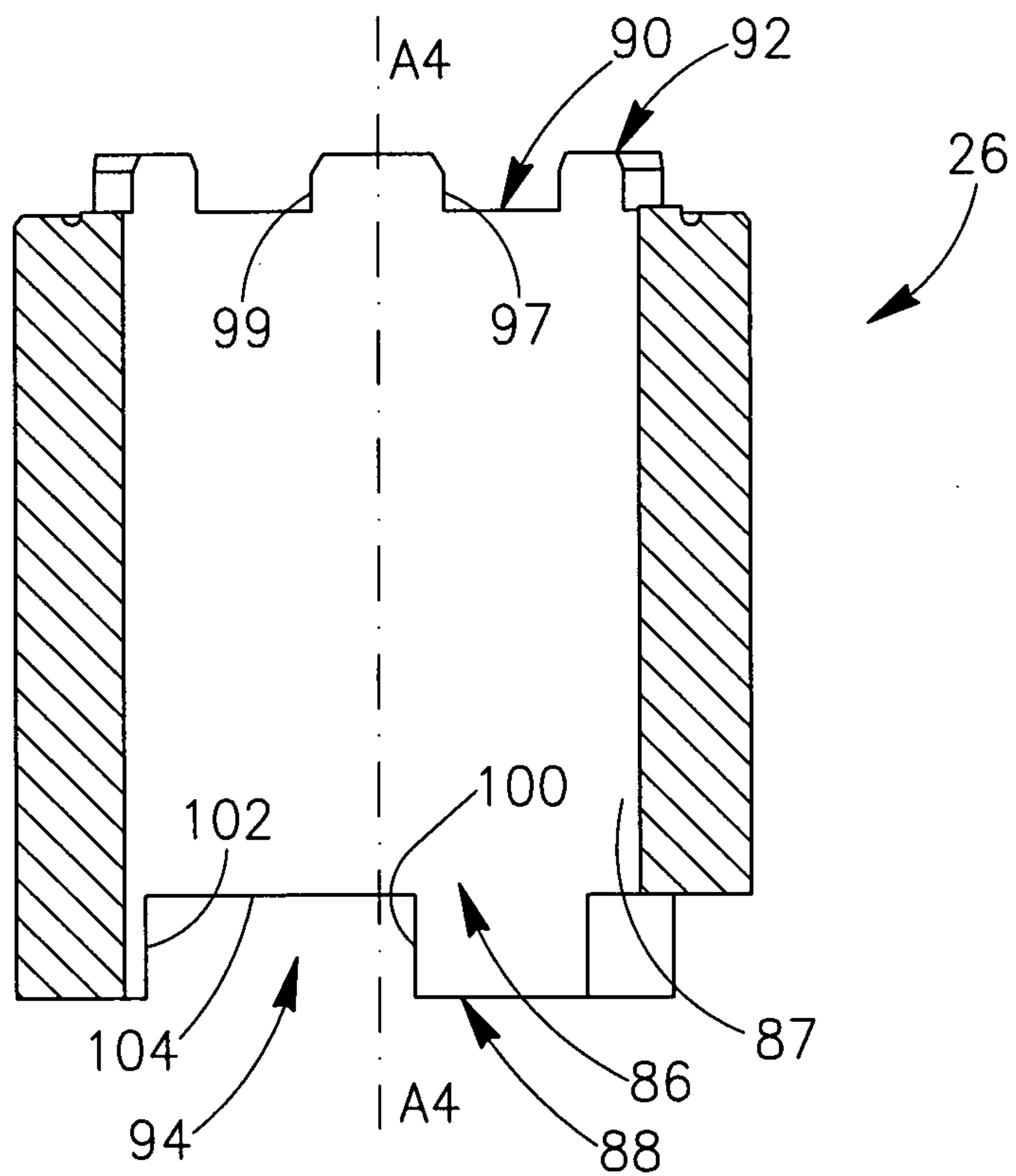


FIG. 8

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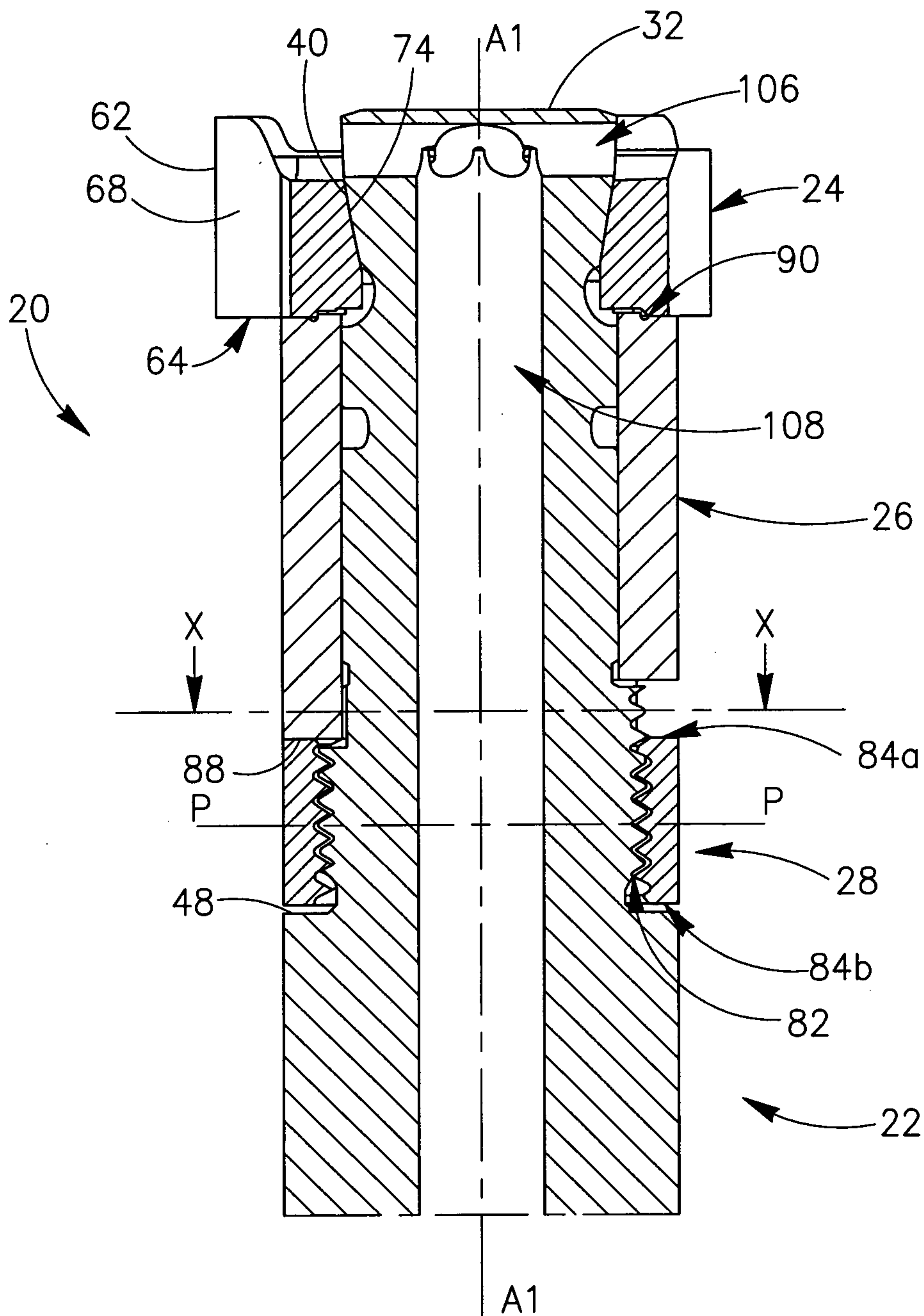


FIG. 9

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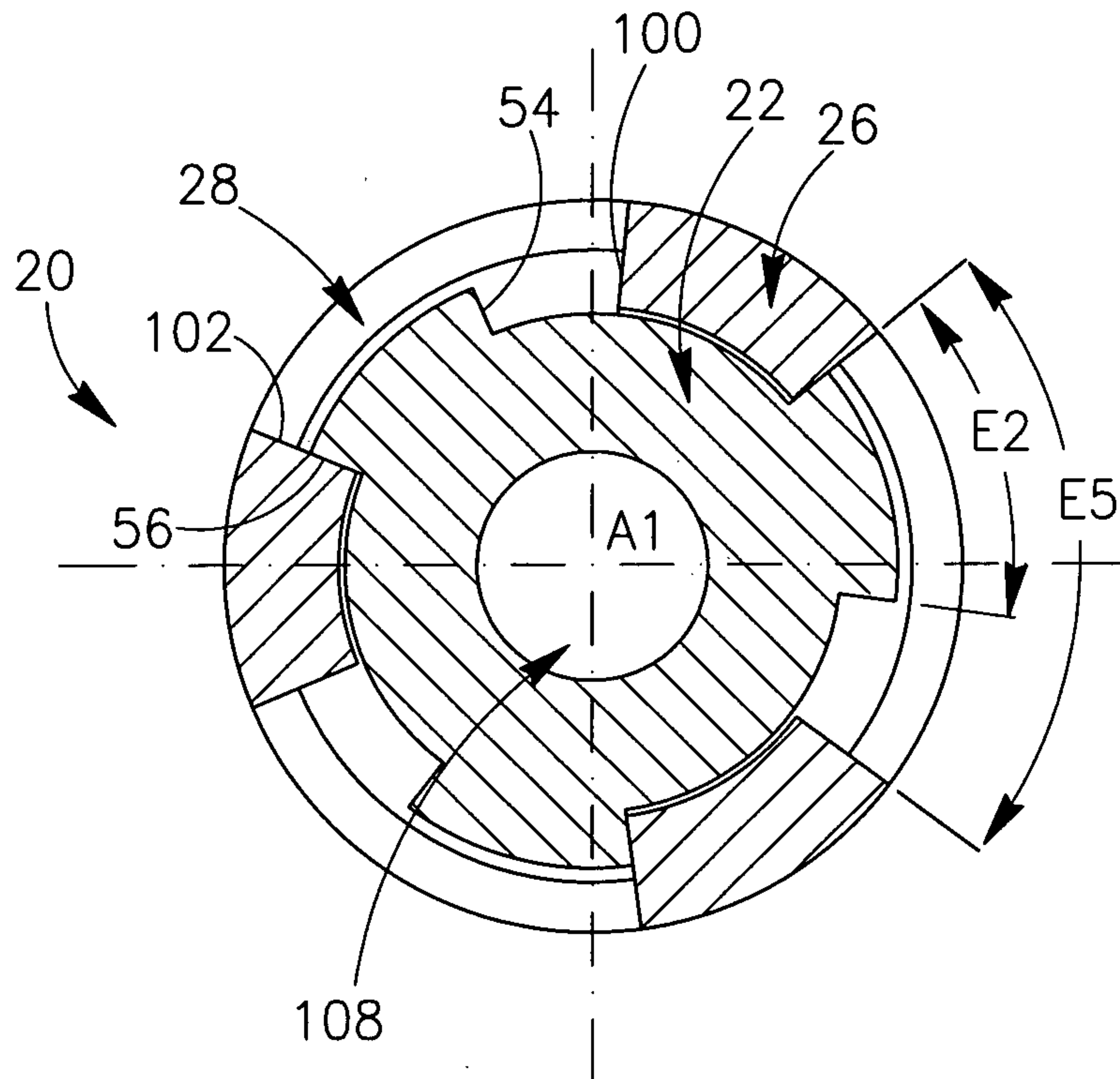


FIG. 10

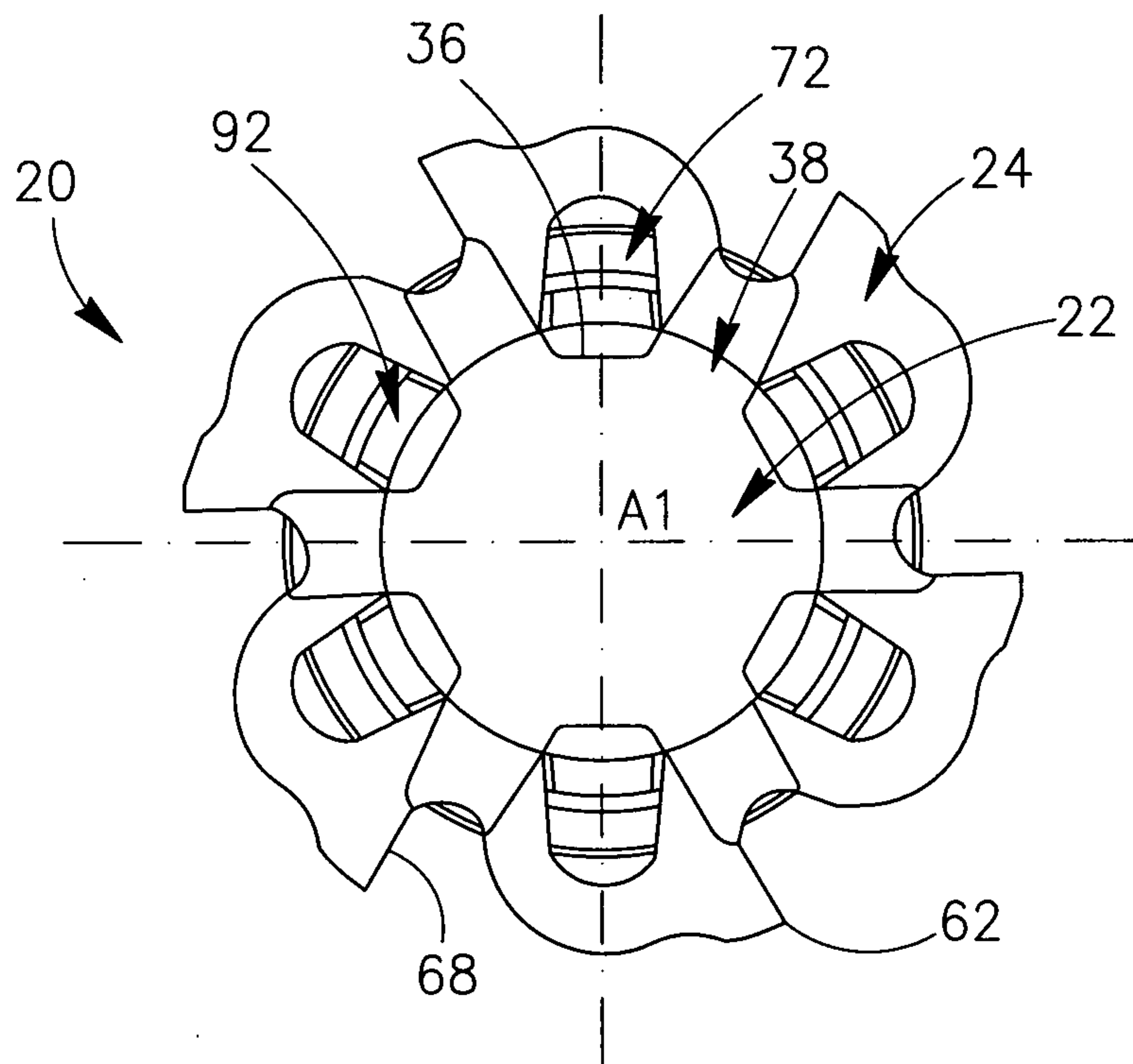


FIG. 11

