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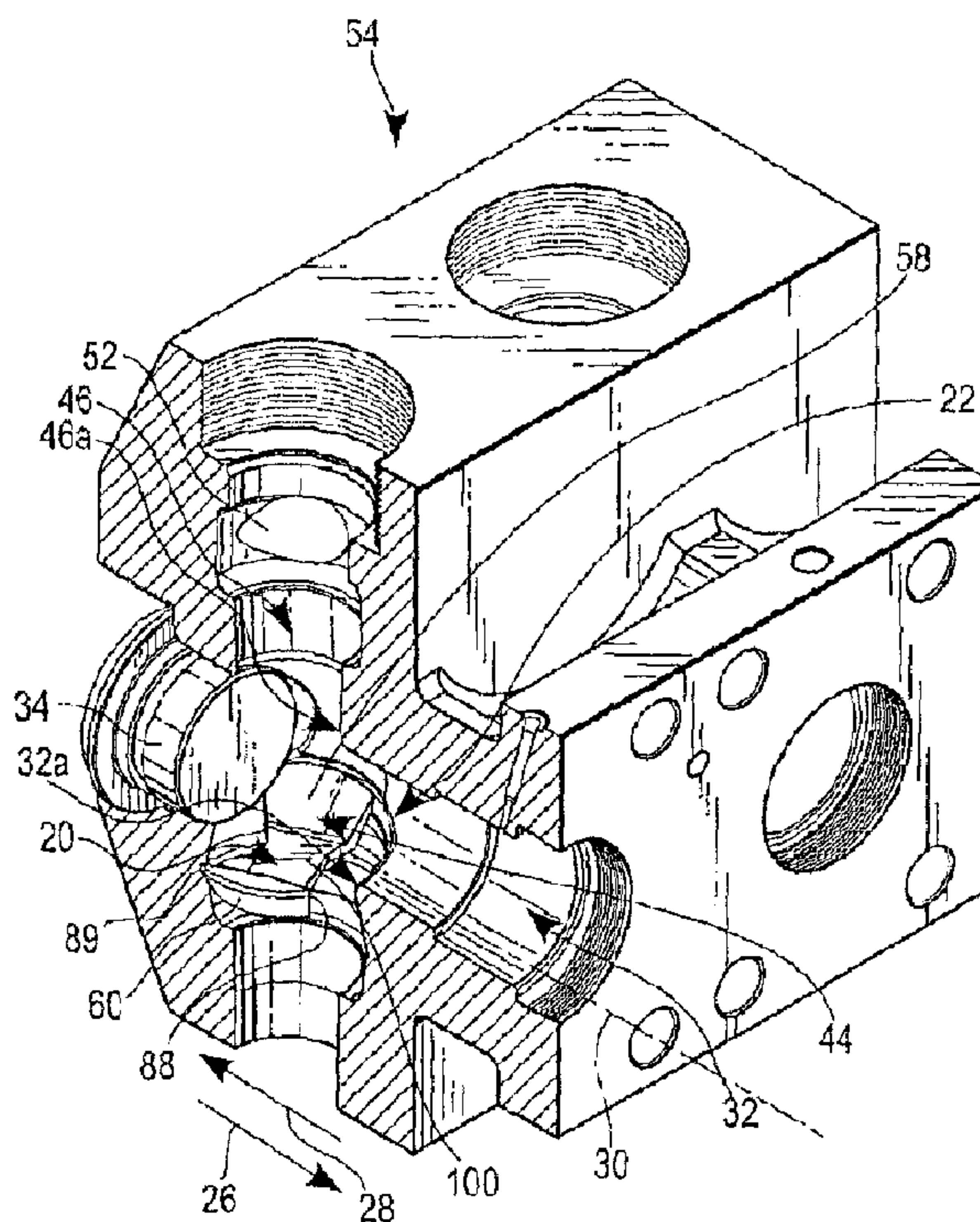
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(54) Titre : BOUT FLUIDIQUE D'UNE POMPE HAUTE PRESSION AYANT UNE RAINURE ADAPTEE POUR RECEVOIR UN DISPOSITIF DE RETENUE D'UNE SOUPE D'ASPIRATION

(54) Title: FLUID END OF A HIGH PRESSURE PUMP HAVING A GROOVE ADAPTED TO RECEIVE A RETAINER OF A SUCTION VALVE



(57) Abrégé/Abstract:

A fluid end of a high-pressure pump having a bore, a discharge bore, a suction bore, a valve cover bore, and a cross-bore intersection formed in portions of the fluid end. The bore, discharge bore, valve cover bore, and suction bore each having an opening which opens into the cross-bore intersection with the suction and discharge bores substantially orthogonal to the bore. A groove is formed in a wall of the fluid end within in the cross-bore intersection. The groove traverses a curvilinear path around an open space. The groove has a first section and a second section, each section having a first end and a second end. The first and second sections are separated by a gap proximate the bore and valve cover bore. A spring retainer is received into the groove and secured therein for pump operation.

ABSTRACT

A fluid end of a high-pressure pump having a bore, a discharge bore, a suction bore, a valve cover bore, and a cross-bore intersection formed in portions of the fluid end. The bore, discharge bore, valve cover bore, and suction bore each having an opening which opens into the cross-bore intersection with the suction and discharge bores substantially orthogonal to the bore. A groove is formed in a wall of the fluid end within in the cross-bore intersection. The groove traverses a curvilinear path around an open space. The groove has a first section and a second section, each section having a first end and a second end. The first and second sections are separated by a gap proximate the bore and valve cover bore. A spring retainer is received into the groove and secured therein for pump operation.

FLUID END OF A HIGH PRESSURE PUMP HAVING A GROOVE ADAPTED TO RECEIVE A RETAINER OF A SUCTION VALVE

FIELD

[0001] The present disclosure concerns a tapered groove in a high pressure plunger pump; the groove receives a retainer; the retainer at a first portion and a second portion is carried in the groove; the groove is configured to prevent the retainer from moving out of the groove along the long axis of the suction bore.

BACKGROUND

[0002] Spring retainers for suction valves in high pressure plunger pumps are known. U.S. Patent 7,186,097, Blume, discloses suction valve spring retainers. The retainers are for use in plunger pump housings incorporating structural features for stress relief. These pump housing structural features accommodate access bore plugs that secure suction valve spring retainers that are internally located substantially centrally over the suction bore transition area of the plunger pump housing. Access bore plugs are secured in place on the pump housing using one or more threaded retainers. Plunger pumps so constructed are relatively resistant to fatigue failure because of stress reducing structural features, and they may incorporate a variety of valve styles, including top and lower stem-guided valves and crow-foot-guided valves in easily-maintained configuration. Suction valve spring retainers mounted in plunger pump housings may also incorporate a suction valve top stem-guide. Further, certain structural features of access bore plugs may be dimensioned to aid in improving volumetric efficiency of the pumps in which they are used.

[0003] U.S. Patent 6,910,871, Blume, discloses valve guide and spring retainer assemblies for use in plunger pump housings that incorporate features for stress relief.

These pump housings have structural features to accommodate correspondingly shaped valve guides and/or spring retainers that are internally fixed in place using one or more non-threaded spacers.

[0004] U.S. Patent 6,544,012, Blume, discloses a Y-block fluid section plunger pump housing having a cylinder bore which is transversely elongated at its intersection with suction and discharge bores to provide stress relief and reduction in housing weight. A spoked, ring valve spring retainer further reduces stress near the bore intersection and allows use of a top stem guided suction valve. Tapered cartridge packing assemblies facilitate use of a one-piece plunger in Y-block housings and also allow packing in such housings to be changed without removing the plunger.

SUMMARY

[0005] One aspect of the invention is embodied by a fluid end of a pump. The fluid end has a bore formed in a portion of said fluid end. The bore has a long axis. The fluid end also has a discharge bore formed in a portion of said fluid end, said discharge bore having a long axis. The fluid end further has a suction bore formed in a portion of said fluid end, said suction bore having a long axis and a valve cover bore formed in a portion of the fluid end. The valve cover bore has a central axis. The central axis extends into the bore.

[0006] A cross-bore intersection is formed in a portion of said fluid end. The bore, discharge bore, valve cover bore, and suction bore each have an opening which opens into the cross-bore intersection. The suction bore long axis extends through the opening of the discharge bore which opens into the cross-bore intersection. The discharge bore long axis extends through the opening of the suction bore which opens into the cross-bore intersection. The valve cover bore axis extends through the opening of the bore which opens into the cross-bore intersection.

[0007] A bore transition area is at the bore opening into the cross-bore intersection and is adjacent the cross-bore intersection. A valve cover bore transition is

at the valve cover bore opening into the cross-bore intersection and is adjacent the valve cover bore and cross-bore intersection.

[0008] A groove traverses a curvilinear path around an open space, The discharge bore and suction bore long axes each extend into the open space. The groove has a first section and a second section. The first section has a first end and a second end. The second section has a first end and a second end. The first and second sections each have a closed base opposite and an open side of each section. The first and second sections each have a first angled surface and a second angled surface. The first angled surface and second angled surface of the first section converge towards each other towards the base of the first section. The angle formed between the first angled surface and second angled surface of the first section is greater than 90° and less than 180° . The first angled surface and second angled surface of the second section converge towards each other towards the base of the second section. The angle formed between the first angled surface and second angled surface of the second section is greater than 90° and less than 180° .

[0009] A gap is between the first ends of the first and second sections of the groove. A gap is also between the second ends of the first and second sections of said groove.

[00010] A retainer is disposed in said fluid end and adapted to receive a valve stem of a suction valve. The retainer has a first portion which has a first surface and a second surface. The first surface is angled relative to the second surface. The exterior angle formed by the surfaces is greater than 180° and less than 270° . The retainer has a second portion which has a first surface and a second surface. The first surface is angled relative to the second surface. The exterior angle formed by the surfaces is greater than 180° and less than 270° . The retainer has a base from which the first portion extends and the second portion extends. The base has a valve guide aperture to receive the stem of the suction valve.

[00011] The first portion of the retainer can have a third surface angled outwardly relative to the base. The third surface of the first portion intersects an axial extending surface of the base. The axial surface extends away from the point of intersection towards an upper surface of the base. The upper surface and a portion of the axial surface are above the point of intersection.

[00012] The second portion of the retainer can have a third surface angled outwardly relative to the base. The third surface of the second portion intersects an axial extending surface of the base, The axial surface extends away from the point of intersection towards an upper surface of the base. The upper surface and a portion of the axial surface are above the point of intersection.

[00013] Another aspect of the invention is embodied by the retainer.

BRIEF DESCRIPTION OF THE DRAWINGS

[00014] FIG. 1 is an isometric sectional view of a fluid end of a plunger pump.; wherein the section is taken through the housing of the fluid end of a plunger pump; the section being parallel to the long axis of the plunger bore, the long axis of the suction bore, and the long axis of the discharge bore; a spring retainer is disposed in and is rotatable about its central axis in the retainer groove; the view shows the spring retainer having been rotated in a first circumferential direction, counter clock-wise direction, until further rotation is prevented by abutment of a portion of the spring retainer against a portion of the valve cover; components of the fluid end have been omitted for simplicity.

[00015] FIG. 2 is the same sectional shown in FIG. 1 except the spring retainer has been rotated in a second circumferential direction opposite from the first

circumferential direction, clockwise direction, until the rotation is stopped by a portion of the spring retainer abutting up against the valve cover.

[00016] FIG. 3 is a sectional view of the fluid end of FIG. 1; the section, however, is taken perpendicular to the plunger bore and parallel to the suction and discharge bores; additionally, components of the fluid end such as the plunger, suction valve assembly and discharge valve assembly are shown; the spring retainer is shown disposed in the retainer groove holding the suction valve spring in place to bias a suction valve in the closed position against its valve seat.

[00017] FIG. 4A is an isometric sectional view of the fluid end shown in FIG. 1, wherein the spring retainer and valve cover have been omitted from the view; the view shows a first section of the retaining groove extending between the transition area of the plunger bore and the transition area of the valve cover bore.

[00018] FIG. 4B is an isometric sectional view of the fluid end shown in FIG. 1, wherein the spring retainer and valve cover have been omitted from the view; the view shows a second section of the retaining groove, radially opposite the first section of the retaining groove, extending between the transition area of the plunger bore and the transition area of the valve cover bore.

[00019] FIG. 4C is and 4D are blow ups of the details of FIG. 4A and 4B respectively; the detail shows that the retaining groove has a first surface angled in a first direction, a second surface angled in a second different direction and a rounded transition area joining the first surface to the second surface at a base of the groove; opposite the base of the groove is an open side.

[00020] FIG. 5 is a sectional view of the fluid end shown in FIG. 1, wherein the spring retainer and valve cover have been omitted; the view shows the retainer groove first section and second section wherein the plunger bore has a transition area which is between a first end of the first section and a second end of the second section thereby

providing a break, gap or discontinuity between the retaining groove first section and the retaining groove second section; the gap is between the first and second section first ends.

[00021] FIG. 6 is a sectional view of the fluid end shown in FIG. 5 wherein the spring retainer and valve cover have been omitted; the view shows the retainer groove first section and second section wherein the valve cover bore has a transition area which is between the first section and the second section thereby providing a break, gap or discontinuity between the retaining groove first section and the retaining groove second section; the gap is between the first and second section second ends.

[00022] FIGs 7A through 7H show various views of the spring retainer shown in FIG. 1; FIG. 7A is a top view; FIG. 7B is a right-sided isometric view; FIG. 7C is a right-sided view; FIG. 7D is a left-sided view; FIG. 7E is a front-side view; FIG. 7F is a back-side view; FIG. 7G is a bottom view; and FIG. 7H is a left-side isometric view.

[00023] FIG. 8 is an isometric sectional view of the fluid end shown in FIG. 4A wherein the spring retainer is aligned so that a first retainer portion is disposed between the first ends of the first and second groove sections; a second retainer portion is disposed between the second ends of the first and second groove sections; the first retainer portion is seating against the plunger bore transition area; the second retainer portion is seating against the valve cover bore transition area; the valve cover is not present; the retainer spring is compressed.

[00024] FIG. 9 is a cutaway isometric sectional view of the fluid end shown in FIG. 8 wherein the spring coupled to the spring retainer and valve is compressed; the valve is in the closed position; the spring has been rotated to an installed position where the retainer's long axis is perpendicular to the plunger bore axis.

[00025] FIG. 10 is an isometric sectional view of a fluid end of a piston pump; wherein the section is taken through the housing of the fluid end of a piston pump; the section being parallel to a long axis of the piston bore, a long axis of the suction bore,

and a long axis of the discharge bore; a spring retainer is disposed in and is rotatable about its central axis in a retainer groove; the view shows the spring retainer having rotated in a second circumferential direction, clock-wise direction, until further rotation is prevented by a retainer section of the spring retainer abutting against a projection on the valve cover; components normally found in the fluid end have been omitted for simplicity.

[00026] FIG. 11 is a blow up of a sectional view of the first section of the retainer groove; the detail shows that the retaining groove has a first surface angled in a first direction, a second surface angled in a second different direction and a rounded transition area joining the first surface to the second surface at a base of the groove.

[00027] FIGs. 12A through H show various views of the spring retainer shown in FIG. 10; FIG. 12A is a top isometric view; FIG. 12B is a top view; FIG. 12C is a front-side view; FIG. 12D is a back-side view; FIG. 12E is a left-side view; FIG. 12F is a right-side view; FIG. 12G is a bottom view; and FIG. 12H is a bottom isometric view.

[00028] FIG. 13 is a cross-sectional view of the spring retainer of FIG. 12A cut along the line 13-13.

[00029] FIG. 14 is an isometric sectional view of the fluid end of the piston pump shown in FIG 10; wherein the section is taken through the housing of the fluid end of a piston pump; the section being parallel to the long axis of the piston bore, the long axis of the suction bore, and the long axis of the discharge bore; a suction valve is installed in the suction bore and a spring retainer is disposed in and is rotatable about its central axis in the retainer groove; the view shows the spring retainer having been rotated in a first circumferential direction until it is completely received within the retainer groove; the valve cover shown in FIG 10 has been intentionally omitted.

[00030] FIG. 15 is a cross-sectional view of the fluid end of FIG. 14 cut along the line 15-15; the discharge valve assembly and discharge valve retaining cover intentionally omitted in figure 14 is included in FIG. 15.

[00031] FIG. 16 is an isometric sectional view of a fluid end of a piston pump of FIG. 14; wherein the section is taken through the housing of the fluid end of the piston pump; the section being parallel to the long axis of the piston bore, the long axis of the suction bore, and the long axis of the discharge bore; the suction valve is installed in the suction bore and the spring retainer is disposed in and is rotatable about its central axis in the retainer groove; the view shows the spring retainer is in a drop in or pre-installation position; the retainer has not yet been rotated to be installed in the retainer groove.

DETAILED DISCLOSURE

[00032] The present disclosure is to be considered as an exemplification of the principles of the invention, and is not intended to limit the invention to the specific embodiment illustrated.

[00033] With reference to FIGs 1, 2 and 3, the general operation of the high pressure pump and the function of the retainer ring 20 and groove 22 can be understood. The retainer ring can also be called a spring retainer 20. The plunger 24 shown in FIG. 3 reciprocates in a first direction 26 and an opposite second direction 28 along the long axis 30 of the plunger bore 32. The long axis extends along the length of the plunger bore. As the plunger 24 reciprocates in the first direction 26 away from the valve cover 34, fluid is sucked into suction bore 36 through a fluid inlet 38. Suction valve 40, normally in the closed position, moves off its valve seat 42 towards the spring retainer 20. Fluid then passes over the spring retainer into the cross-bore intersection 44. The plunger 24 then reciprocates in the opposite second direction 28 along the plunger bore long axis 30 toward the valve cover 34. The reciprocation causes the fluid to exit the fluid end 54 through discharge bore 46. The fluid exits the discharge bore by

pushing discharge valve 48 off its valve seat 50 and exiting the discharge bore through a fluid outlet 52. As the plunger 24 reciprocates, fluid is drawn into the fluid end 54 and ejected from the fluid end 54. As can be seen the fluid end is a single monoblock piece machined from a single casting or forging.

[00034] The forces of the fluid may cause the spring retainer 20 to rotate about the retainer central axis 56. The central axis can also be called a third axis of the spring retainer. The retainer, however, is prevented by the valve cover 34 from rotating in a manner which enables the first end portion 58a of the first retainer portion 58 or the first end portion 60a of the second retainer portion 60 to be in a position such that the plunger will contact these end portions or any other portions of the retainer. The valve cover 34 extends through the valve cover bore 34a and overlaps a valve cover bore transition area 78. The valve cover transition area 78 is between a second end of first groove section 86 and a second end of a second section 90. The valve cover bore transition area 78 is coplanar with the second ends of the first and second groove sections 86, 90. The valve cover bore transition area 78 is also coplanar with groove 22. The valve cover is thus in the path of rotation of the retainer 20. The cover provides an abutment to prevent 360° rotation of the spring retainer in either the clockwise or counter clockwise direction.

[00035] The configuration of the groove 22 and the retainer 20 further prevent the retainer 20 from moving in a first direction 62 along the long axis 64 of the suction bore 36 towards the discharge bore 46. The configuration of the groove 22 and the retainer 20 further prevent the retainer 20 from moving in a second direction 66 along the long axis 68 of the discharge bore 46 towards the suction valve 40. This further ensures that the end portions 58a, 60a of the retainer 20 and all other portions of the retainer 20 remain outside of the pathway of the plunger 24 so that the plunger 24 does not contact the retainer 20 during its reciprocation. Therefore, the configuration of the groove 22 and the configuration of the portions of the retainer 20 in the groove 22 cooperate such that the retainer 20 will not slip out of the groove 22. The retainer will not slip out of the

groove 22 in the direction 62 of the discharge valve 48 along the long axis 64 of the suction bore. It will also not slip out of the groove in the direction 66 along discharge bore long axis 68 towards the suction bore valve 40. The discharge bore long axis extends along the length of the discharge bore. The suction bore long axis extends along the length of the suction bore.

[00036] The valve cover bore, suction bore, discharge bore, and plunger bore each have an opening, 34b, 36a, 46a and 32a which opens into the cross-bore intersection 44. The valve cover bore transition area 78 is at the valve cover bore opening 34b. The plunger bore transition area 70 is at the plunger bore opening 32a. The suction bore axis 64 extends through the opening of the discharge bore opening 46a. The discharge bore axis 68 extends through the opening 36a of the suction bore. The valve cover bore central axis 34c extends through opening 32a in the plunger bore. The plunger bore axis 30 extends through opening 34b of the valve cover bore.

[00037] Referring to Figures 1-3 and 8 and 9 we can understand the ease with which the spring retainer 20 can be installed in the retaining groove 22. To place the spring retainer in the installed position, the suction valve 40 and valve seat 42 are installed in the suction bore 36. The valve cover 34 is not yet installed. The plunger 24 is not in the cross-bore intersection 44 or overlapping the plunger bore transition area 70. Spring 72 is disposed so that one end 72a of the spring is seated on the valve 40. It is seated around the valve boss 74. The portion of the valve which supports the spring can be called a spring support. The spring retainer 20 is oriented to be placed in a first position. The first position can be called a drop in position or pre-installed position. To place the spring retainer in the first position, first retainer portion 58 of the spring retainer is aligned with the plunger bore transition 70 area so it overlaps the transition area. Simultaneously with aligning the first portion with the plunger bore transition area, second spring retainer portion 60 is aligned with the valve cover bore transition area 78 so it overlaps the transition area. Simultaneously with the alignment of the first portion with the plunger bore transition area and the second portion with the

valve cover bore transition area, a boss 82 extending along the central axis 56 is aligned and inserted into an end 72b of compression spring 72. Alternatively, the boss could be a recessed area which receives the second end of the compression spring. The portion of the retainer which supports the second end of the spring can generally be called a spring support. Once the spring retainer is aligned as described above, an installer pushes the spring retainer 20 along the suction bore long axis 64 towards the suction valve 40. Pushing in the axial direction compresses the spring. The installer moves the spring retainer 20 in the axial direction towards the suction valve 40 until an abutment between retainer first portion 58 and the plunger transition area 70 and retainer second portion 60 and valve cover bore transition area 78 prevent further axial movement of the spring retainer 20. The valve cover and plunger transition areas 70,78 can be called transition edges. The edges are rounded. The installer then rotates the spring retainer about its central axis such that a leading edge 84 of the first retainer portion 58 of the retainer is brought to be adjacent an opening 22a of the groove. The opening 22a is at the first end of the first groove section 86. The rotation also causes a leading edge 88 of the retainer second portion 60 to be adjacent the opening 22b in the groove 22. The opening is at the second end of the second groove section 90. During rotation, the installer maintains the spring retainer 20 so its first portion 58 is abutted by the plunger bore transition area 70 and its second portion 60 is abutted by the valve cover bore transition area 78. The retainer 20 is as axially close to the suction valve 40 as permitted by the construction of the transition areas 70, 78 and retainer groove 22. Immediately prior to insertion of the first end portion 58a of the retainer first portion 58, which includes the leading edge 84, into the opening 22a at the first end of the first groove section 86, the spring retainer 20 can be said to be in an aligned position. Also immediately prior to insertion of the first end portion 60a of the retainer second portion 60, which includes the leading edge 88 of the second portion 60, into the opening 22b at the second end of the second section 90, the spring retainer 20 can be said to be in the aligned position. The aligned first position can also be called the aligned drop in position or the aligned pre-installation position. Additionally in the aligned position, a portion of the first side surface 76a of the retainer first portion 58 is in axial alignment

with a first surface 23a of the first section 86 of the retaining groove 22. The first surface 23a of the first section 86 of the retaining groove 22 is angled. Additionally, at least a portion of a second side surface 76b of the retainer first portion 58 is in axial alignment with a second surface 23b of the first section 86 of the retaining groove 22. The second surface 23b is angled. The first side surface 76a and second side surface 76b are angled. The spring retainer in the aligned position is also oriented such a portion of the first side surface 80a of the second portion 60 of the spring retainer 20 is in axial alignment with the first surface 23a of the second section 90 of the retaining groove 22. Additionally, at least a portion of a second side surface 80b of the retainer second portion 60 is in axial alignment with the second surface 23b of the second section 90 of the retaining groove. The first side surface 80a, and second side surface 80b are angled.

[00038] From the alignment position the spring retainer is rotated to its installed position. It is rotated so that the retainer's long axis is perpendicular to the plunger bore axis. In the installed position, a portion of the first side surface 76a of the retainer first portion 58 overlaps said groove first surface 23a and at least partially contacts said surface. The second side surface 76b of the first retainer portion 58 overlaps and at least partially contacts said second surface 23b of the groove. Further, a rounded transition area 76c between the first side surface 76a and the second side surface 76b of the retainer first portion 58 overlaps a rounded transition area 23c between the groove first surface 23a and groove second surface 23b. The transition areas may contact each other. The first and second side surfaces 76a and 76b of the first portion 58 of the retainer are at the first side 76 of the first portion 58. The first and second side surfaces can also be called first and second surfaces. The first groove section 86 forms a portion of the groove 22 overlapped by the first side surface 76a, second side surface 76b, and rounded transition area 76c of the first retainer portion 58.

[00039] Also in the installed position, a portion of the retainer first side surface 80a of the retainer second portion 60 overlaps said groove first surface 23a and at least

partially contacts said surface. The second side surface 80b of the retainer second portion 60 overlaps and at least partially contacts said second surface 23b of the groove. Further, a rounded transition 80c area between the first side surface 80a and the second side surface 80b of the retainer second portion overlaps 60 the rounded transition area 23c between the groove first surface 23a and groove second surface 23b. The transition areas may contact each other. The second groove section 90 forms a portion of the groove overlapped by the first side surface 80a, second side surface 80b, and rounded transition area 80c of the second retainer portion 60. The first and second side surfaces 80a and 80b of the second portion 60 of the retainer are at the first side 80 of the second portion 60. The first and second side surfaces can also be called first and second surfaces. Once the retainer is in the installed position the valve cover 34 is installed. The plunger 24 may also be allowed to reciprocate freely in the plunger bore.\

[00040] In more detail, the retainer groove 20, as stated has a first section 86 and a second section 90. The first section has a first end with opening 22a that opens into the plunger bore transition area 70. The first section 86 has second end with a second opening 22c which opens into the valve cover bore transition area 78. The valve cover bore transition area 78 can also be called the valve bore transition edge. The groove first section 86 has first surface 23a which can be called a first angled surface. The groove first section 86 has second surface 23b which can be called the second angled surface. The second angled surface and the first angled surface converge towards each other towards the base of the groove. The angle 200 formed between the groove first surface 23a and second surface 23b is greater than 90° and less than 180°. More usually the angle is greater than 100° and less than 150°. The angle is preferably 120° for plunger sizes from 3.75 up to 6.75 inches in diameter. The base of the groove is closed. At the base of the groove is the transition area 23c which joins an end of the first surface 23a to an end of the second surface 23b. As known in the art the fluid end changes in size and dimension as the plunger size changes. The transition area 23c is a rounded surface and has a valley.

[00041] The second groove section 90 is of the same construction as the first groove section 86. The second groove section has a first end that has a first opening 22d that opens into the plunger bore transition area 70. The second section 90 has a second end with second opening 22b which opens into the valve cover bore transition area 78. The groove second section 90 has first surface 23a which can be called first angled surface. The groove second section 90 has second surface 23b which can be called the second angled surface. The second surface 23b and the first surface 23a converge towards each other towards the base of the groove. The angle 200 formed between the groove first surface 23a and second surface 23b is between 90° and 180°. The base of the groove is closed. At the base of the groove is the transition surface 23c which joins an end of the first angled surface 23a to an end of the second angled surface 23b. The transition area is rounded and has a valley. Although the first angled surface, second angled surface and rounded transition area of the first and second groove sections 86 and 90 are the same in terms of construction and dimension it is possible they could be different.

[00042] Notably the plunger bore transition area is between and coplanar with the first end of the first section 86 of the groove 22 and the first end of the second section 90 of the groove. The plunger bore transition area provides a groove-less gap formed as a rounded surface between the first ends. Also the valve cover bore transition area 78 is between and coplanar with the second end of the first section 86 of the groove 22 and the second end of the second section 90 of the groove 22. The valve cover bore transition area 78 provides a groove-less gap formed as a rounded surface between the second ends.

[00043] As can be seen in FIGS. 7A-7H, the retainer 20 has a unique construction. The retainer is a single monoblock piece which can be made from a single casting without machining or machined from a cylindrical bar forging. As stated, the retainer has a first portion 58 and a second portion 60. The first portion extends from a base

portion 100 at a first end 100a of said base 100. The second portion 60 extends from the base 100 portion at a second end of said base 100b. The base portion has a first surface 102a on a first side 102 of the base. The base first surface 102a is flat. The base portion has a second surface 104a on a second side 104 of the base. The base second surface is flat. The second side is opposite the first side. The first portion 58 of the retainer extending from the base 100 is angled relative to the base. The exterior angle 202 is greater than 180° and less than 270° . More usually the angle is greater than 200° and less than 250° . The angle is preferably 240° for plunger sizes from 3.75 up to 6.75 inches in diameter. The retainer first portion 58 has a third surface 106 at a second side 108 of the first portion 58. The third surface 106 is angled relative to the base second side surface 104a. The angle 204 is greater than 90° and less than 180° . More usually the angle is greater than 100° and less than 150° . The angle is preferably 123° for plunger sizes from 4.5 up to 6.75 inches in diameter wherein the retainer is cast and 130° wherein the retainer is machined. The angle is preferably 125° for plunger sizes 3.75 & 4 inches in diameter wherein the plunger is cast. The angle is such that a direction going from the base along the third surface towards the first end portion 58a of the first retainer portion 58 is away from the retainer's central axis 56. The first surface 76a of the first side 76 is also angled relative to the base first surface 102a. The exterior angle 202 is greater than 180° and less than 270° . More usually the angle is greater than 200° and less than 250° . The angle is preferably 240° for plunger sizes from 3.75 up to 6.75 inches in diameter. The surface is angled such that a direction from the base along the first surface 76a towards the first end portion 58a is away from the retainer central axis 56. The first side 76 second surface 76b is angled relative to the first surface 76a. The exterior angle 206 is greater than 180° and less than 270° . More usually the angle is greater than 200° and less than 250° . The angle is preferably 240° for plunger sizes from 3.75 up to 6.75 inches in diameter. The second surface is angled such that going in a direction from the first surface along the second surface towards an end edge 114 of the first end portion 58a, the direction is towards the central axis 56. The first 76a and second 76b surfaces of the retainer first side 76 are not flat. They are rather rounded. The rounded surfaces can be considered convex or arcuate.

They have a peak. The transition area 76c which joins the first surface 76a to the second surface 76b is rounded. It has a peak. Further, a rounded transition area 102b with a peak joins the base first surface 102a to the first surface 76a. Also, a rounded transition area 104b with a valley joins the base second side surface 104a to the first portion, third surface 106. As stated, the retainer first portion has a leading edge 84. It also has a trailing edge 85.

[00044] The first portion 58 second surface 76b is angled towards the first portion third surface 106. At the closest point between the third and second surface, end edge 114 is formed. The end edge extends from the leading edge 84 to the trailing edge 85. It has a peak between the trailing and leading edges.

[00045] A fourth surface 116 of the retainer first portion 58 extends from the trailing edge to the base. The fourth surface 116 is bounded on one side by the third surface 106 and the opposite side by first surface 76a, second surface 76b and the transition area 76c between the first and second surfaces.

[00046] A fifth surface 118 of the retainer first portion 58 extends from the leading edge 84 to the base 100. The fifth surface is bounded on one side by the third surface 106 and the opposite side by first surface 76a, second surface 76b and the transition area 76c between the first and second surfaces.

[00047] The second portion 60 of the retainer extending from the base 100 is angled relative to the base. The exterior angle 216 is greater than 180° and less than 270°. More usually the angle is greater than 200° and less than 250°. The angle is preferably 240° for plunger sizes from 3.75 up to 6.75 inches in diameter. The second retainer portion 60 has a second side 126 with a third surface 124 which is angled relative to the base second side surface 104a. The angle 218 is greater than 90° and less than 180°. More usually the angle is greater than 100° and less than 150°. The angle is preferably 123° for plunger sizes from 4.5 up to 6.75 inches in diameter wherein

the retainer is cast and 130° wherein the retainer is machined. The angle is preferably 125° for plunger sizes 3.75 & 4 inches in_ diameters wherein the retainer is cast. The angle is such that a direction going from the base along the third surface towards the first end portion 60a of the retainer second portion 60 is angled away from the retainer's central axis 56. The retainer second portion's first surface 80a is also angled relative to the base first surface 102a. The exterior angle 216 is greater than 180° and less than 270° . More usually the angle is greater than 200° and less than 250° . The angle is preferably 240° for plunger sizes from 3.75 up to 6.75 inches in diameter. The surface is angled such that a direction from the base along the first surface 80a towards the first end portion 60a of the retainer second portion 60 is away from the retainer central axis 56. The retainer second portion's second surface 80b is angled relative to the first surface 80a. The exterior angle 220 is greater than 180° and less than 270° . More usually the angle is greater than 200° and less than 250° . The angle is preferably 240° for plunger sizes from 3.75 up to 6.75 inches in diameter. The second surface is angled such that going in a direction from the first surface along the second surface towards an end edge 132 of the first end portion 60a, the direction is towards the central axis 56. The first 80a and second 80b surfaces of the retainer second portion 60 are not flat. They are rather rounded. The rounded surfaces can be considered convex or arcuate. They have a peak. The transition area 80c which joins the first surface to the second surface is rounded. It has a peak. Further, a rounded transition area 128 which has a peak joins the base first surface 102a to the first surface 80a. Also, a rounded transition area 130 with a valley joins the base second side surface 104a to the third surface 124 of the retainer second portion. As stated, the retainer second portion has a leading edge 88. It also has a trailing edge 89.

[00048] The second surface 80b of the retainer second portion is angled towards the third surface 124 of the retainer second portion. At the closest point between the third surface and second surface end edge 132 is formed. The end edge extends from the leading edge 88 to the trailing edge 89. It has a peak between the trailing 89 and leading 88 edges.

[00049] A fourth side surface 134 of the retainer second portion 60 extends from the trailing edge 89 to the base 100. The fourth side surface 134 is bounded on one side by the third surface 124 and the opposite side by first surface 80a, second surface 80b and the transition area 80c between the first and second surfaces.

[00050] A fifth side surface 136 of the retainer second portion 60 extends from the leading edge 88 to the base 100. The fifth side surface 136 is bounded on one side by the third surface 124 and on an opposite side by first surface 80a, second surface 80b and the transition area 80c between the first and second surfaces.

[00051] The base has a third surface 120 and an opposite fourth surface 122. The fourth surface is between the base first 102a and second 104a surface. The third surface, opposite the fourth surface, is between the base first and second surface. The fourth surface has a central portion 122a and a first end portion 122b angled relative to the central portion and a second end portion 122c angled relative to the central portion. The angle 208 between the first end portion and the central portion is between 90° and 180°. The angle 210 between the central portion and the second end portion is between 90° and 180°. The angles between the first portion and central portion and the second portion and central portion are the same and more usually the angles 208, 210 are greater than 100° and less than 150°. The angles 208, 210 are preferably 155° for plunger bore sizes from 3.75 up to 6.75 inches in diameter.

[00052] The third surface of the base has a central portion 120a and a first end portion 120b angled relative to the central portion and a second end portion 120c angled relative to the central portion. The angle 212 between the first end portion 120b and the central portion 120a is between 90° and 180°. The angle 214 between the central portion 120a and the second end portion 120c is between 90° and 180°. The angles between the first portion and central portion and the second portion and central portion are the same and more usually the angles 212, 214 are greater than 100° and

less than 150°. The angles 212, 214 are preferably 155° for plunger bore sizes from 3.75 up to 6.75 inches in diameter. The angles 208, 210, 212, 214 help ensure the retainer properly abuts up against the valve cover as it tries to turn in either rotational direction.

[00053] Spring receiving boss 82 extends outward from the base 100 first side surface 102a along the retainer central axis 56.

[00054] Notably the base third surface 120 is integral with the fourth surface 116 of the first 58 retainer portion and the fifth surface 136 of the second 60 retainer portions. The base fourth surface 122 is integral with the fifth surface 118 of the first retainer portion and the fourth surface 134 of the second retainer portion.

[00055] In addition to a central axis, the retainer has a second, short axis 138, extending through the base third and fourth surfaces. It also has a first, long axis 140, extending through the end at the end edge 114 of the retainer first portion 58 and the end at the end edge 132 of the retainer second portion 60. The first axis is perpendicular to the second axis and central or third axis 56. The third axis is perpendicular to the second axis. The second axis extends along a width of the retainer. The first axis extends along a length of the retainer. The length is at least twice the width.

[00056] The distance 230, wherein the distance is taken along the direction of the suction bore axis, between the plunger's long axis and rounded transition portion 23c as shown in figure 3 is 1.58 inch for plunger sizes 3.75 & 4 inches, 1.88 inch for plunger sizes 4.5 & 5 inches, 2.13 inch for plunger sizes 5.5 & 6 inches and 2.39 inch for plunger sizes 6.5 & 6.75 inches.

[00057] Another embodiment of fluid end 400 for use in a piston pump is illustrated in FIGS. 10-16. As shown in FIG. 10, fluid end 400 includes a bore 402, on the piston side having a long axis 404, a valve cover bore 406 having a central axis 408, a suction

bore 410 having a suction bore long axis 412, and a discharge bore 414 having discharge bore long axis 416. The bore on the piston side can be called a piston bore 402. The piston, however does not actually enter the bore 402, but rather operates inside the liner (not shown in figure) to create pressure inside the fluid end 400. Piston bore 402 and valve cover bore 406 are at least partially aligned and, likewise, suction bore 410 and discharge bore 414 are also at least partially aligned and lie substantially orthogonal to piston bore 402 and valve cover bore 406. The valve cover bore 406 can also be called a valve cap bore 406. Piston bore 402, valve cover bore 406, suction bore 410 and discharge bore 414 all intersect at a cross-bore intersection 418 which includes surfaces that define an open space 420. As best shown in FIG. 11, the valve cover bore 406 terminates at the cross-bore intersection 418 and open space 420. A valve bore transition or termination area 422 defines a transition from the valve cover bore 406 to the open space 420 and cross bore intersection 418. The piston bore 402 also terminates at open space 420 and cross bore intersection 418. A piston bore transition or termination area 424 defines a transition from the piston bore to the open space 420 and cross bore intersection 418. These transition areas 422 and 424 may be machined to have a rounded profile.

[00058] As shown in FIG. 10, cross bore intersection 418 is configured to contain a spring retainer 428 secured in a groove 430, wherein spring retainer 428 carries and guides a spring-resistance valve assembly for a suction valve disposed to control fluid flow into and through suction bore 410. The spring retainer 428 can also be called a retainer or retainer ring 428. Thus, when retainer 428 is subject to the forces of the fluid flowing through open space 420, it can be subject to rotation. A valve cover 426 may be secured within valve cover bore 406 at an end opposite cross-bore intersection 418. The valve cover 426 may be called a valve cap 426. Valve cover 426 may include a protuberance 427 which is configured to extend into open space 420 and cross bore intersection 418 when valve cap 426 is secured to the fluid end 400 in order to abut retainer ring 428 and prevent it from rotating when retaining ring 428 is installed within open space 420 of cross-bore intersection 418 and secured in groove 430.

[00059] FIG. 15 illustrates groove 430 comprising opposing sections being a first section 432 and a second section 434 opposite said first section 432. Both first and second sections 432 and 434 share substantially identical components and, thus, first section 432 will be described in detail herein and its elements will be identified with an "a" designation wherein all of the same elements of the second section will be designated herein with a "b" designation. FIG. 11 is a section view of one embodiment of cross-bore intersection 418 showing a first section 432 of groove 430 wherein first section 432 of groove 430 includes a first end 436a and a second end 438a, and wherein first end 436a is proximate piston bore transition area 424 and second end 438a is proximate valve cap bore transition area 422 as shown. First section 432 of groove 430 also includes a first inclined surface 440a and a second inclined surface 442a wherein an angle 444a is defined by first inclined surface 440a and second inclined surface 442a. The angle can be formed by an intersection between surface 440a and 442a or just by the convergence of the surfaces towards one another and towards a rounded base 431a of the first section 432 of the groove 430. The base 431a can be considered to be formed by surfaces 440a and 442a gradually coming to an intersection. Angle 444a may be greater than ninety (90) degrees, but less than one-hundred eighty (180) degrees. As shown in FIG. 14, gaps 446a and 446b separate first section 432 and second section 434 of groove 430. The location of gaps 446a and 446b occur when groove 432 intersects piston bore 402 and valve cap bore 406 respectively.

[00060] Now turning to FIG. 12A, an embodiment of retainer ring 428 is shown wherein retainer ring 428 is configured for use with a piston pump. This configuration differs from the embodiment described above because the piston does not enter the cross-bore intersection 418, or even bore 402. Therefore, the retaining ring 428 may be positioned within open space 420 without impeding the functionality of the pump. As described above, retainer ring 428 may be a single monoblock piece which can be made from a single casting without machining or machined from a cylindrical bar

forging. FIGS. 12A-H illustrate retainer ring 428 comprising a base 448, a first retainer portion 450, and a second retainer portion 452. In addition, retainer ring 428 has a center axis 454. A spring retaining boss 476 configured to receive or otherwise engage with a valve spring 530 extending downward from the base 448 in an installed position as shown in FIGS. 14 and 15.

[00061] As shown in FIGS. 12A and 13, base 448 includes an upper surface 458 and a lower surface 460 that defines a thickness 462. The thickness is exclusive of the retaining boss 476. As shown best in FIG. 12A, base 448 comprises a first end 464 and a second end 466 that define a length 469. Further base 448 comprises a first side 470 and a second side 472 that define a width 474. In one embodiment, base 448 may be circular as shown wherein the length 468 and width 474 are substantially equal. However, the shape of base 448 shall not be limited to a circular shape. An axially extending surface 445 extends between the upper 458 and lower surface 460. It forms an outer surface of base 448. Portions of the axial surface 445 are between retaining portions 450 and 452. With respect to these portions, one end of the axially extending surface of each of these portions joins to the upper surface 458 and one opposite end, joins to the lower surface 460. These portions are at the first side 470 and second side 472. Retaining portions 450 and 452 extend radially outward from other portions of axial surface 445. An upper portion of axial surface 445 is continuous with upper surface 458, unbroken, and surrounds axis 454 and a central area of base 448. The axially extending surface 445 is located about axis 454. It curves about the axis and is circumferential. Axial surface 445 is displaced from the axis a radial distance. It has an outer diameter. As further shown in FIGS. 12A-H and 13, spring retaining boss 476 extends away from lower surface 460 and a valve guide aperture 478 passes through both base 448 and spring retaining boss 476 (if present). As shown in FIG. 13, valve guide aperture 478 defines a diameter 524 and is configured to receive a guide arm or valve stem 536 on a valve 532 (both shown in FIG. 15). In some cases, aperture 478 may include a step 526 that allows for insert 528 to be housed within base 448 and/or spring retaining boss 476 as shown. In this case the diameter of the insert is the diameter to receive guide

arm/valve stem 536. In addition to aperture 478, the base 448 may have a clearance aperture 478', co-extensive with and along axis 454 and in fluid communication with aperture 478. Boss 476 has an axially extending surface 477 which has an end that terminates at the lower surface 460. The axially extending surface extends axially away from the lower surface and terminates at a free end of the boss 476 opposite lower surface 460. It forms an outer surface. The axially extending surface 477 is about axis 454. It is continuous and unbroken. It curves about the axis and is circumferential. It is displaced from the axis a distance. It has an outer diameter. It may taper axially inward from the lower surface to the boss free end. The radial displacement from the axis 454 and the outer diameter of the axial surface 477 at the lower surface 460 is less than the radial displacement from the axis 454 and the outer diameter of the axial surface 445 at lower surface 460.

[00062] FIG. 13 illustrates the embodiment of retainer ring 428 of FIGS. 12A-H and shows first retainer portion 450 and second retainer portion 452 in relation to base 448. As shown, first retainer portion 450 extends radially outward from first end 464 and includes a third surface 480 and a fourth surface 482 which define a thickness 484. First retainer portion 450 also has a first end 486 and a second end 488 wherein first end 486 of first retainer portion 450 is coupled to base 448 proximate base's 448 first end 464 and between the base upper surface 458 and the base lower surface 460. First retainer portion 450 further includes a first end portion 490 at second end 488. The first end portion 490 includes a first surface 492 and a second surface 494 wherein first and second surfaces 492 and 494 are inclined and form an exterior angle 496. The first end portion may be called a first key 490. The angle may be formed by the intersection of the surfaces 492 and 494 or just by the convergence of the surfaces towards one another and towards a rounded transition area 503 joining surfaces 492 and 494. The transition area can be considered to be formed by the surfaces 492 and 494 coming to an intersection. Exterior angle 496 may be any angle greater than one-hundred eighty (180) degrees and less than three-hundred sixty (360) degrees, with a common range between one-hundred eighty (180) degrees and two-hundred seventy (270) degrees,

but preferably in a range between around two-hundred (200) degrees and around two-hundred forty (240) degrees. The intersection of first surface 492 and second surface 494 may be pointed or rounded, like the transition area 503 as shown in FIG. 12E. First surface 492 and second surfaces 494 may be flat or slightly convex (curved outwardly).

[00063] Further, as shown in FIGS. 12E and 13, third surface 480 of first retainer portion 450 is inclined with respect to first end 464 of base 448 at an angle 498 and fourth surface 482 is inclined with respect to first end 464 of base 448, wherein surface 482 is orientated at an angle 500 relative to bottom surface 460 as shown. Angles 498 and 500 may be configured such that third surface 480 and fourth surface 482 are substantially parallel resulting in a constant thickness 484, or angles 498 and 500 may be configured so as third surface 480 and fourth surface 482 are oblique in relation to each other resulting in a variable thickness 484 of first retainer portion 450. Angle 498 may be greater than around twenty (20) degrees or less than around one-hundred-sixty (160) degrees, and preferably between around forty-five (45) degrees and around one-hundred thirty-five (135) degrees. Angle 500 may range from one-hundred ten (110) degrees to two-hundred fifty (250) degrees, preferably being in a range between around one-hundred thirty-five (135) degrees and around two-hundred twenty-five (225) degrees. The third surface 480 intersects axial surface 445 at end 464. The angle 498 is between the third surface 480 and axial surface 445. The point of intersection is between the upper 458 and lower 460 surfaces. The axial surface 445 extends away from the point of intersection towards the upper surface 458. The upper surface 458 and a portion of the axial surface 445 are above the point of intersection. The fourth surface 482 joins to the base 448 at end 464. It joins to a radially outer most part of lower surface 460 including at a place where axial surface 445 joins to lower surface 460. Angle 500 is formed between fourth surface 482 and lower surface 460.

[00064] Third surface 480 may intersect with a primarily radially extending surface 491 of key 490 at an angle 499 wherein angle 499 may range from one-hundred ten

(110) degrees to two-hundred fifty (250) degrees, preferably being in a range between around one-hundred thirty-five (135) degrees and around two-hundred twenty-five (225) degrees. Further fourth surface 482 may intersect with a primarily radially extending surface 493 of key 490 at an angle 501 wherein angle 501 may range from one-hundred ten (110) degrees to two-hundred fifty (250) degrees, preferably being in a range between around one-hundred thirty-five (135) degrees and around two-hundred twenty-five (225) degrees. In one embodiment, angles 499 and 501 are configured to orientate key 490 substantially orthogonal to the wall forming open space 420 that includes groove 430. The primarily radially extending surface 491 intersects a primarily axially extending surface 495 of key 490. The surface 495 is opposite first surface 492. Surface 495 is raised in the axial direction relative to surface 491. The area of intersection of surface 495 with surface 491 is concavely rounded. The primarily radially extending surface 493 intersects a primarily axially extending surface 497 of key 490. The surface 497 is opposite second surface 494. Surface 497 is raised in the axial direction relative to surface 493. The area of intersection of surface 497 with surface 493 is concavely rounded.

[00065] Similarly, as shown in FIGS. 12E and 13, second retainer portion 452 includes a third surface 502 and a fourth surface 504 that define a thickness 506. Second retainer portion 452 also has a first end 508 and a second end 510 wherein first end 508 of second retainer portion 452 is coupled to base 448 proximate the second end 466 of base 448. Second retainer portion 452 further includes a second end portion 512 at second end 510 wherein second end portion 512 includes a first surface 514 and a second surface 516 wherein first and second surfaces 514 and 516 are inclined and form an angle 518. The angle is exterior. The angle may be formed by the intersection of the surfaces 514 and 516 or just by the convergence of the surfaces towards one another and towards a rounded transition area 505 (shown in FIG. 12E) joining surfaces 514 and 516. The transition area 505 can be considered to be formed by the surfaces 514 and 516 coming to an intersection. Angle 518 may be any angle greater than one-hundred eighty (180) degrees and less than three-hundred sixty (360)

degrees, with a common range between one-hundred eighty (180) degrees and two-hundred seventy (270) degrees, but preferably in a range between around two-hundred (200) degrees and around two-hundred forty (240) degrees. The intersection of first surface 514 and second surface 516 may be pointed or a rounded transition area 505 as shown in FIG. 12E. The second end portion 512 may be called a second key 512. As shown in FIG. 15, the orientation and configuration of surfaces 492 and 494 of first key and 514 and 516 of second key are complimentary to the orientation and configuration of surfaces 440a and 442a of first section 432 of groove 430 and surfaces 440b and 442b of second section 434 of groove 430.

[00066] Further, as shown in FIG. 13, third surface 502 is inclined with respect to second end 466 of base 448 at an angle 520 and fourth surface 504 is inclined with respect to second end 466 of base 448 at an angle 522. Angles 520 and 522 may be configured such that third surface 502 and fourth surface 504 are substantially parallel resulting in a constant thickness 506, or angles 520 and 522 may be configured so as third surface and fourth surface are oblique in relation to each other resulting in a variable thickness 506. Angle 520 may be greater than around twenty (20) degrees or less than around one-hundred-sixty (160) degrees, and preferably between around forty-five (45) degrees and around one-hundred thirty-five (135) degrees. Angle 522 may range from one-hundred ten (110) degrees to two-hundred fifty (250) degrees, preferably being in a range between around one-hundred thirty-five (135) degrees and around two-hundred twenty-five (225) degrees. The third surface 502 intersects an axial surface 445 at end 466. The angle 520 is between the third surface 502 and axial surface 445. The point of intersection of third surface 502 and surface 445 is between the upper 458 and lower 460 surfaces. The axial surface 445 extends away from the point of intersection towards the upper surface 458. The upper surface 458 and a portion of the axial surface 445 are above the point of intersection. The fourth surface 504 joins to the base 448 at end 466. It joins to radially outer most part of lower surface 460 including at a place where axial surface 445 joins to lower surface 460. Angle 522 is formed between fourth surface 504 and lower surface 460.

[00067] Third surface 502 may intersect with a primarily radially extending surface 513 of key 512 at an angle 521 wherein angle 521 may range from one-hundred ten (110) degrees to two-hundred fifty (250) degrees, preferably being in a range between around one-hundred thirty-five (135) degrees and around two-hundred twenty-five (225) degrees. Further fourth surface 504 may intersect with a primarily radially extending surface 515 of key 512 at an angle 523 wherein angle 523 may range from one-hundred ten (110) degrees to two-hundred fifty (250) degrees, preferably being in a range between around one-hundred thirty-five (135) degrees and around two-hundred twenty-five (225) degrees. In one embodiment, angles 521 and 523 are configured to orientate second key 512 substantially orthogonal to the wall forming open space 420 that includes groove 430. The primarily radially extending surface 513 intersects a primarily axially extending surface 517 of key 512. The surface 517 is opposite first surface 514. Surface 517 is raised in the axial direction relative to surface 513. The area of intersection of surface 517 with surface 513 is concavely rounded. The primarily radially extending surface 515 intersects a primarily axially extending surface 519 of key 512. The surface 519 is opposite second surface 516. Surface 519 is raised in the axial direction relative to surface 515. The area of intersection of surface 519 with surface 515 is concavely rounded.

[00068] As shown in FIGS. 12E and 12F, the first 450 and second 452 retainer portions each have first and second lateral sides. The first and second lateral sides respectively have first 600a, 600b and second 610a, 610b lateral surfaces. Each lateral surface 600a, 600b, 610a, 610b has a curved portion 600a', 610a', 600b', 610b'. Each lateral surface 600a, 600b, 610a, 610b has a straight portion 600a'', 610a'', 600b'', 610b''. The first 600a and second 610a lateral surfaces of the first retaining portion 450 extend from the retaining portion 450 first end 486 to the second end 488. The first lateral surface 600a extends from the first side 470 of the base 448 and the second lateral surface 610a extends from the second side 472 of the base. The curved portion 600a' of the first lateral surface 600a extends from the base 448 on the first side 470

and from the first end 486 towards the second end 488 but does not reach the second end 488. The straight portion 600a'' extends from the second end 488 towards the base 448 and first end 486 but does not reach the first end 486. The curved portion 600a' and straight portion 600a'' meet between the first 486 and second 488 end. The second lateral surface 610a and its curved 610a' and straight 610a'' portions are configured in the same manner as the first lateral surface 600a and its curved 600a' and straight 600a'' portions except they are oriented on the second side 472 of base 448. The first 600a and second 610a lateral surfaces each join the third 480 and fourth 482 surfaces. They also each join the first 492 and second 494 surfaces. The first lateral surface 600b of the second retainer portion 452 extends from the second portion 452 first end 508 to the second portion second end 510 at the base 448 first side 470. Lateral surface 600b and its curved 600b' and straight 600b'' portions are oriented relative to the base 448 and first side 470 and are configured as part of the second portion 452 in the same manner as first lateral surface 600a and its curved 600a' and straight portions 600a'' are oriented relative to the base 448 and first side 470 and configured as part of first retainer portion 450. The second lateral surface 610b and its curved 610b' and straight 610b'' portions are configured in the same manner as the first lateral surface 600b and its curved 600b' and straight 600b'' portions except they are oriented on the second side 472 of base 448.

[00069] As shown in FIG. 15, spring retaining boss 476 may be inserted in one end of a spring 530. Alternatively, spring retaining boss 476 may include a recess (not shown) configured for receiving and retaining spring 530. The other end of spring 530 is in operable connection with a suction valve 532. As best shown in FIG. 15, suction valve 532 includes a contacting surface 534 and a guide arm 536. The arm can be called a valve stem 536. Bearing surface 534 of suction valve 532 bears against a valve seat 538 which is carried by fluid end 400. A discharge valve assembly 900 and retaining valve cover 901 are shown in the fluid end.

[00070] Retainer ring 428 is installed similarly to the embodiment described above. To install retainer ring 428 and retain valve 532 in suction bore 410, a user will insert valve seat 538 and valve 532 through valve cap bore 406 and drop the valve seat 538 and valve 532 into suction bore 410 into an installed position with valve stem 536 extending upward as shown in FIGS. 14 and 15. Next, spring 530 is fed through valve cap bore 406 and is dropped over valve stem 536 so that valve stem is received into spring 530. Spring 530 bears on a top surface of valve 532.

[00071] As shown in FIG. 16, retainer ring 428 is inserted through valve cover bore 406 with first and second retainer portions 450 and 452 aligned with long axis 404 and central axis 412. This allows retaining ring 428 to be inserted freely into open space 420 as width 474, see figure 16, is less than the clear distance between first groove section 432 and second groove section 434. Spring receiving boss 476 is then received into spring 530. To secure retainer ring 428 within fluid end 400, the retainer ring may be slightly depressed to preload spring 530 and then the retainer ring 428 is rotated about center axis 454 such that, as best shown in FIG. 15, first key 490 is received into first section 432 of groove 430 and second key 512 is received into second section 434 of groove 430. As shown, keys 490 and 512 are configured to be complimentary to groove sections 432 and 434. First surface 492 of first key 490 engages first surface 440a of first section 432 of groove 430. Likewise, second surface 494 of first key 490 engages second surface 442a of first section 432 of groove 430, first surface 514 of second key 512 engages first surface 440b of second section 434 of groove 430, and second surface 516 of second key 512 engages second surface 442b of second section 434 of groove 430. The engagement of keys 490 and 512 with the portions 432 and 434 of groove 430 secure retainer ring 428 within open space 420 and the engagement of the surfaces prevent linear translation of retaining ring in either direction due to the passage of pumped fluent through the fluid end 400.

[00072] FIG. 14 illustrates the installed position of retaining ring 428 in fluid end 400 wherein retaining ring is positioned within the cross-bore intersection 418 and open

space 420. Turning back to FIG. 10, even though retaining ring 428 may rotate within open space 420 due to the forces applied by the fluid passing through the cross-bore intersection 418 from the suction bore 410 into the discharge bore 414. The retainer ring 428 will not rotate so much that its first and second retainer portions 450 and 452 section will come out of groove sections 432 and 434. The valve cover 426 prevents the excess rotation. Rotation of the retainer in the second circumferential direction is stopped by projection 427 of valve cover 426 abutting up against retainer portion 452. Rotation in the first circumferential direction is stopped by projection 427 of valve cover 426 abutting up against retainer portion 450. Valve cover 426 acts as an abutment because its projection 427 intersects the path of circumferential rotation of portions 450 and 452. Projection 427 on valve cover 426 is configured as shown in FIG. 10 to extend into open space 420 and cross bore intersection 418 to an extent to abut first or second retainer portions 450 or 452 and prevent it from rotating out of retaining connection with groove 430.

[00073] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[00074] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[00075] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any

method or process so disclosed.

CLAIMS:

1. A fluid end of a pump comprising:
 - a bore formed in a portion of said fluid end; said bore having a long axis;
 - a discharge bore formed in a portion of said fluid end, said discharge bore having a long axis;
 - a suction bore formed in a portion of said fluid end, said suction bore having a long axis;
 - a valve cover bore formed in a portion of said fluid end, said valve cover bore having a central axis, said central axis extending into said bore;
 - a cross-bore intersection formed in a portion of said fluid end, said bore, discharge bore, valve cover bore, and suction bore each having an opening which opens into said cross-bore intersection, said suction bore long axis extends through said opening of said discharge bore which opens into said cross-bore intersection, said discharge bore long axis extends through said opening of said suction bore which opens into said cross-bore intersection, said valve cover bore axis extends through said opening of said bore which opens into said cross-bore intersection;
 - a bore transition area at said bore opening into said cross-bore intersection and adjacent cross-bore intersection;
 - a valve cover bore transition at said valve cover bore opening into said cross-bore intersection and adjacent said valve cover bore and cross-bore intersection;
 - a groove, said groove traverses a curvilinear path around an open space, said discharge bore and suction bore long axes each extend into said open space, said groove has a first section and a second section; said first section has a first end and a second end; said second section has a first end and a second end; said first and second sections each have a closed base opposite and an open side of each section, said first and second sections each have a first angled surface and a second angled surface, the first angled surface and second angled surface of the first section converge towards each other towards the base of the first section, the angle formed between the first angled surface and second angled surface of the first section is between 90° and

180°; the first angled surface and second angled surface of the second section converge towards each other towards the base of the second section, the angle formed between the first angled surface and second angled surface of the second section is greater than 90° and less than 180°;

a gap is between said first ends of said first and second sections of said groove;

a gap is between said second ends of said first and second sections of said groove

a retainer is disposed in the fluid end and is adapted to support a stem of a suction valve, said spring retainer comprising:

a first portion having a first surface and a second surface, the first surface is angled relative to the second surface, the exterior angle formed by the surfaces is greater than 180° and less than 270°;

a second portion having a first surface and a second surface, the first surface is angled relative to the second surface, the exterior angle formed by the surfaces is greater than 180° and less than 270°;

a base from which the first portion extends and the second portion extends, the base has a valve guide aperture which is adapted to receive the stem of the suction valve;

wherein a third surface of the retainer first portion is angled outwardly relative to the base; and wherein a third surface of the retainer second portion is angled outwardly relative to the base.

2. A retainer adapted to support a stem of a suction valve in a pump, said retainer comprising:

a first portion having a first surface and a second surface, the first surface is angled relative to the second surface, the exterior angle formed by the surfaces is greater than 180° and less than 270°;

a second portion having a first surface and a second surface, the first surface is angled relative to the second surface, the exterior angle formed by the surfaces is greater than 180° and less than 270°;

a base from which the first portion extends and the second portion extends, said base having a valve guide aperture to receive said stem of said suction valve;

wherein a third surface of the retainer first portion is angled outwardly relative to the base, and

wherein a third surface of the retainer second portion is angled outwardly relative to the base.

3. The retainer of claim 2 wherein the base includes a first end and a second end and the third surface of the retainer first portion is angled relative to said first end at an angle between around forty-five (45) degrees and around one-hundred thirty-five (135) degrees, and the third surface of the retainer second portion is angled relative to said second end at an angle between around forty-five (45) degrees and around one-hundred thirty-five (135) degrees.

4. The retainer of claim 2 wherein said first surface and said second surface of said first portion define a first key and said first surface and said second surface of said second portion define a second key wherein said first and second keys are configured to be received into a groove within a cross-bore intersection of a fluid end of said pump.

5. The retainer of claim 4 wherein said first and second key are substantially orthogonal to a wall including a groove within a cross-bore intersection of a fluid end of a piston pump when said spring retainer is in an installed position.

6. The retainer of claim 2 wherein the base further includes an upper surface and a lower surface which define a thickness and the base includes a valve guide aperture through the thickness of said base, wherein the valve guide aperture is sized to receive a valve stem of a suction valve.

7. The retainer of claim 2 wherein the base includes an upper surface and a lower surface that defines a thickness and the base includes a spring receiving boss extending outwardly from said lower surface of said base.

8. The retainer of claim 7 wherein the said valve guide aperture extends through the thickness of said base and through said spring receiving boss wherein the valve guide aperture is sized to receive said valve stem of a suction valve.

9. The retainer of claim 8 wherein the valve guide aperture includes a step in thickness defining a first section of a first diameter and a second section of a second diameter wherein the first diameter is smaller than the second diameter and wherein said valve guide aperture includes a valve guide insert disposed within said second section.

10. The retainer of claim 2 wherein the base includes a first side and a second side which define a width wherein said width is less than a diameter of a valve cover bore of a piston pump.

11. The retainer of claim 2 wherein the base further includes an upper surface and a lower surface which define a thickness;

the first portion includes a fourth surface opposite said third surface, said third and fourth surfaces define a first portion thickness;

the second portion includes a fourth surface opposite said third surface, said third and fourth surfaces define a second portion thickness; and

wherein the first and second portion thicknesses are less than the thickness of the base.

12. A spring retainer adapted to support a spring of a suction valve in a pump, said spring retainer comprising:

a base having a first end, a second end, an upper surface and a lower surface;

a first portion extending outwardly from said first end of said base, said first portion including a first end and a second end, said first end proximate said base and said second end including a first key defined by a first surface and a second surface, said first and second surfaces angled outwardly and intersecting to form an exterior angle being greater than 180° and less than 270° , said first portion extending at an angle from said first end of said base, the angle being around forty-five (45) degrees to around one-hundred thirty-five (135) degrees;

a second portion extending outwardly from said second end of said base, said second portion including a first end and a second end, said first end proximate said base and said second end including a second key defined by a first surface and a second surface, said first and second surfaces angled outwardly and intersecting at an exterior angle being greater than 180° and less than 270° , said second portion extending at an angle from said first end of said base, the angle being around forty-five (45) degrees to around one-hundred thirty-five (135) degrees;

a spring-retaining boss extending outwardly from said lower surface of said base; and

a valve guide aperture through said upper surface and lower surface of said base and through said spring-retaining boss, said valve guide aperture being sized to receive a valve stem of a suction valve.

13. The retainer according to any one of claims 1-12 wherein the pump is a piston pump.

14. The retainer of claims 1 or 2 wherein the third surface of the first portion intersects an axial extending surface of said base, the axial surface extends away from the point of intersection towards an upper surface of the base; the upper surface and a portion of the axial surface are above the point of intersection; and

wherein the third surface of the second portion intersects an axial extending surface of said base, the axial surface extends away from the point of intersection

towards an upper surface of the base; the upper surface and a portion of the axial surface are above the point of intersection.

FIG. 1

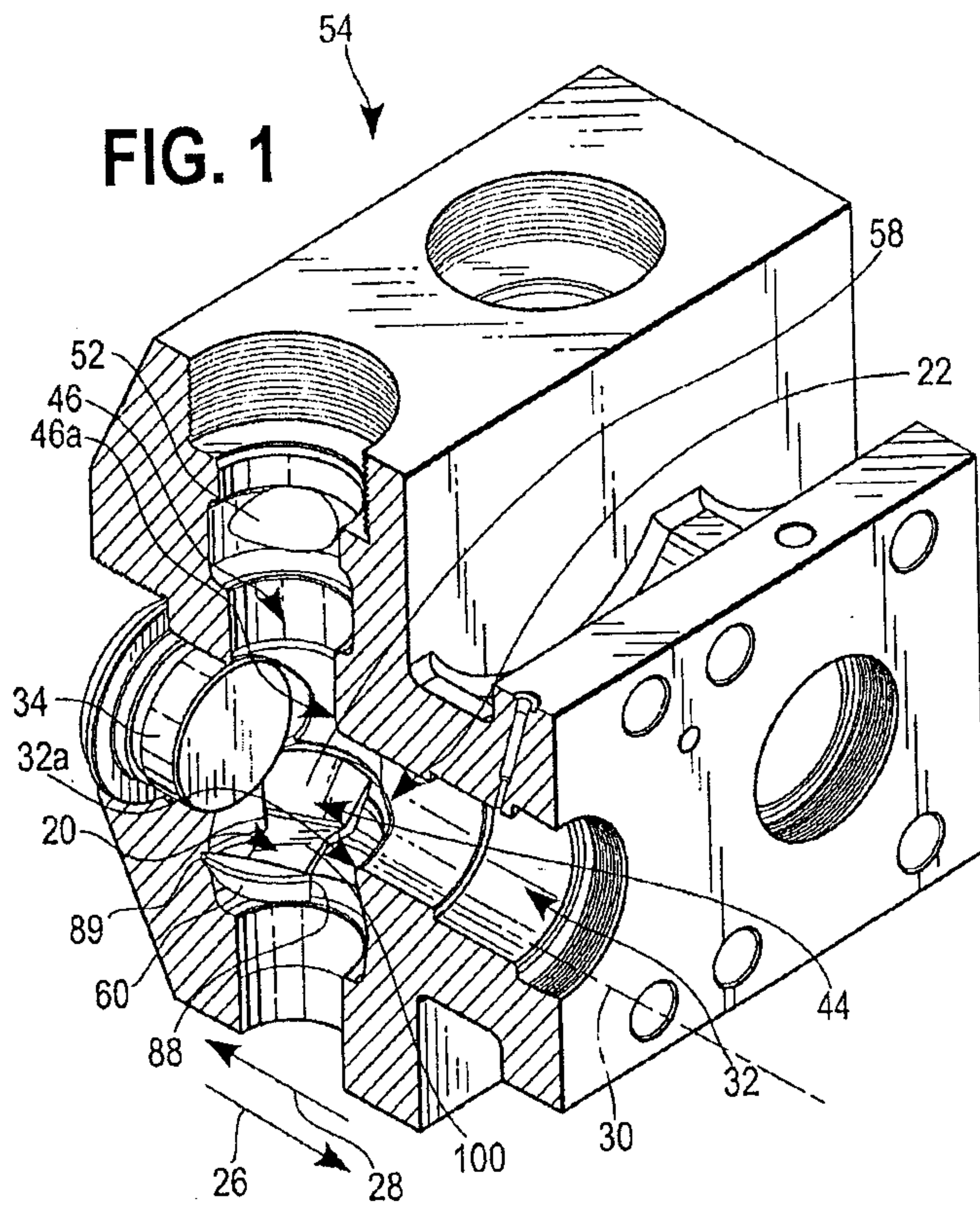
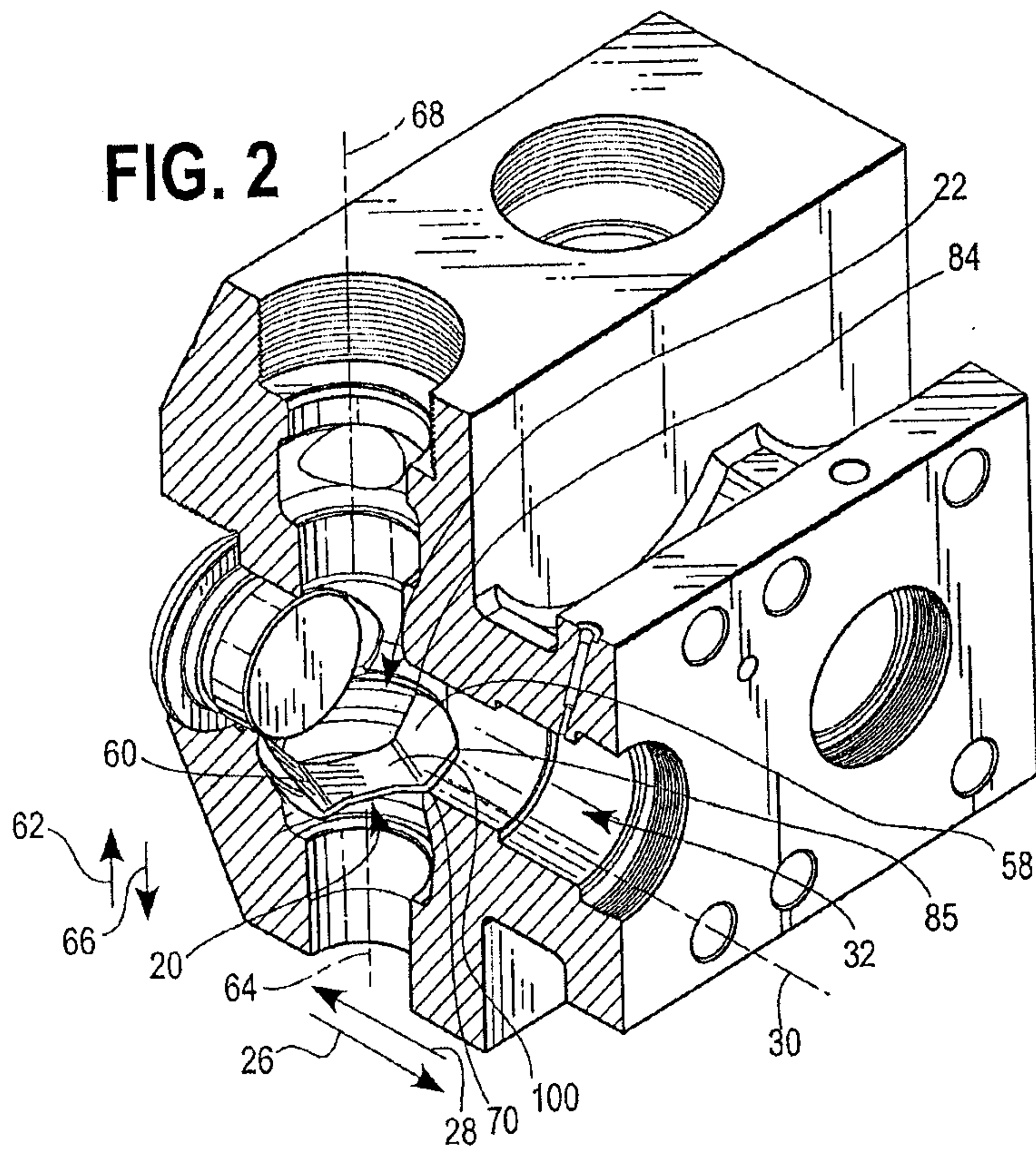
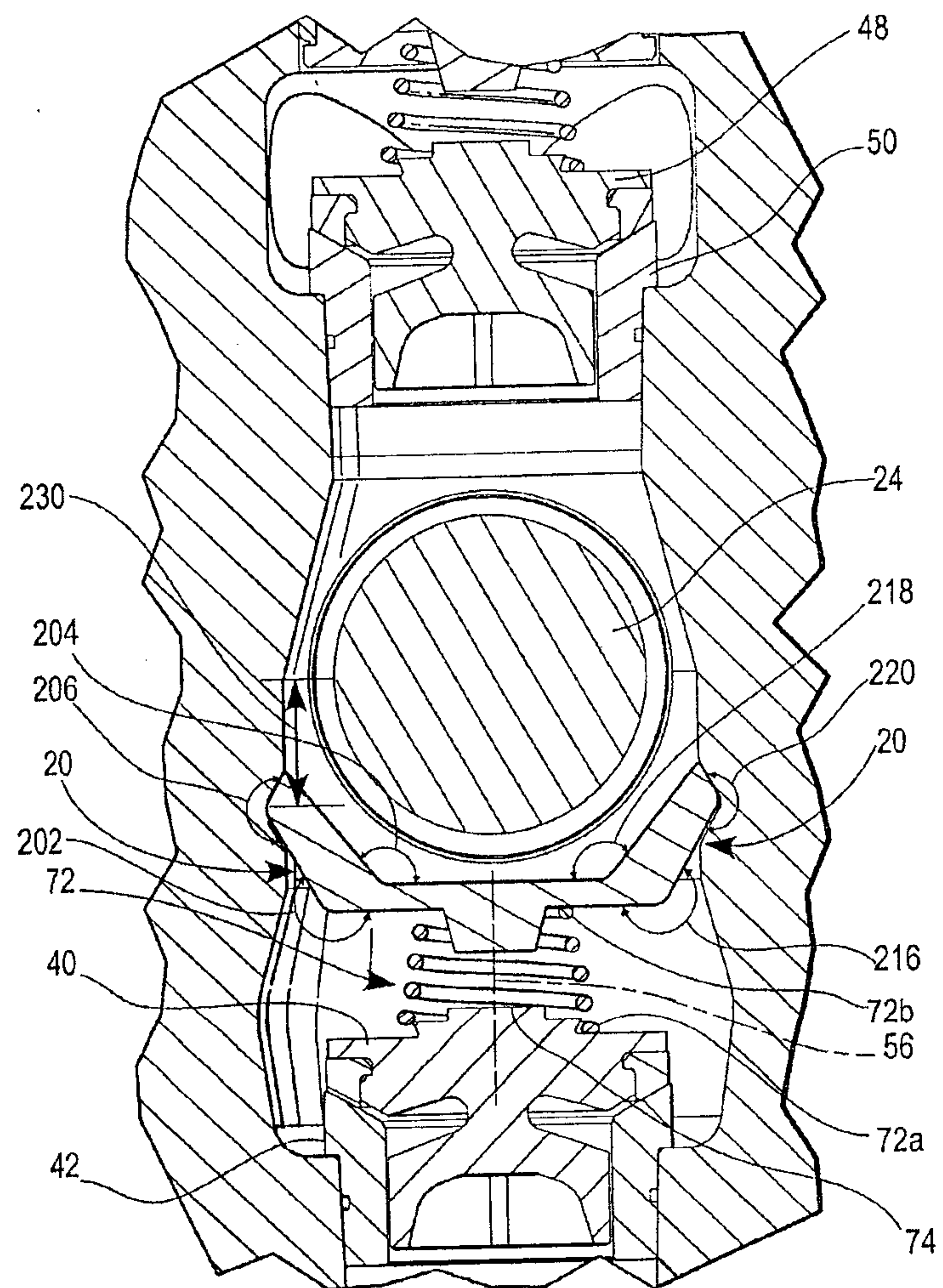
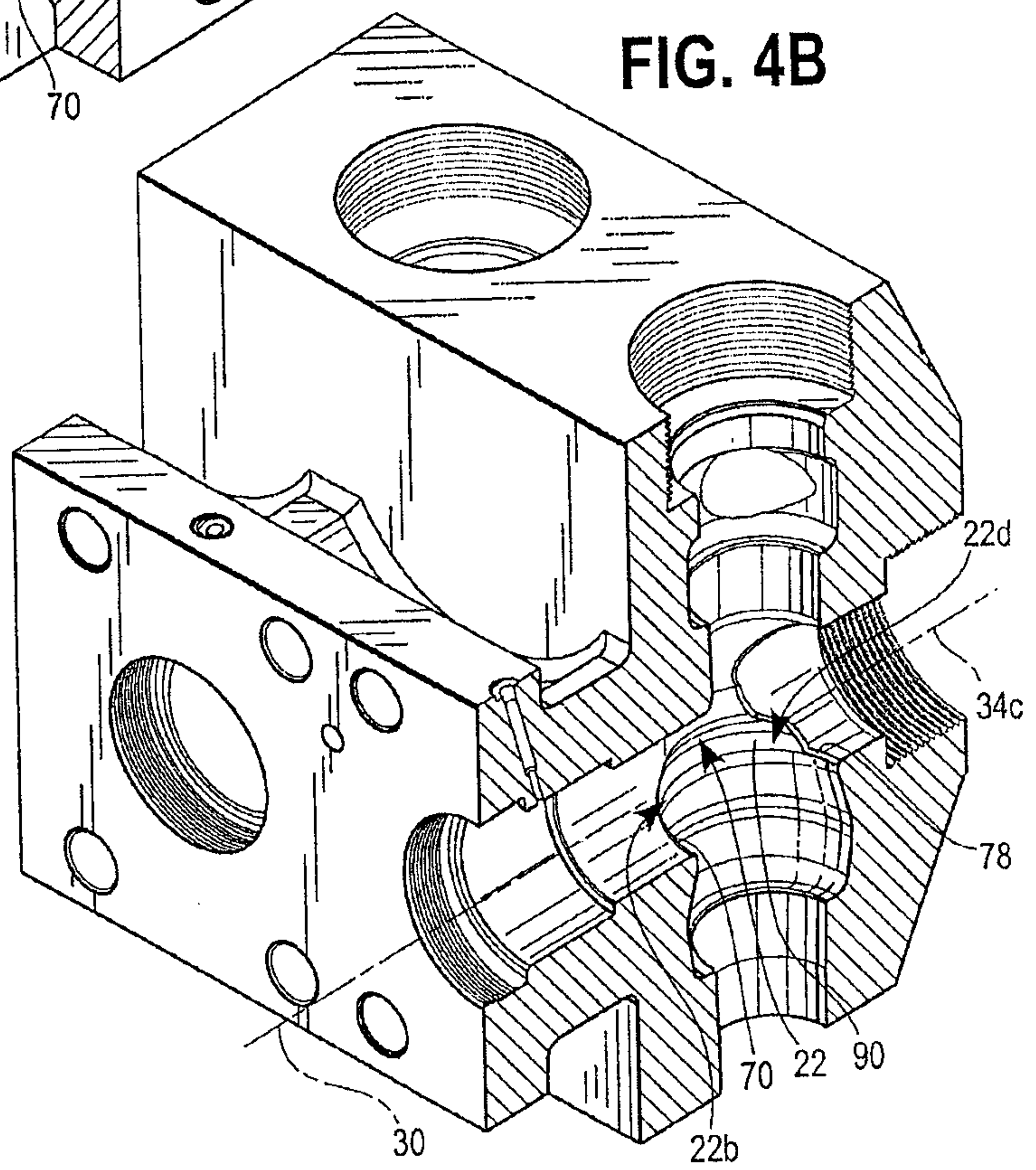
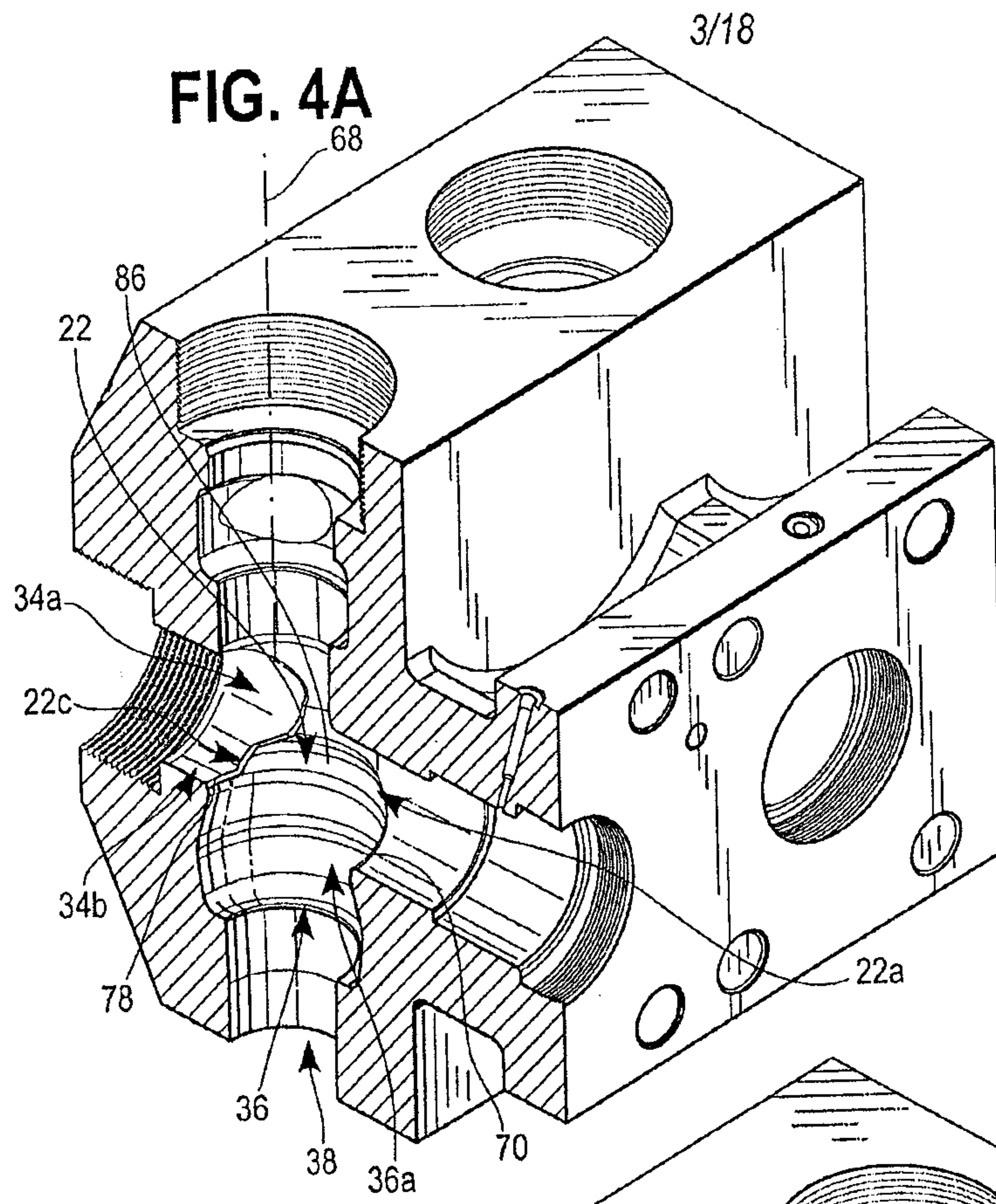


FIG. 2



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FIG. 3



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FIG. 4C

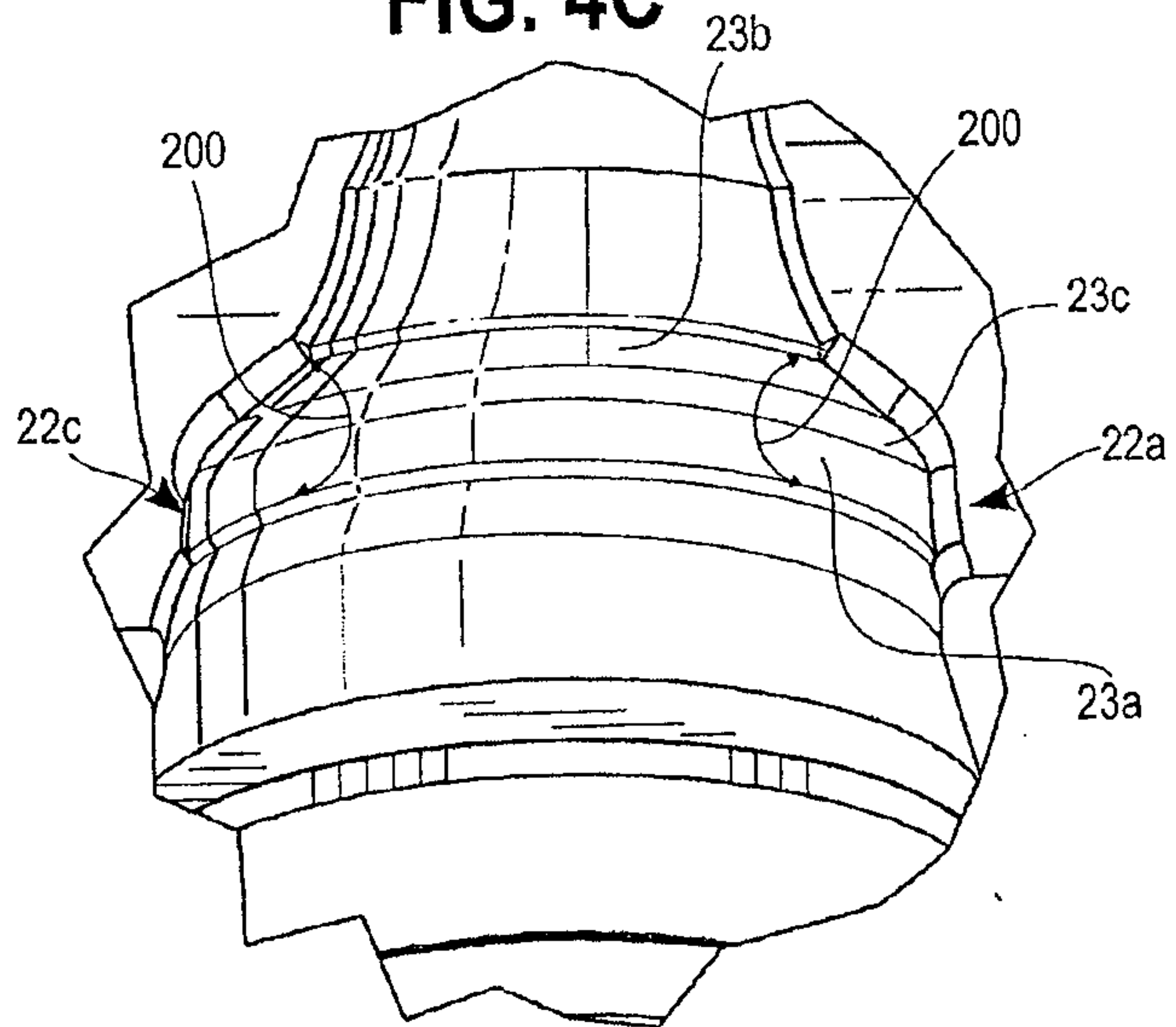
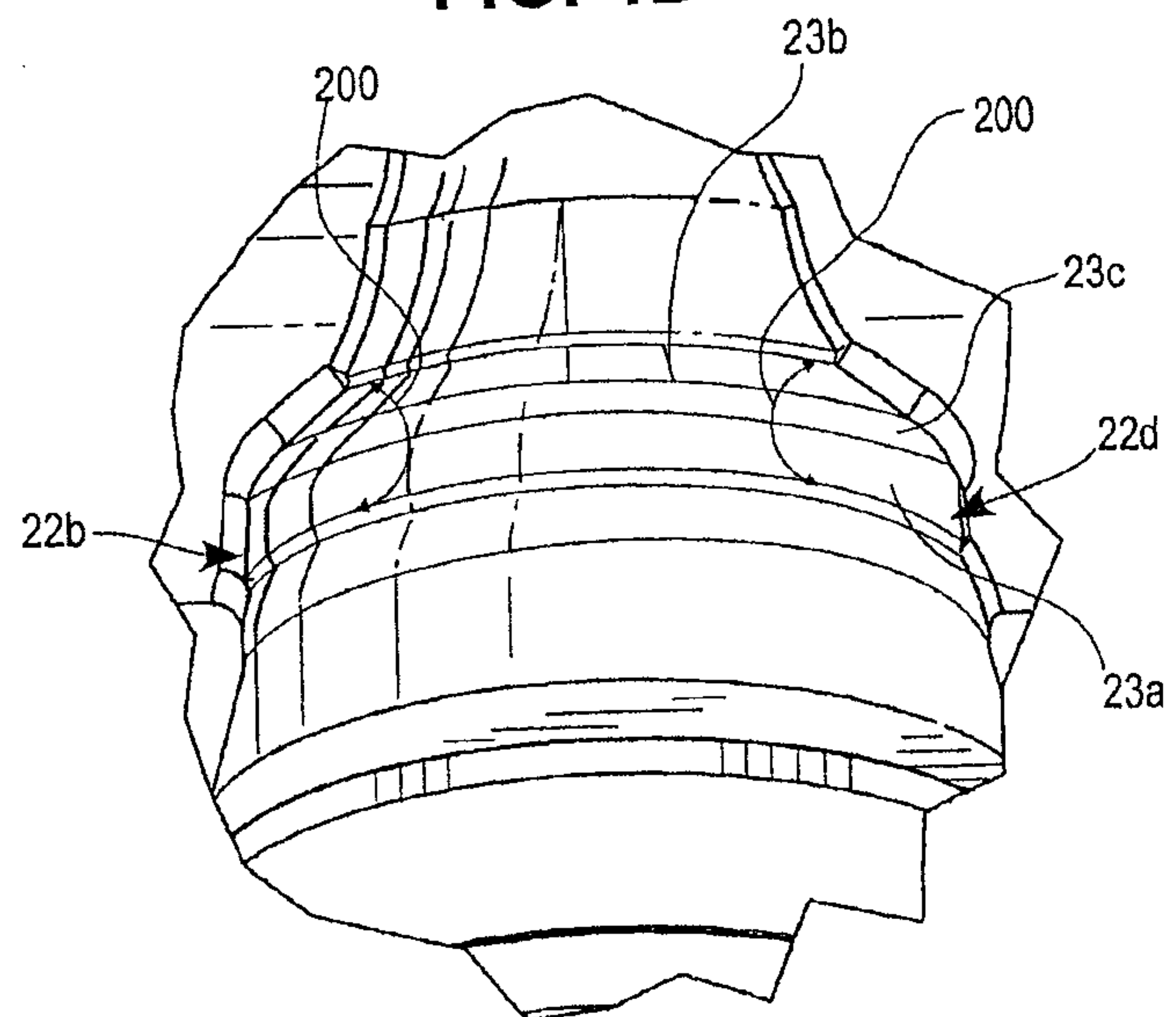


FIG. 4D



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FIG. 5

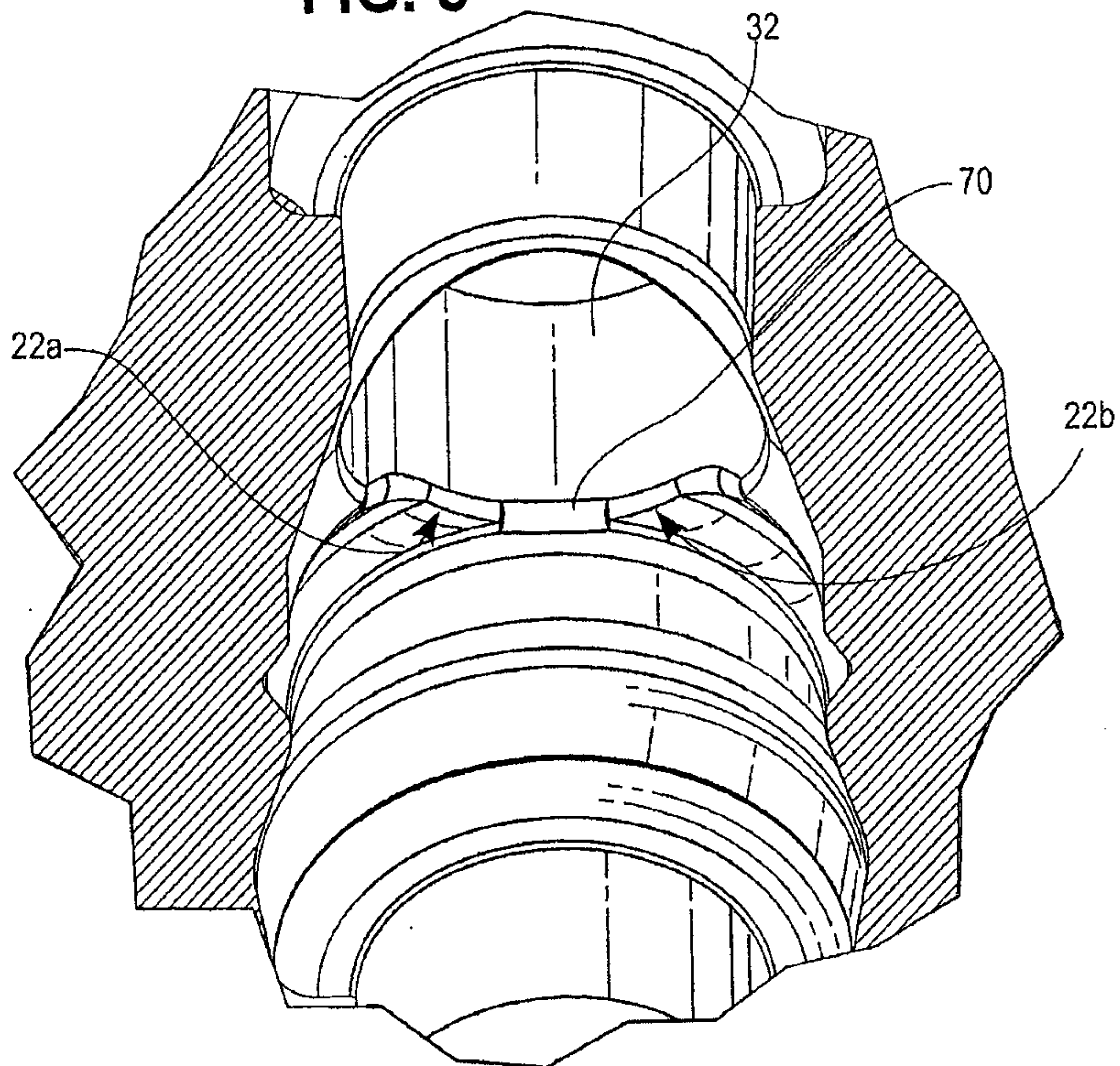
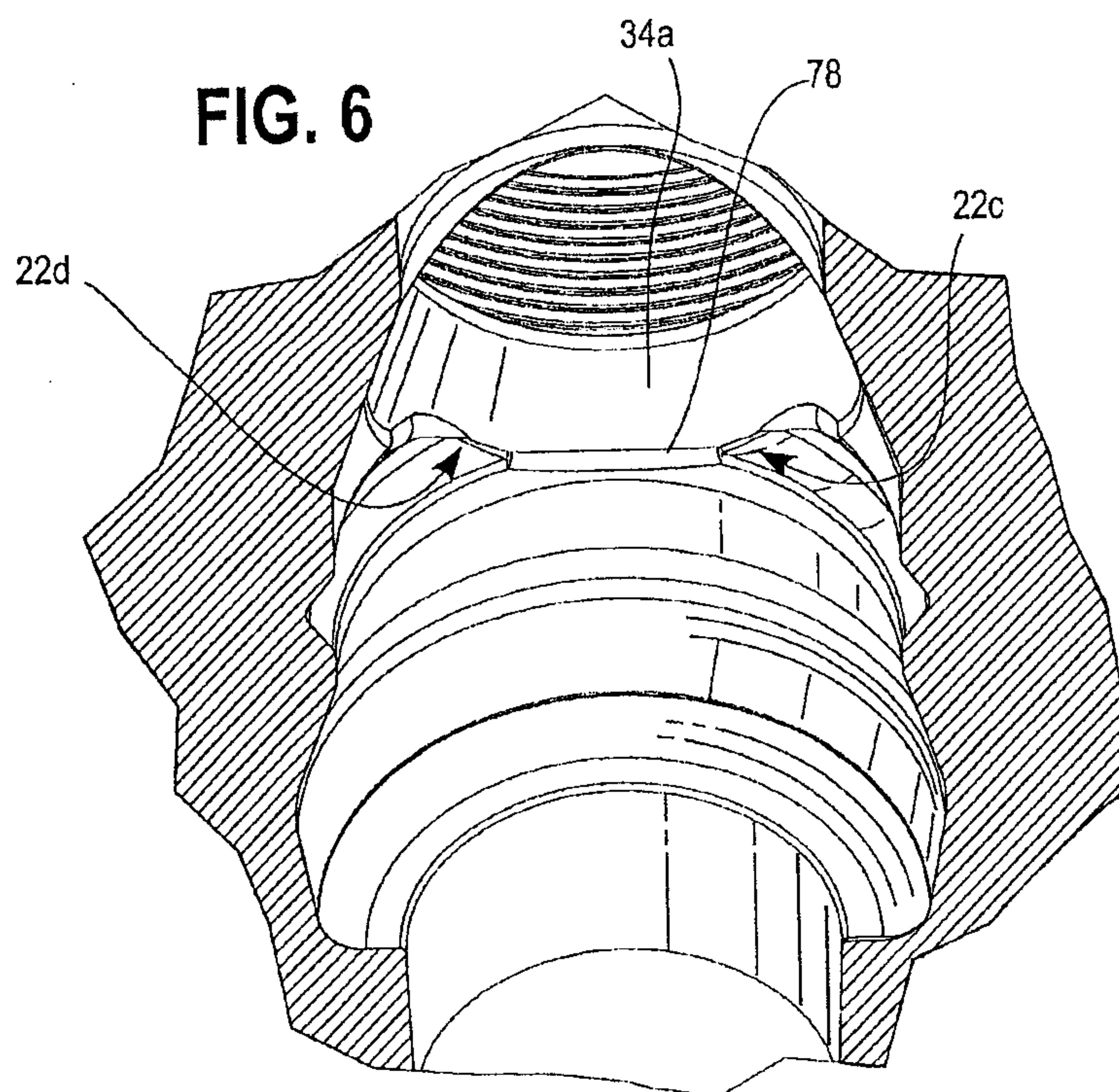
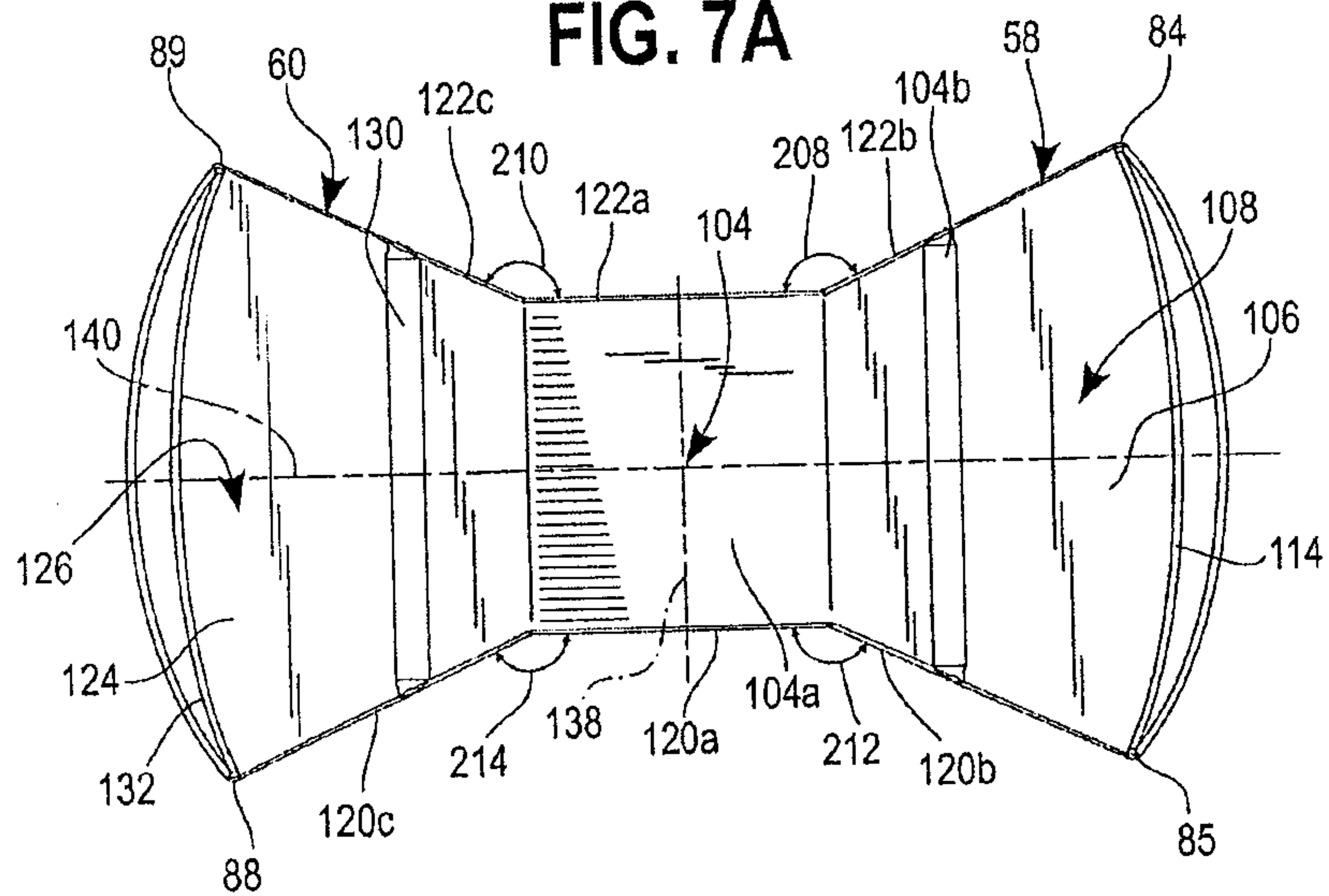
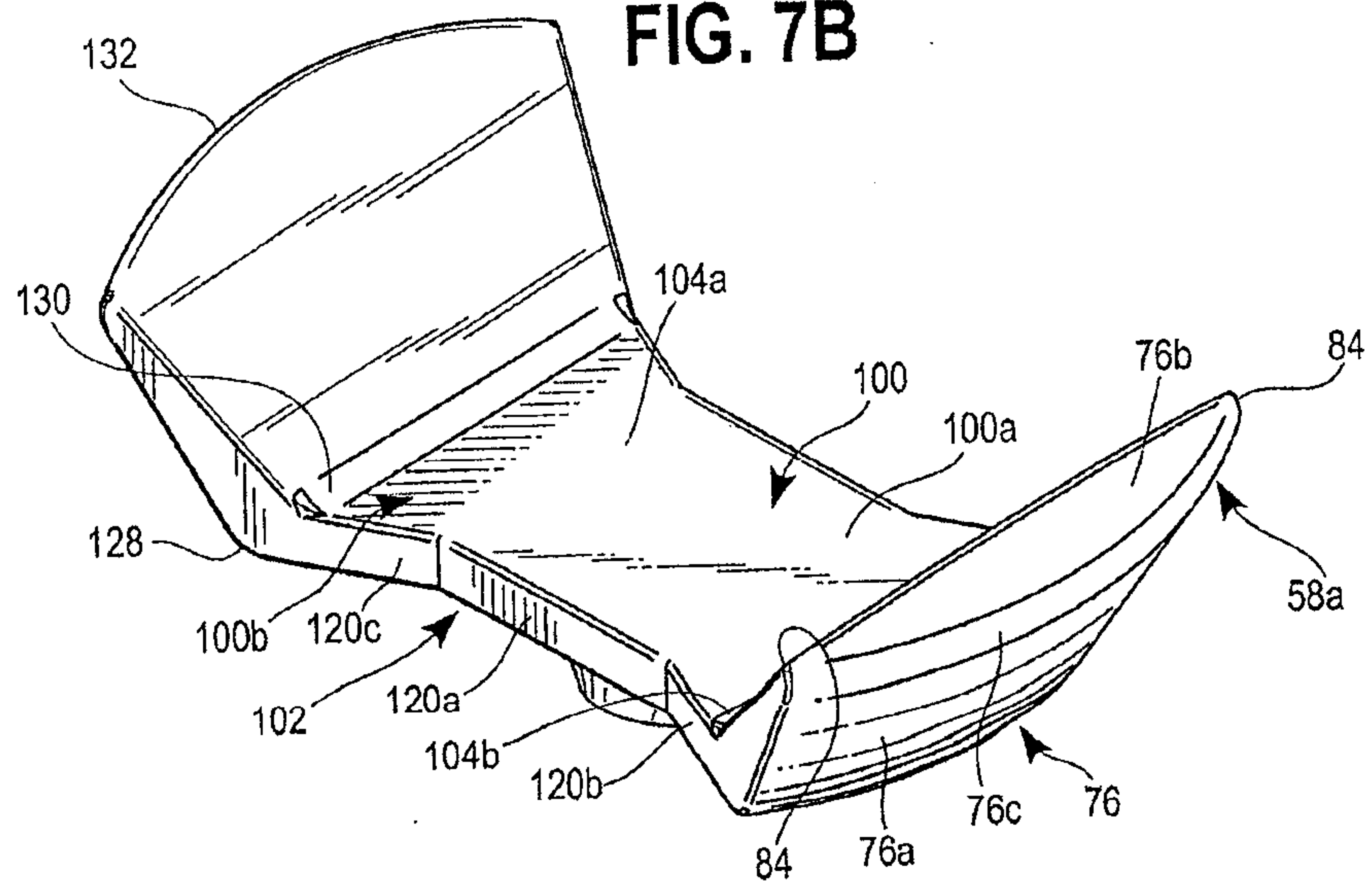
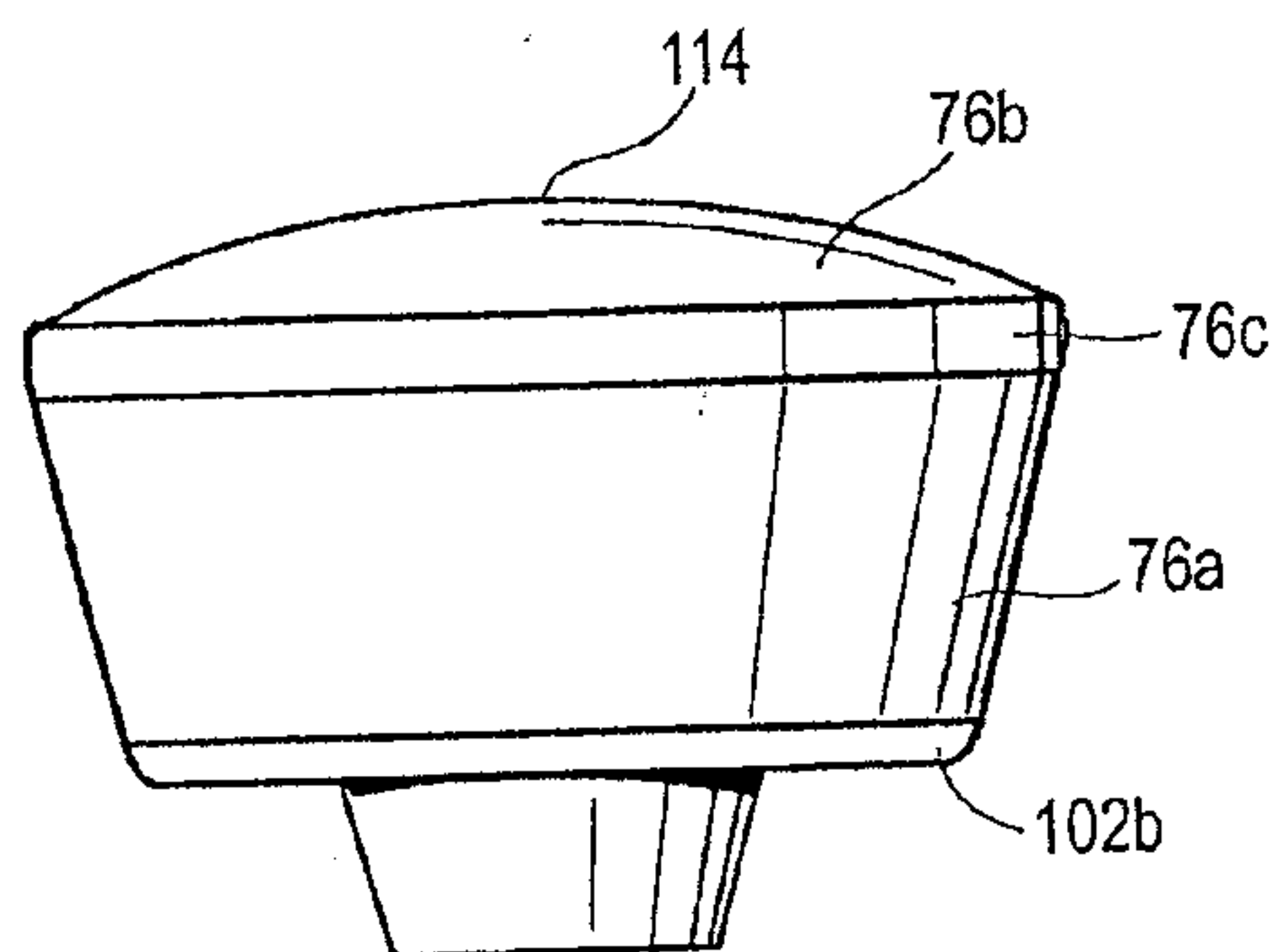
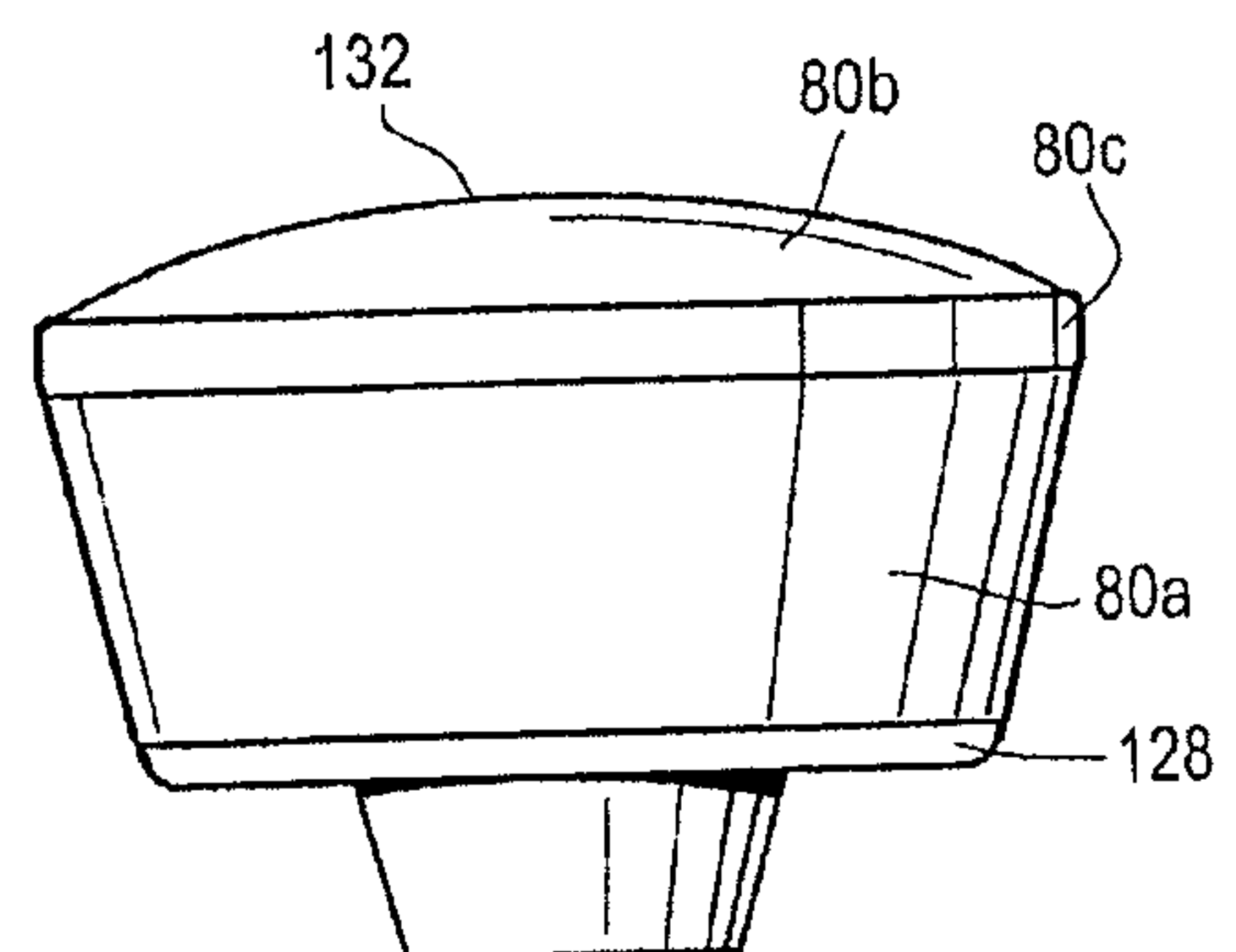


FIG. 6



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FIG. 7A**FIG. 7B****FIG. 7C****FIG. 7D**

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FIG. 7E

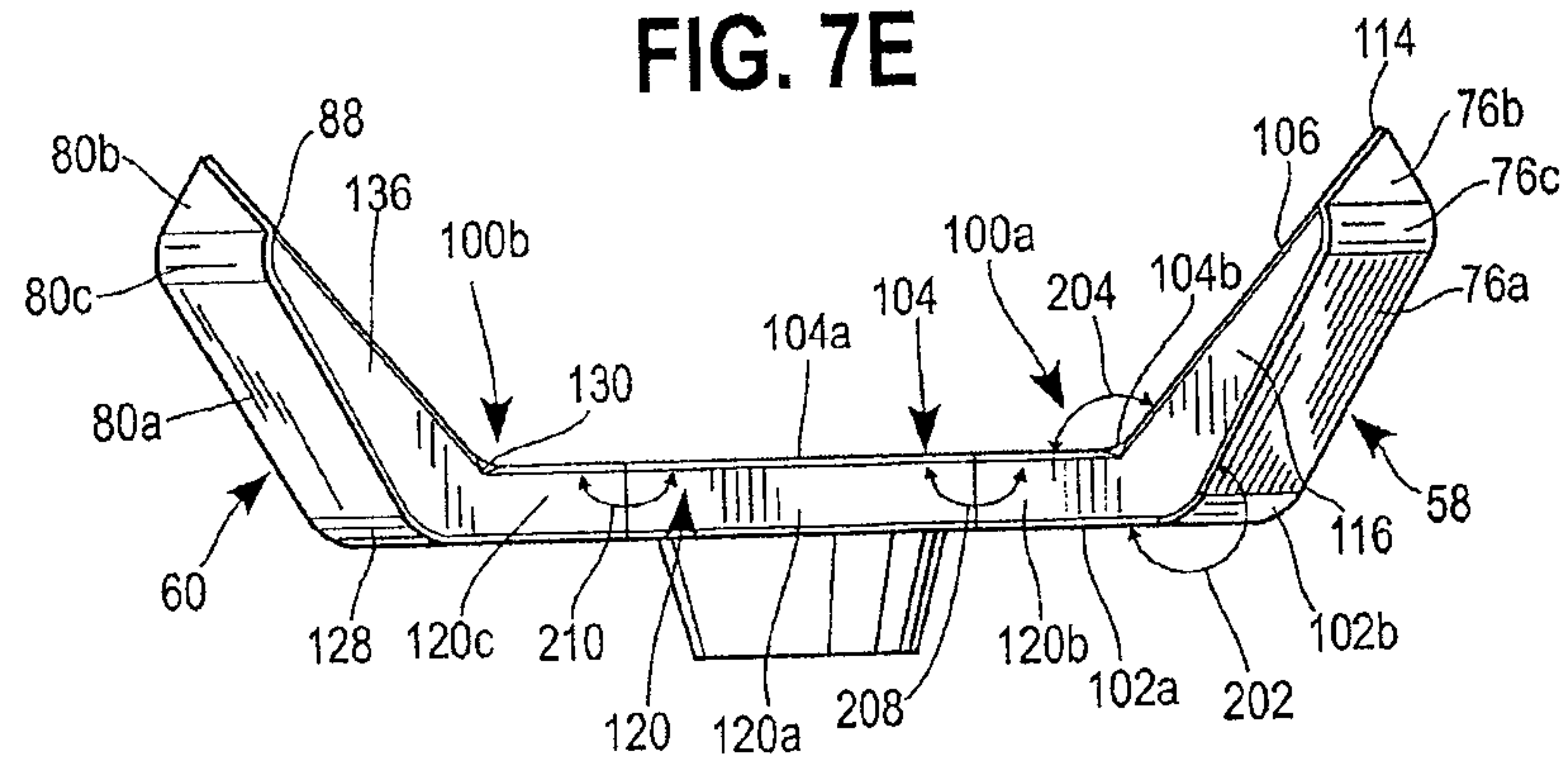


FIG. 7F

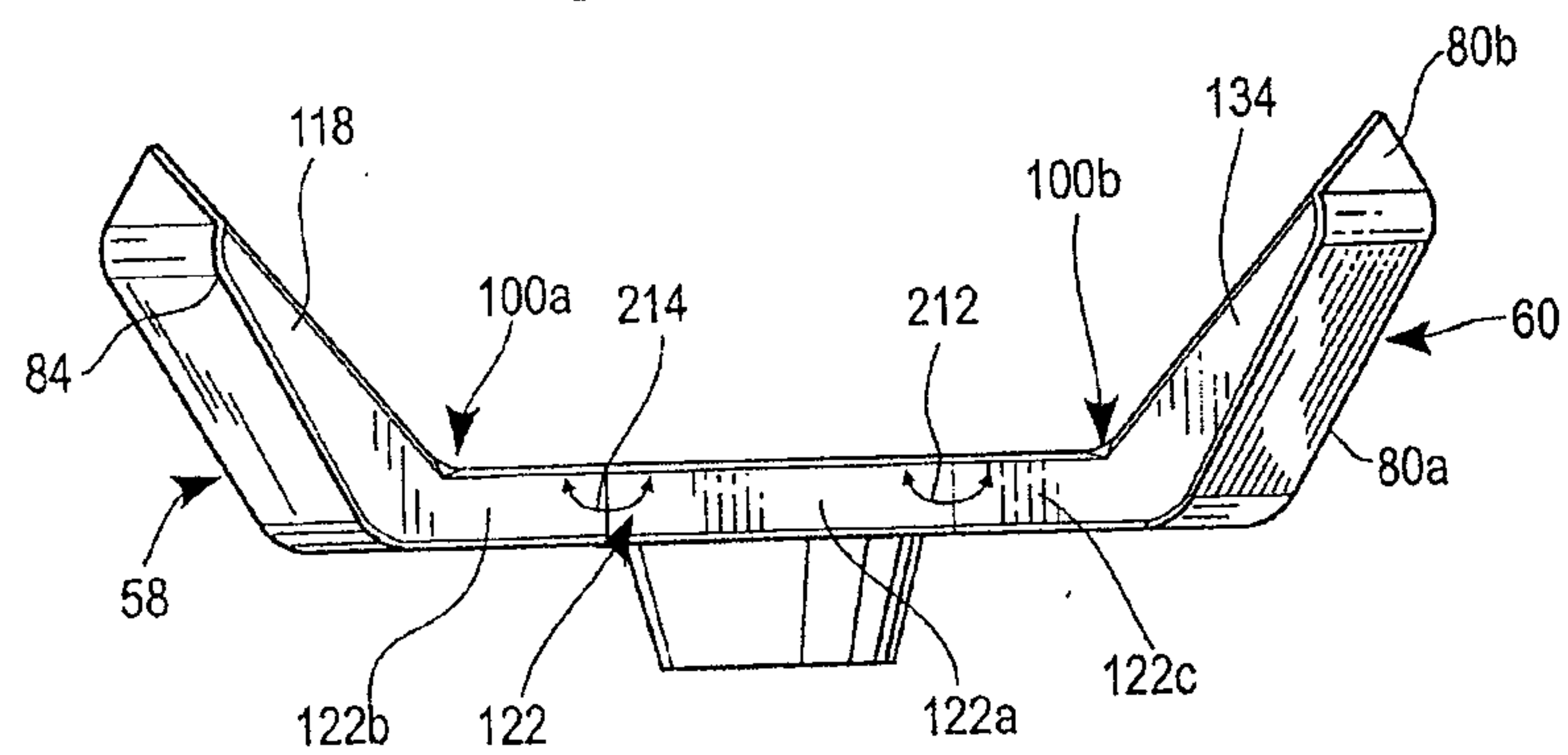


FIG. 7G

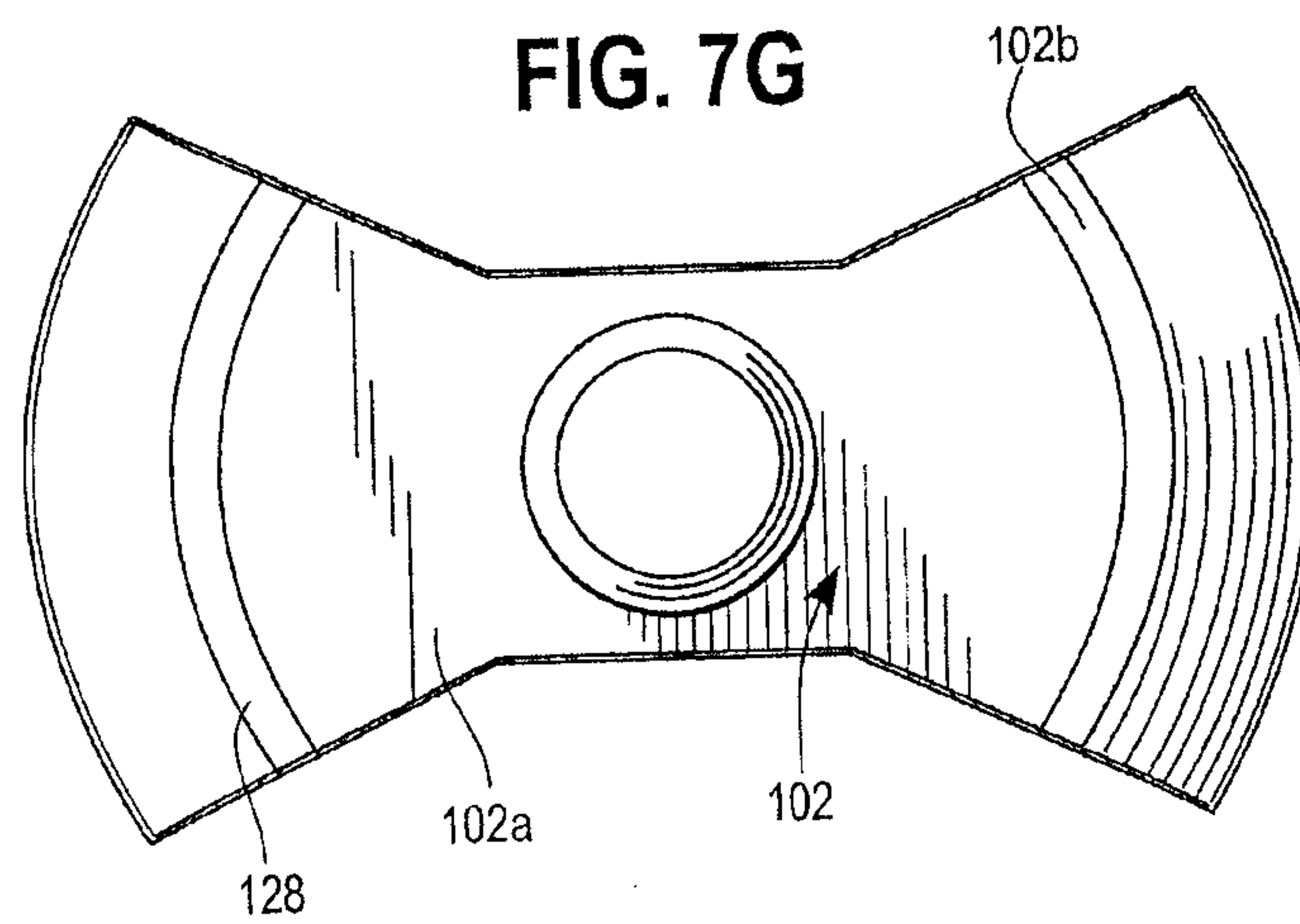
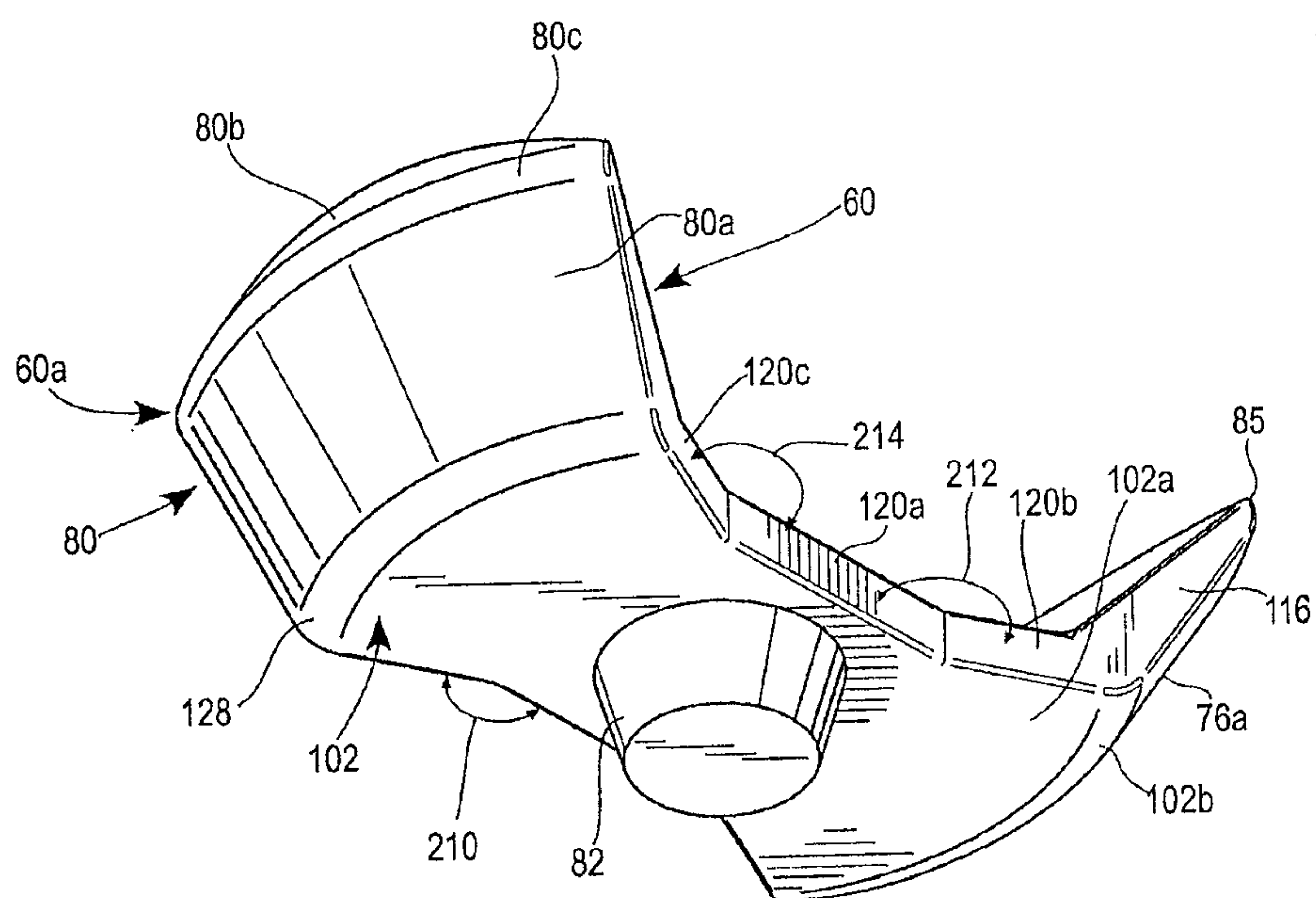


FIG. 7H



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FIG. 8

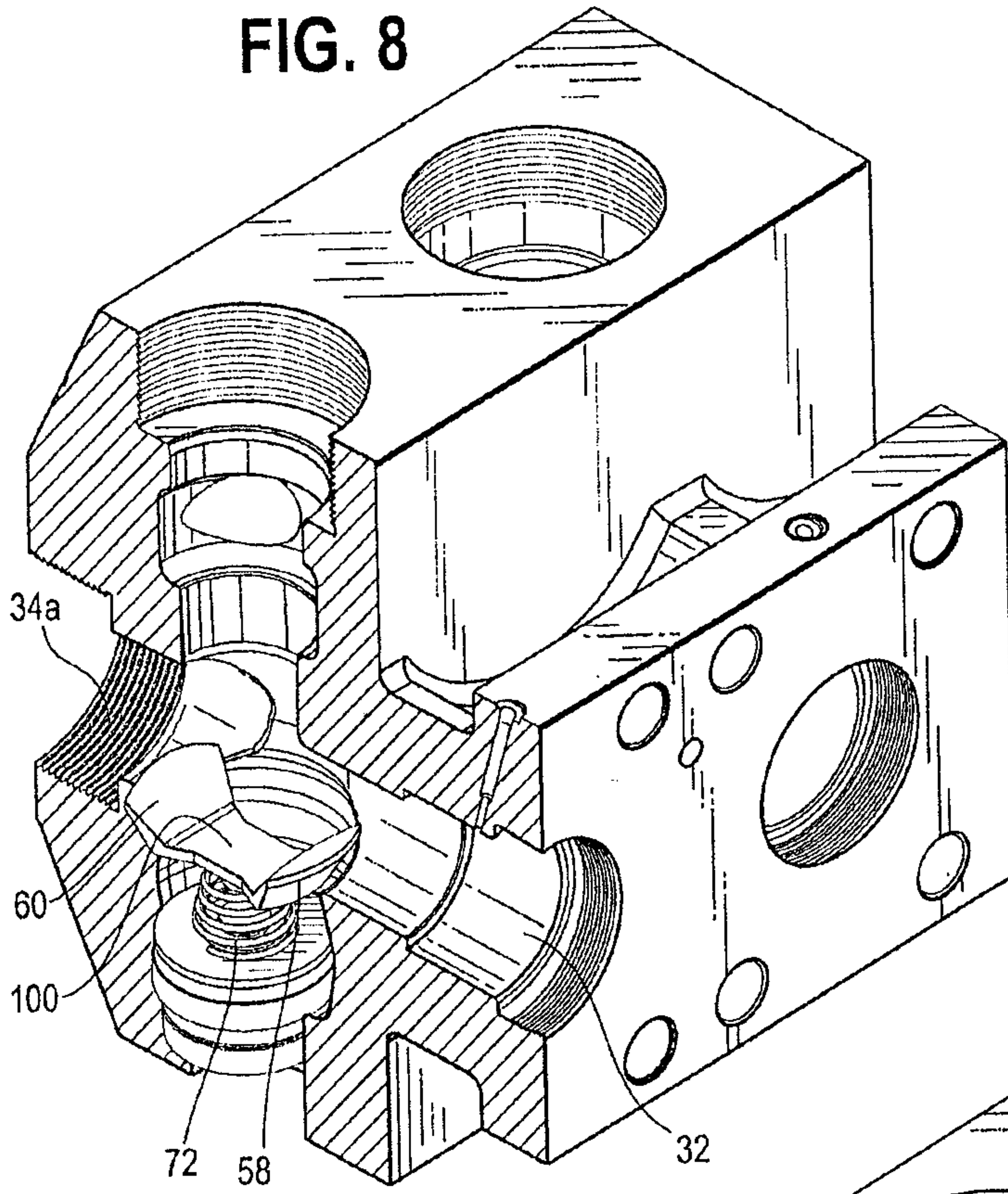
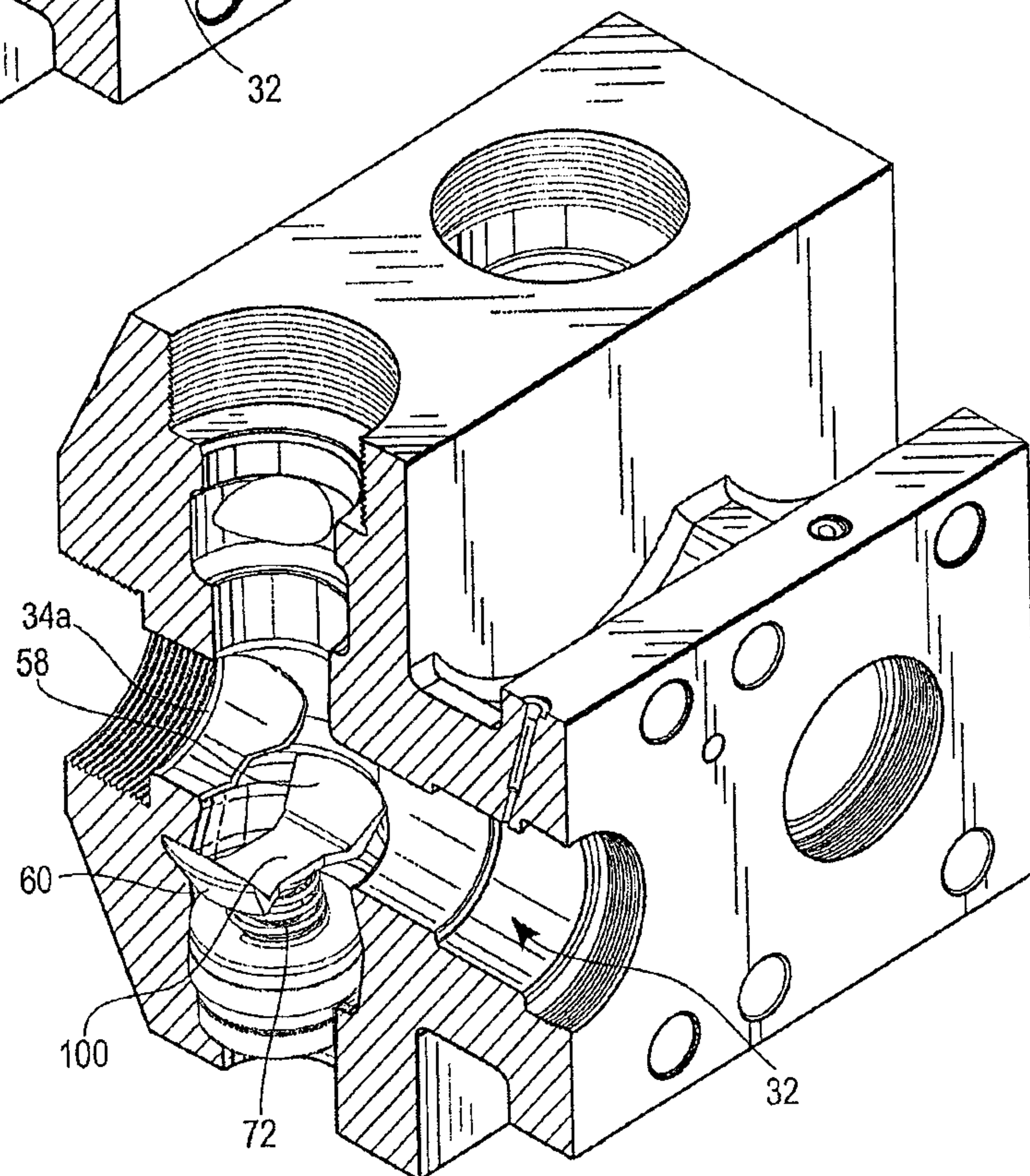
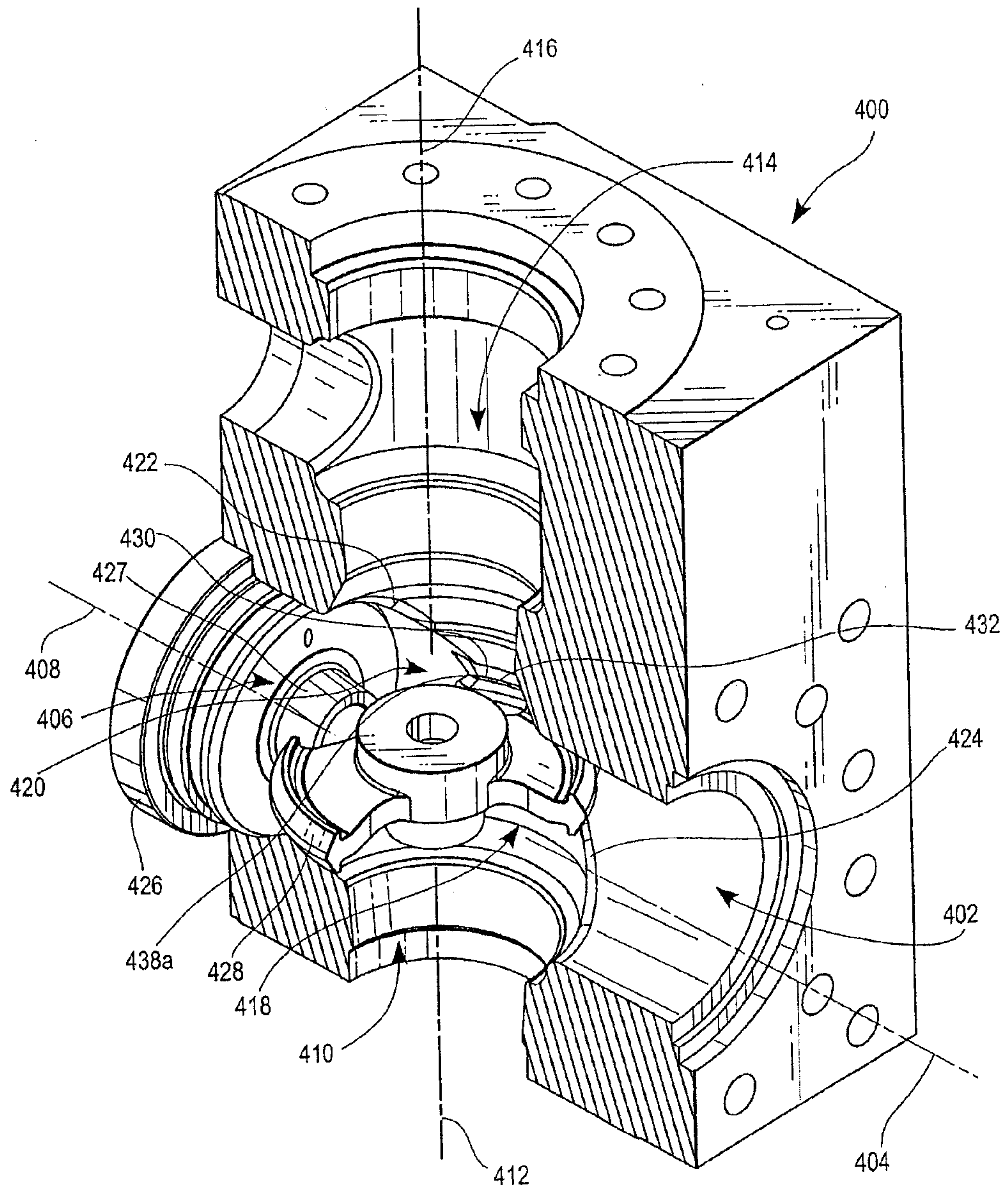


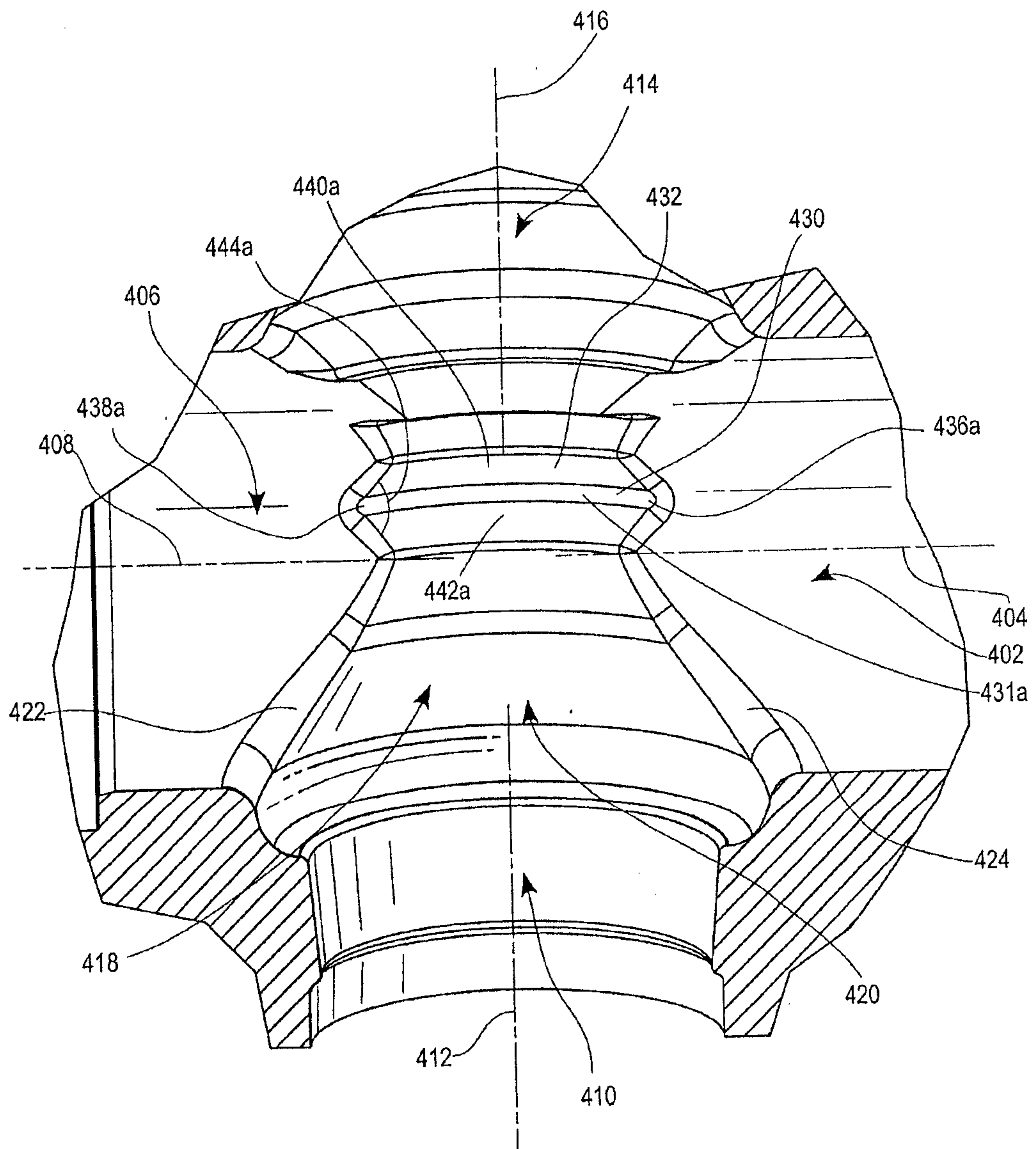
FIG. 9

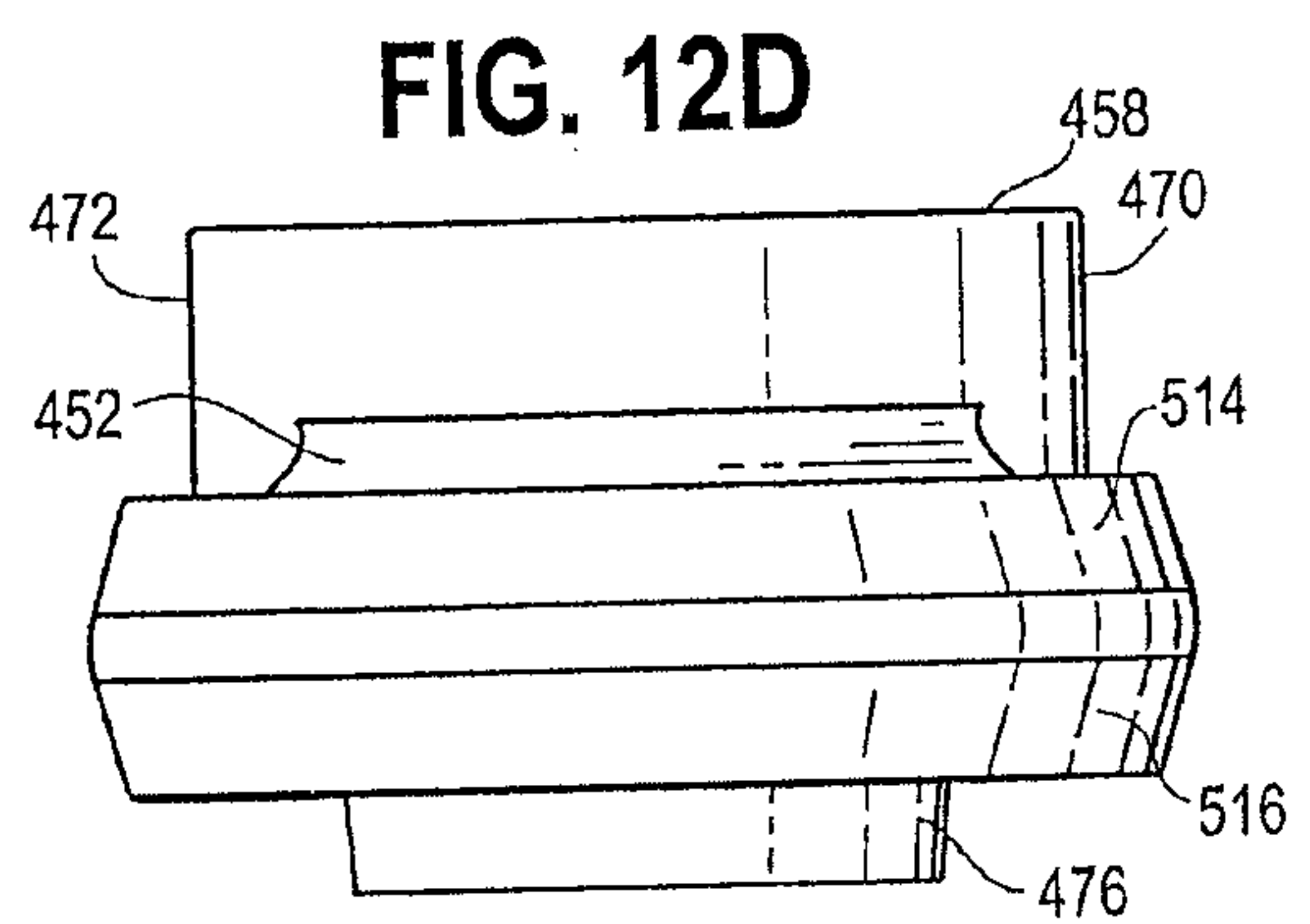
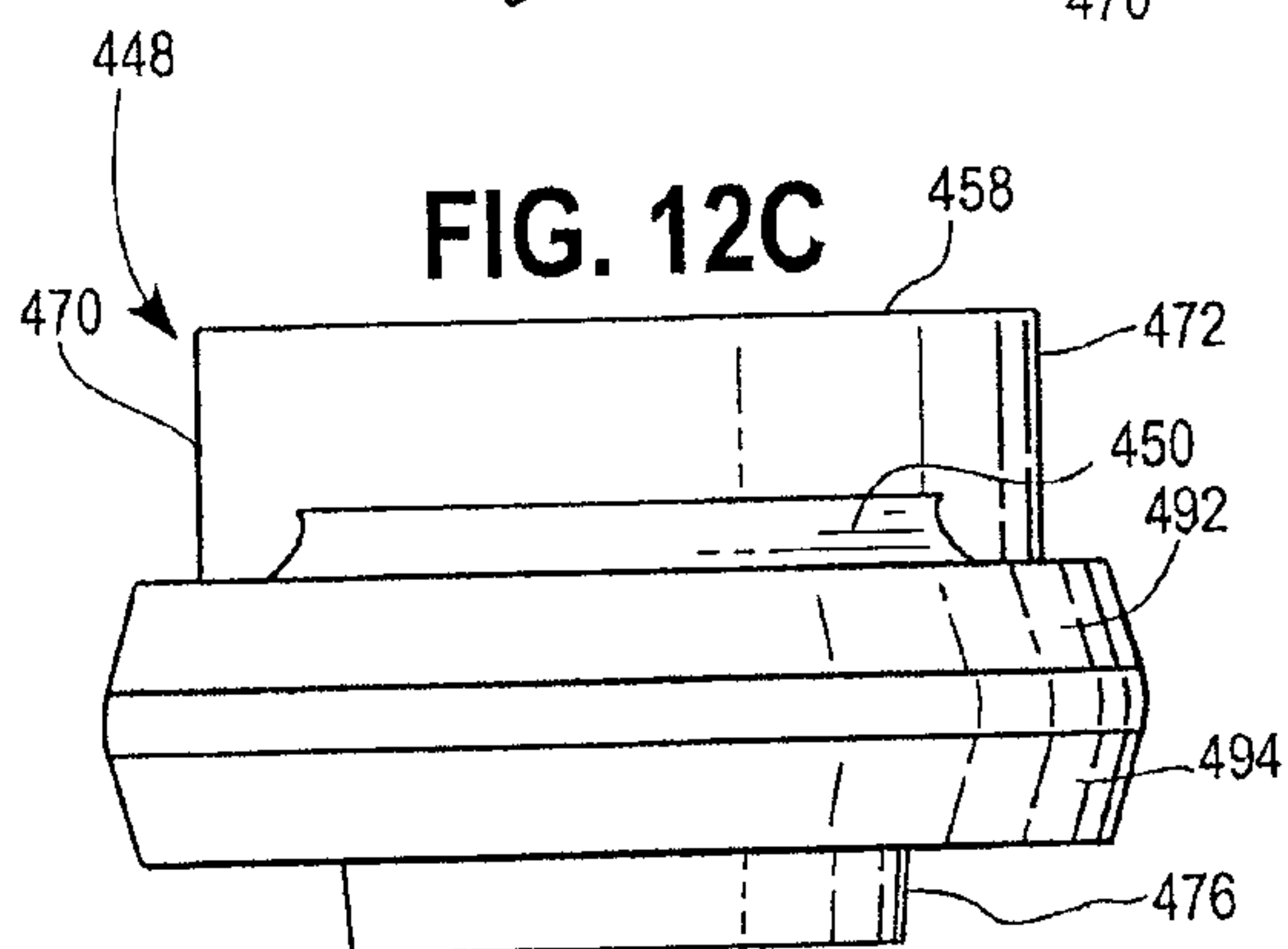
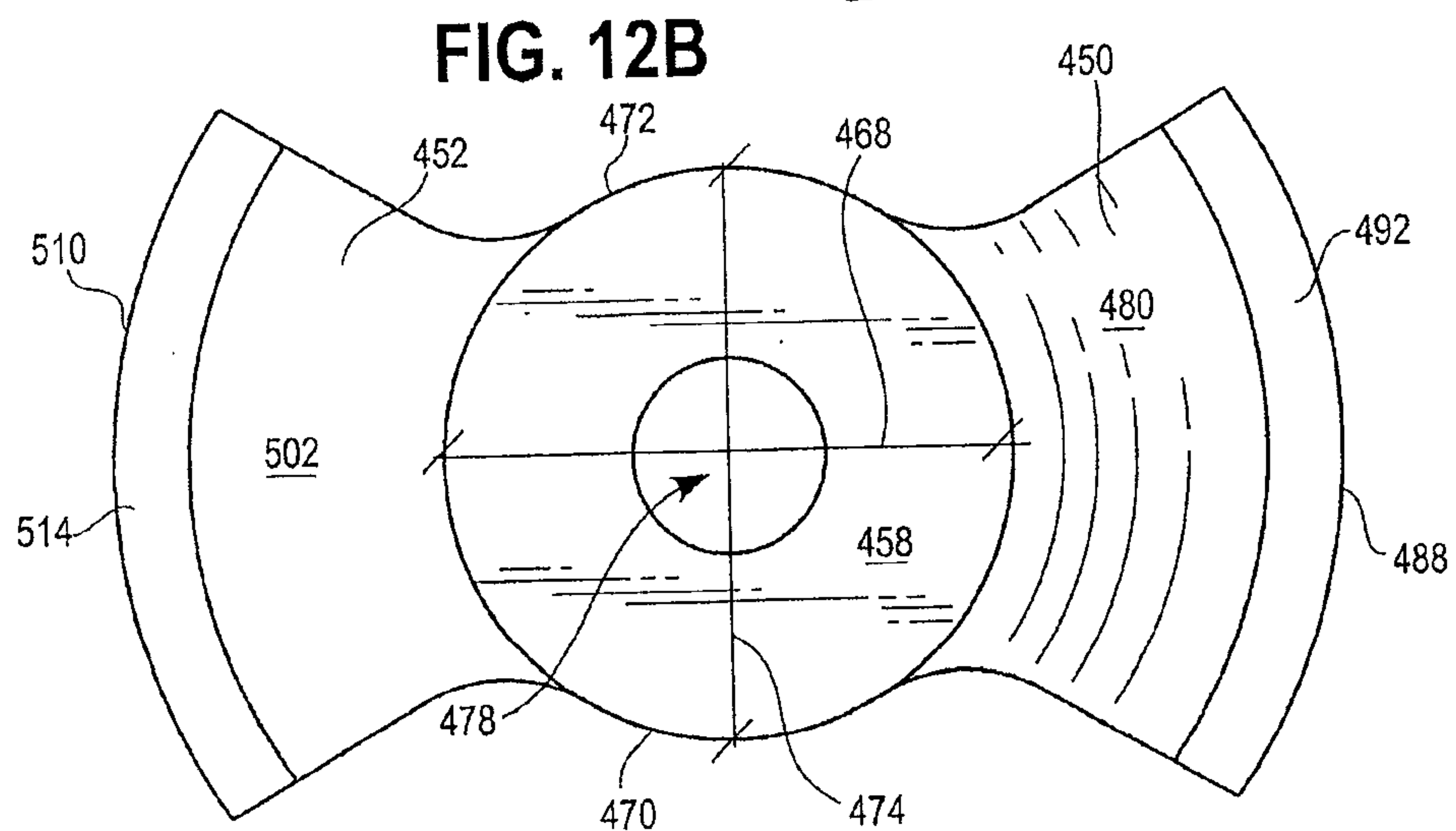
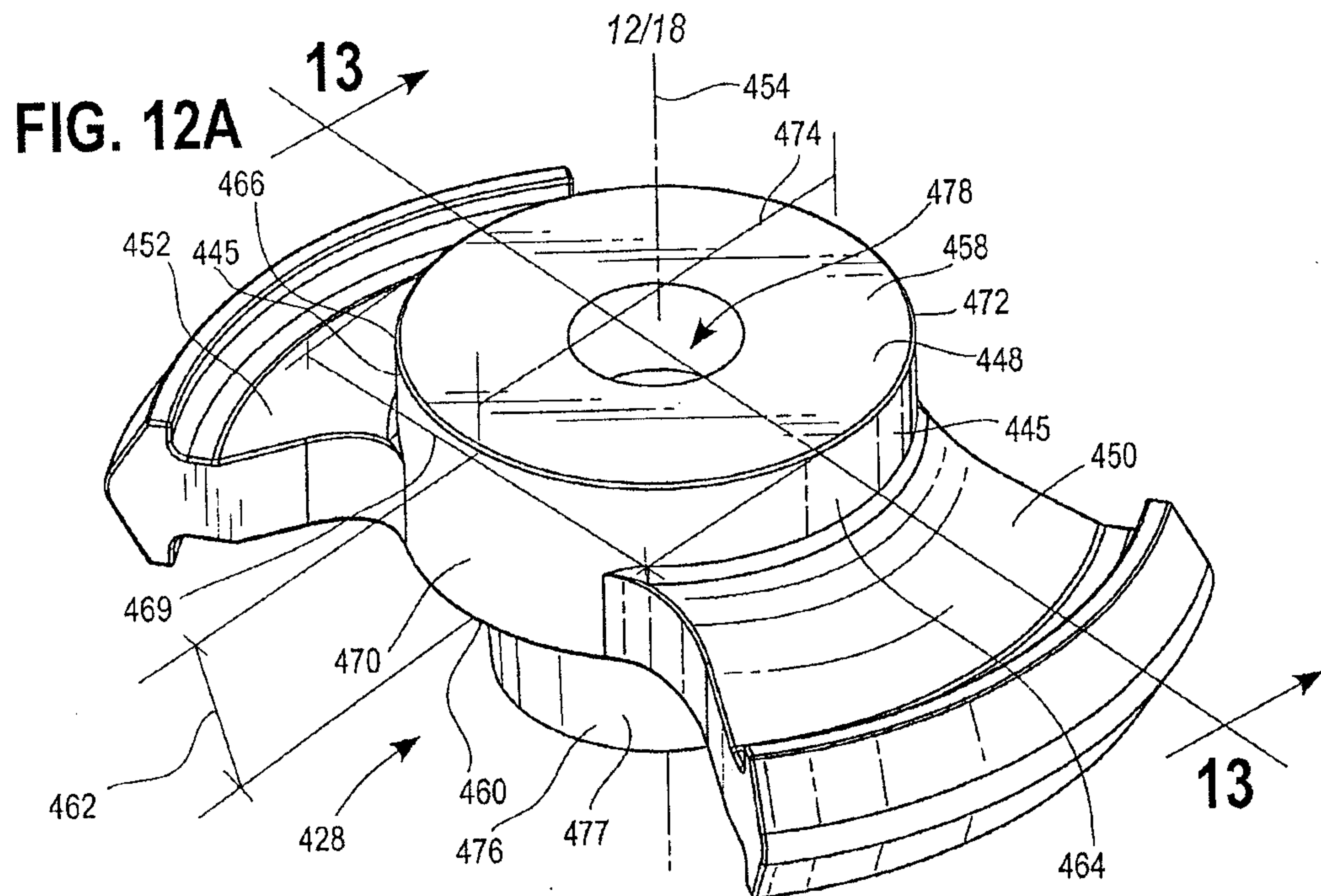


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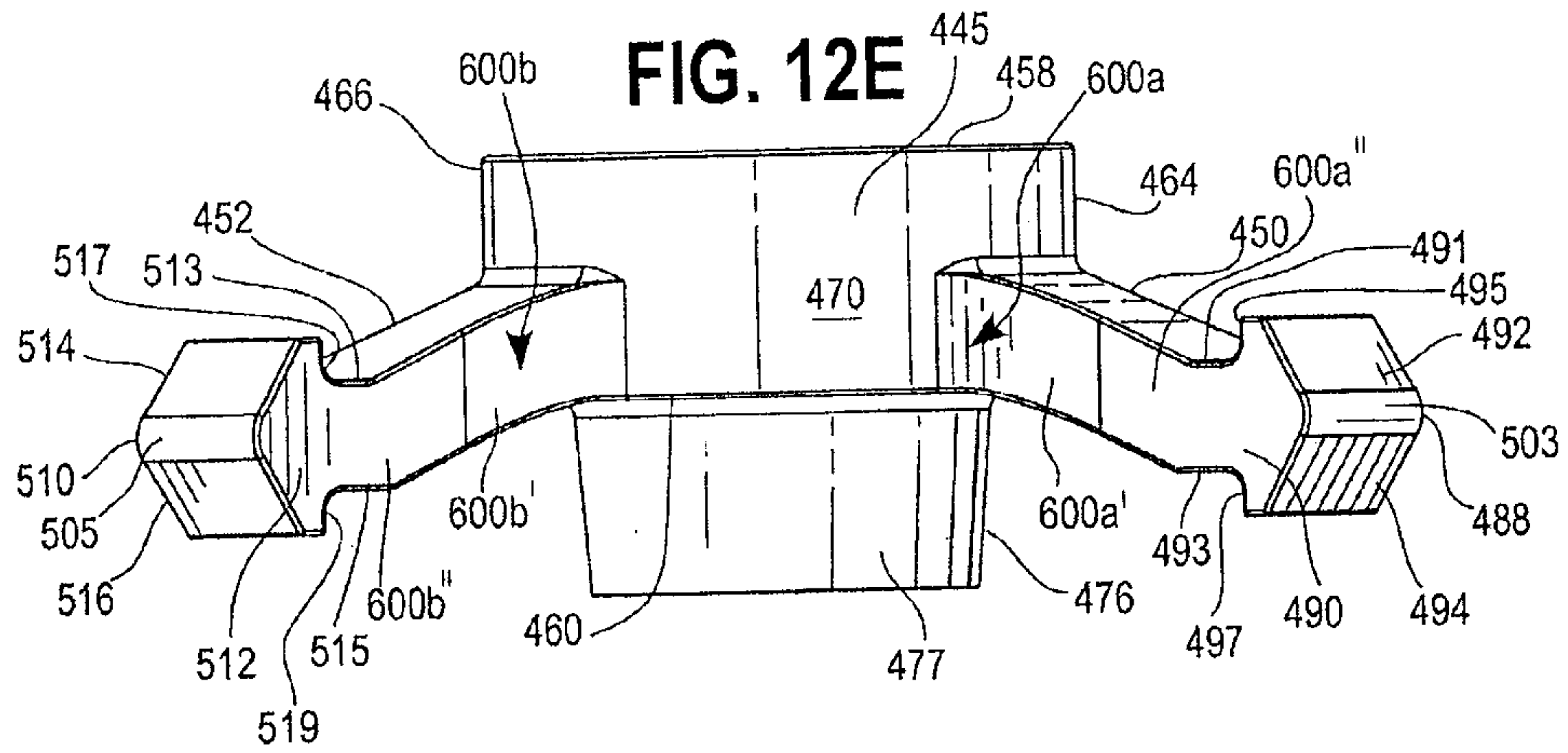
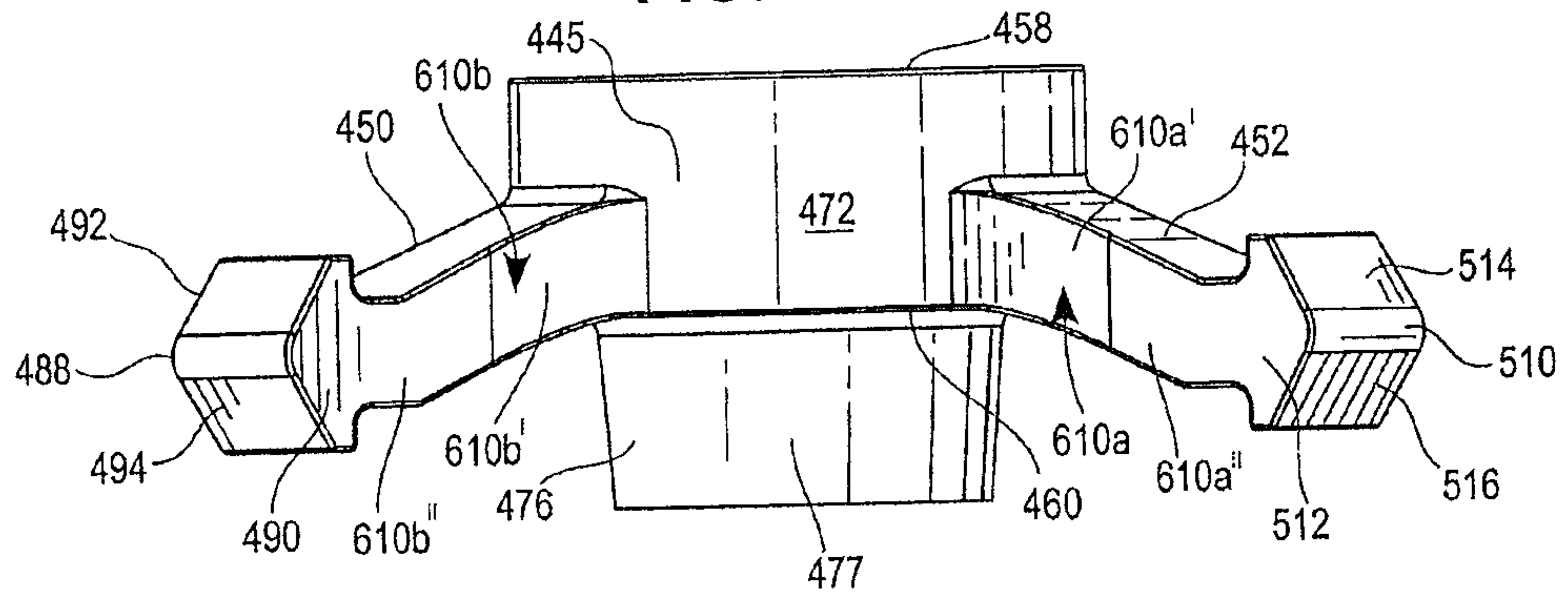
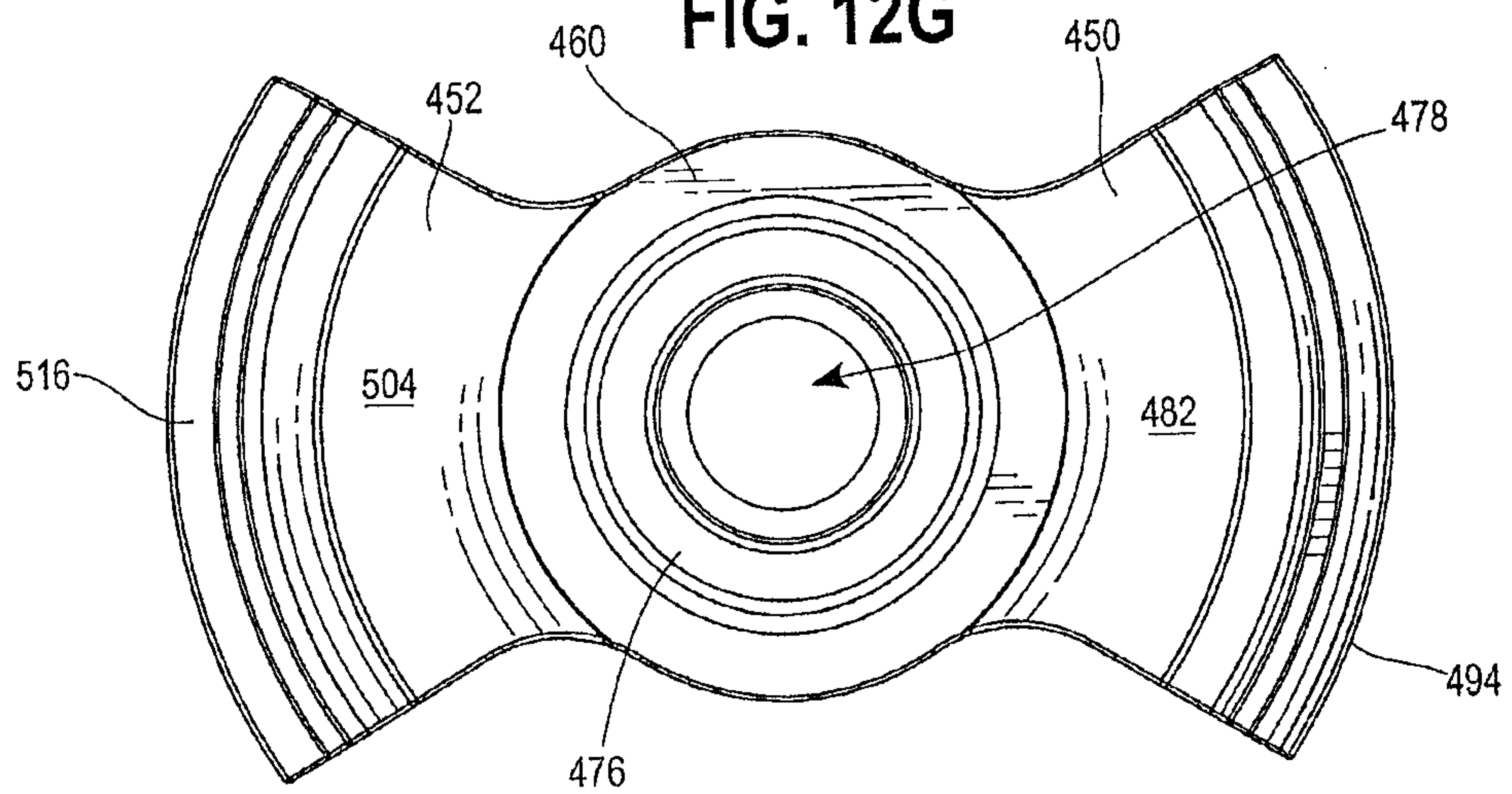
FIG. 10

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FIG. 11



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FIG. 12E**FIG. 12F****FIG. 12G**

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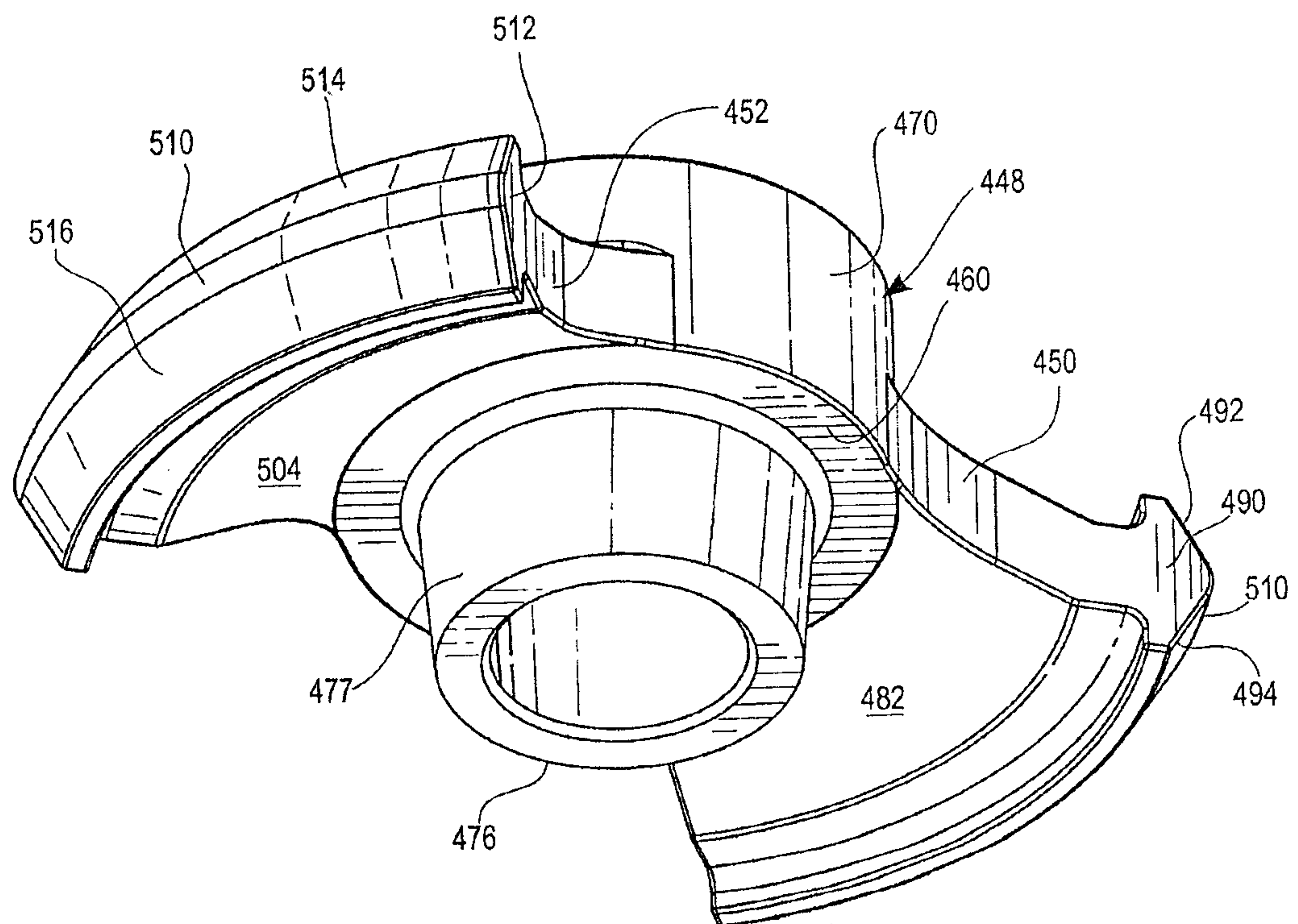
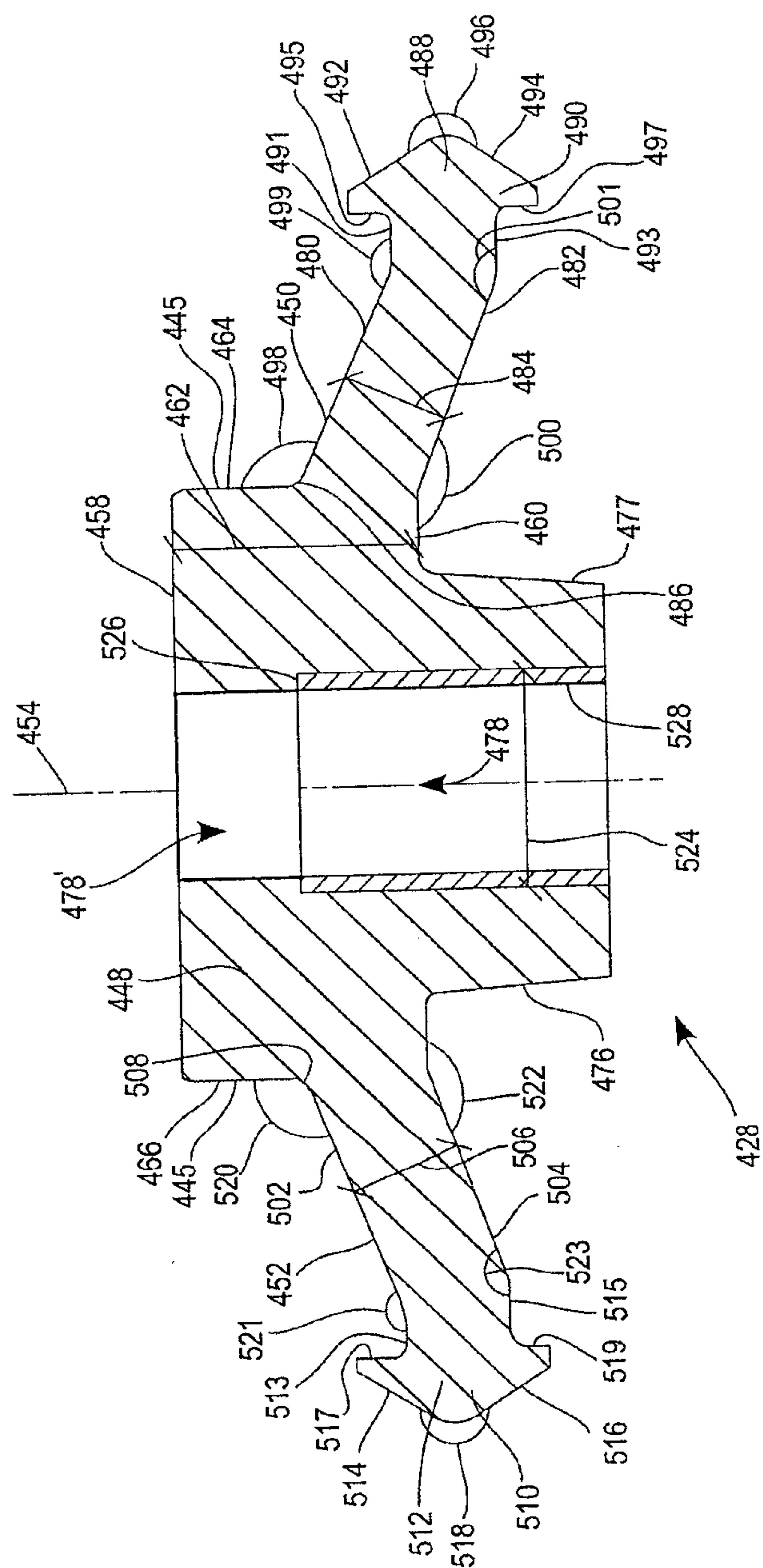
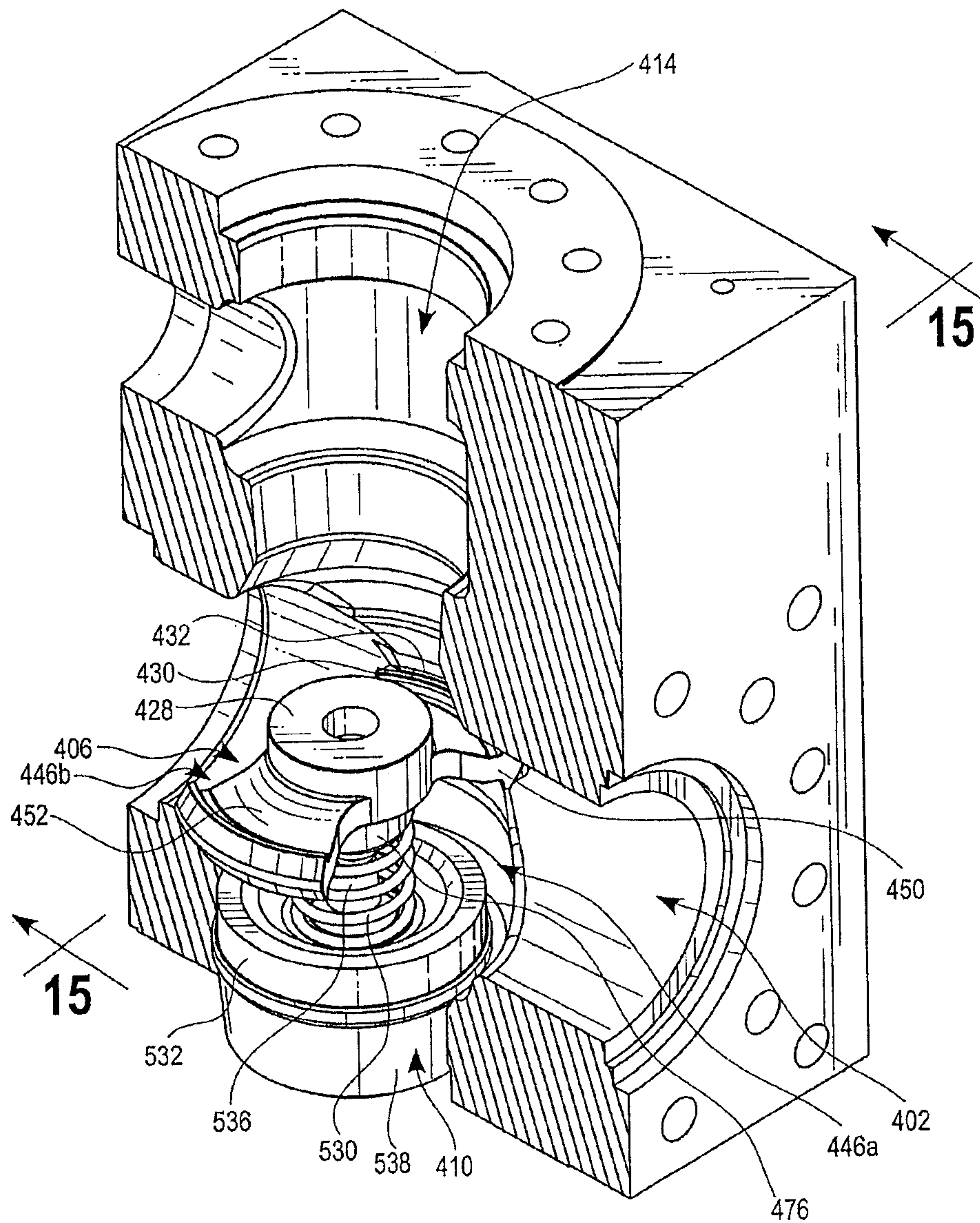
FIG. 12H

FIG. 13



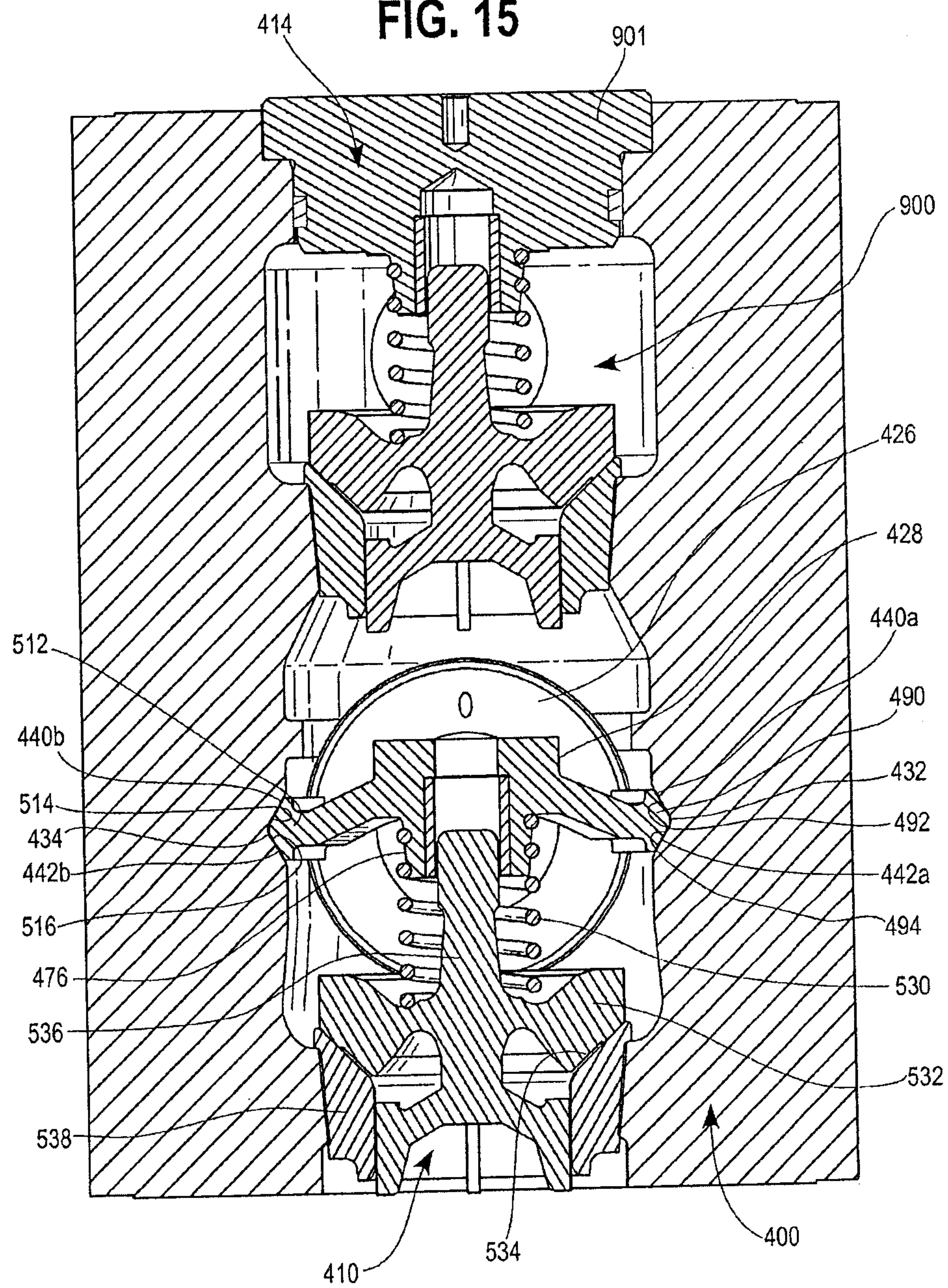
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FIG. 14



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FIG. 15



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FIG. 16