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

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2493643 A1 2004/01/29

(21) 2 493 643

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2002/07/23
(87) Date publication PCT/PCT Publication Date: 2004/01/29
(85) Entrée phase nationale/National Entry: 2005/01/21
(86) N° demande PCT/PCT Application No.: US 2002/023262
(87) N° publication PCT/PCT Publication No.: 2004/008999

(51) Cl.Int.$^{7}$/Int.Cl.$^{7}$ A61F 2/44, A61F 2/30

(71) Demandeur/Applicant:
MALONE, DAVID G., US

(72) Inventeur/Inventor:
MALONE, DAVID G., US

(74) Agent: MACRAE & CO.

(54) Titre : CAGE DE FUSION INTERVERTEBRALE
(54) Title: INTERBODY SPINE FUSION CAGE

(57) Abrégé/Abstract:
An improved spine fusion cage is provided which is particularly useful with biological compounds which are utilized in place of or in combination with a patient's bone matter. In one embodiment there is provided a cage with preselected perforated and non-perforated zones to direct the growth of bone in desired directions. In another embodiment there is provided a cage having inner and outer perforated cage bodies separated by an annulus. An end closure with occluding surfaces suitable for introduction into the annulus serves to establish one or more desired zones or patterns of occluded apertures in the cage body. In still another embodiment an end closure having occluding surfaces is provided for use in connection with conventional perforated fusion cages so as to establish desired zones or patterns of occluded apertures.

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 January 2004 (29.01.2004)

PCT

(10) International Publication Number
WO 2004/008999 A1

(51) International Patent Classification[7]: A61F 2/44, 2/30

(21) International Application Number:
PCT/US2002/023262

(22) International Filing Date: 23 July 2002 (23.07.2002)

(25) Filing Language: English

(26) Publication Language: English

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 09/737,074 (CIP)
Filed on 12 December 2000 (12.12.2000)

(71) Applicant and
(72) Inventor: **MALONE, David, G.** [US/US]; 2722 E. 72nd Street, Tulsa, OK 74136 (US).

(74) Agent: **WEEKS, R., Alan**; Fellers, Snider, Blankenship, Bailey & Tippens, P.C., Suite 800, 321 South Boston Avenue, Tulsa, OK 74103-3318 (US).

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

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

**Declaration under Rule 4.17:**

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

**Published:**

— *with international search report*

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

WO 2004/008999 A1

(54) Title: INTERBODY SPINE FUSION CAGE

(57) Abstract: An improved spine fusion cage is provided which is particularly useful with biological compounds which are utilized in place of or in combination with a patient's bone matter. In one embodiment there is provided a cage with preselected perforated and non-perforated zones to direct the growth of bone in desired directions. In another embodiment there is provided a cage having inner and outer perforated cage bodies separated by an annulus. An end closure with occluding surfaces suitable for introduction into the annulus serves to establish one or more desired zones or patterns of occluded apertures in the cage body. In still another embodiment an end closure having occluding surfaces is provided for use in connection with conventional perforated fusion cages so as to establish desired zones or patterns of occluded apertures.

# INTERBODY SPINE FUSION CAGE

## BACKGROUND OF THE INVENTION

Technical Field:

This invention is directed to improved devices for facilitating the fusion of vertebral bone structure, which devices can be inserted either anteriorly or posteriorly into the spine.

Background:

Chronic back problems cause pain and disability for a large segment of the population. In many cases, such problems are attributable to relative movement between vertebrae in the spine. Spinal surgery includes procedures to stabilize adjacent vertebrae. Common stabilization methods often involve fusing adjacent vertebrae together.

Fusion techniques include removing disc material which separates the vertebrae and impacting bone into the disc area. The impacted bone fuses with the bone material of the two adjacent vertebrae to thereby fuse the vertebrae together. In a further advance in the art, spinal implants have been developed to increase the probability of a successful fusion. Such devices generally comprise a hollow cylindrical cage into which bone growth inducing substances, such as bone chips or bone slurry, may be placed. The cage wall has holes extending radially therethrough, typically throughout the entire cage surface. The combination of the cage and bone growth inducing substance facilitates arthrodesis between the adjacent vertebral bone structures. Fusion cages in both a threaded and non-threaded form have come into wide use in the last several years. Such cages are inserted either anteriorly or posteriorly into the spine in the intervertebral disc space to fuse the adjacent vertebrae as aforedescribed and to decompress neural elements.

With the continued development of techniques for achieving spinal fusion through the use of spine fusion cages, there has also been developed new materials to augment the fusion process. In the older method, the patient's own bone, or cadaver bone, was used in the cage to promote bony fusion. Newer biologic materials have now been discovered that greatly augment the fusion process and in some cases make using the patient's own bone unnecessary.

However, with the utilization of the newer biologic materials there has arisen a significant problem. When bone growth accelerants, such as bone morphogenic proteins,

are used in cages of existing design there is risk of inducing the growth of bone around and into sensitive neural tissues. This is especially the case when a posterior approach is utilized to implant the fusion cage, as bony overgrowth in this direction may impinge on spinal nerve roots. It accordingly should be appreciated that there is a need for a fusion cage designed to be used with such biologic materials to prevent bone growth from impinging on neural tissue.

It is thus an object of the present invention to provide an improved spine fusion cage which prevents the overgrowth of bone around and into sensitive areas of neural tissue.

It is another object of the invention to provide a spine fusion cage having a feature whereby a surgeon may selectively occlude holes in the cage wall to prevent bone growth therethrough.

A further object of this invention is to provide a novel closure for spine fusion cages which can be used with presently available fusion cages in preventing bone growth into undesirable areas.

## SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention there is provided a novel spine fusion cage which can be inserted into an intervertebral disc space using either a posterior or anterior approach and which prevents overgrowth of bone around or into neural tissue. Growth of bone into sensitive areas is prohibited by providing the cage with various zones wherein the cage wall is either perforated or non-perforated. A cage body is provided having a posterior end and an anterior end and defining an internal cavity and a longitudinal axis. The cage body has an outer surface and a plurality of radial apertures extending through the outer surface in communication with the internal cavity in a preselected pattern. Preferably, there is a first non-perforated zone extending from the posterior end of the cage a preselected length toward its anterior end, second and third non-perforated zones on the lateral sides of the cage extending in opposing relation from the first zone further toward the anterior end, and two opposed perforated zones oriented so that upon insertion of the device the perforated zones will be adjacent the vertebral bodies to be fused to allow bone growth across the vertebral interspace. Each

end of the cage is provided with a non-perforated closure. In this manner bone growth is prevented in areas adjacent the non-perforated zones when the fusion cage is in place.

In accordance with another embodiment of the present invention there is provided a novel spine fusion cage which provides for the selective occlusion of apertures in the cage wall so as to prevent the growth of bone in undesired directions. As an example, there is provided an inventive cage having outer and inner cage elements. An outer cage body having a posterior end and an anterior end defines an internal cavity. A plurality of radial apertures extend through the outer surface of the outer cage body to communicate with the internal cavity in a pattern covering a substantial portion of the outer surface of the cage body. An inner cage body is disposed within the internal cavity of the outer cage body and is positioned as to form an annulus between the inner wall surface of the outer cage body and the outer wall surface of the inner cage body. The inner cage body likewise has a plurality of radial apertures extending through its outer surface so as to establish communication with the annulus and the outer surface of the outer cage. An end closure means having occluding surfaces suitable for introduction into the annulus between the outer and inner cages serves to establish one or more desired zones or patterns of occluded apertures amongst the plurality of apertures in the outer cage body, thereby obstructing bone growth in undesired directions.

In still another embodiment there is provided an end closure means for effecting the closure of the posterior end of a fusion cage while establishing a desired occlusion pattern of apertures in the wall of the fusion cage. The closure means comprises a non-perforated sealing member to effect the closure of the posterior end of the internal cavity of the fusion cage and one or more occluding surfaces extending from the sealing member essentially parallel to the longitudinal axis of the fusion cage so as to establish one or more desired zones or patterns of occluded apertures amongst the plurality of apertures in the cage body.

In additional embodiment, a cage body is provided that has a posterior end and an anterior end and defines an internal cavity. The cage body further has an outer surface and a plurality of apertures extending through the outer surface in communication with the internal cavity, wherein the outer surface has a preselected pattern of perforated and non-perforated zones. A first end closure is secured at a first end of said cage body. A

second end closure is provided that has an orifice therein. The second end closure is secured at a second end of the cage body. At least one of the first end closure and the second end closure is removable so as to provide access to the internal cavity. A plug is located in the orifice that is capable of being penetrated by a syringe needle for administering a bone growth accelerant to said internal cavity. Preferably, a carrier, such as a sponge, receives the bone growth accelerant. By using this approach, chances for misapplication of bone growth material are greatly diminished.

A better understanding of the present invention, its several aspects, and its advantages will become apparent to those skilled in the art from the following detailed description, taken in conjunction with the attached drawings, wherein there is shown and described the preferred embodiments of the invention, simply by way of illustration of the best mode contemplated for carrying out the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 anatomically illustrates a bilateral posterior insertion of two inventive cylindrical spine fusion cages to achieve fusion across the L5/S1 disc space.

FIG. 2 is an exploded perspective view of an embodiment of an inventive cage having preselected perforated and non-perforated zones on its outer surface.

FIG. 3 is a perspective view taken along line 3-3 of FIG. 2.

FIG. 4 is a sectional view taken along line 4-4 of FIG. 2.

FIG. 5 is perspective view of an embodiment of an inventive cage having outer and inner cage elements.

FIG. 6 is a sectional view taken along line 6-6 of FIG. 5.

FIG. 7 is a perspective view of an end closure for use in connection with the cage of FIG. 5.

FIG. 8 a top sectional view of the cage of FIG. 5 including the end closure of FIG. 7.

FIG. 9 is an exploded side view of a conventional fusion cage modified to utilize an inventive end closure means to selectively occlude certain apertures in the outer surface of the cage.

FIG. 10 depicts the partial insertion of the inventive closure means into the cage

of FIG. 9.

FIG. 11 depicts the full insertion of the inventive closure means into the cage of FIG. 9.

FIG. 12 is top sectional view of a modified conventional cage including an inventive end closure means.

FIG. 13 is an exploded perspective view of an embodiment of an inventive cage having an end cap and an injection port.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Several types of conventional spine fusion cages have been designed, such as those described by Bagby, Brantigan and Ray, respectively, in *Athrodesis by the Distraction-Compression Method Using a Stainless Steel Implant*, Orthopaedics 1988, Vol. 11:931-4; *A Carbon Fibre Implant to Aid Interbody Lumbar Fusion*, Spine 1991, 16 (Suppl):S277-82 (with Steffee and Geiger); and *Threaded Titanium Cages for Lumbar Interbody Fusions*, Spine 1997, 22:667-80; and as described in the patent art, for example, in U.S. Patent Nos. 4,501,269; 5,055,104; 5,571,192; 5,702,449; 5,876,457; 5,906,616; 5,976,187; 5,980,522; 6,010,502; 6,015,436; and 6,039,762. Each of the foregoing publications and patents is incorporated herein by reference.

Such devices provide for a relatively simple and effective technique for implementing lumbar interbody fusion by correcting any existing mechanical deformity of the spine while providing stability and a good environment until successful arthrodesis is obtained. These cage devices are hollow and are positioned between the articulating vertebrae, where they support and immobilize the joint as well as contain the growth of the bone graft that is packed into the internal cavity of the device.

Anterior lumbar interbody fusion (ALIF) and posterior lumbar interbody fusion (PLIF) are two commonly adopted approaches for grafted lumbar interbody fusion with augmentation via a spine fusion cage. ALIF is performed through a retroperitoneal or transperitoneal approach with extensive discectomy followed by the placement of one or more cages in the vertebral interspace. In PLIF, partial or complete laminectomy and facetectomy is followed by posterior discectomy and the placement of one or more cages in the vertebral interspace. FIG. 1 is illustrative of a bilateral posterior insertion of two

inventive cylindrical spine fusion cages **20** to achieve fusion across the L5/S1 disc space. The cages **20** are secured far enough apart from each other (by a few millimeters) to avoid contact and potential back-threading. It should be understood that the fusion cages of this invention can be installed in their operative positions via either the anterior or posterior approaches; however, the posterior approach is the most dangerous in regards for bony overgrowth impinging on neural tissue particularly when the cage is used along with bone growth inducing materials.

The inventive cages **20** promote bony fusion by holding adjacent levels immobile and by allowing bone to grow only into the vertebral bodies an away from the spinal canal and nerve roots. Designs that do not control direction of growth are undesirable for use with biologic bone growth accelerants to the extent unchecked bony overgrowth may impinge upon neural tissues. Through the present invention there are provided designs for spine fusion cages which prevent bone growth around and into sensitive areas of neural tissue.

Referring now to FIGS. 2-4, and in accordance with one embodiment of the present invention, there is provided an inventive spine fusion cage **20** wherein growth of bone into sensitive areas is prohibited by providing the cage with various zones or areas wherein the cage wall is either perforated or non-perforated. A cage body **22** is provided having a posterior end **24** and an anterior end **26** and defining an internal cavity **28** and a longitudinal axis **30**. The cage body **22** is typically between 20-25 mm in length and may be of a variety of diameters (if cylindrical) and heights. The cage body **22** has an outer surface **32** and a plurality of radial apertures **34** extending through the outer surface **32** in communication with the internal cavity **28** in a preselected pattern. Preferably, there is a first non-perforated zone **36** extending from the posterior end **24** of the cage body **22** a preselected length, preferably 5-10 mm, toward its anterior end **26**, second and third non-perforated zones **38**, **40** on the lateral sides of the cage body **22** extending in opposing relation from the first zone **36** further toward the anterior end **26**, and two opposed perforated zones **42**, **44** oriented cephalad (or to the superior side) and caudad (or to the inferior side) so that upon insertion of the device the perforated zones **42**, **44** will be adjacent the vertebral bodies to be fused to allow bone growth across the vertebral interspace. Each end **24**, **26** of the cage body **22** is provided with a non-perforated

closure. In the illustrated embodiment, the anterior end **26** is closed by an integral non-perforated end wall **46**, while there is provided a removable end cap **48** securable, by threaded attachment, friction fit or otherwise, to the posterior end **24** of the cage body **22**. The end cap **48** may be provided with a recess **50** for receiving an insertion tool, for example if the end cap is made to threadably connect to the cage body, and there is preferably provided on the top of the end cap **48** a line score **52** for aiding proper orientation of the device in the vertebral interspace.

The cage body **22** may be provided with threads **54**, projections, ridges, protrusions, barbs, spurs or other insertion means to aid in placement of the cage within the interbody area. The anterior end **26** can be rounded in order to facilitate the insertion of the cage **20** relative to one or more bone structures. The cage **20** may be made of surgical steel, titanium or other acceptable implantable materials. Typically, the cage **20** is countersunk into the vertebral interspace with the end cap **48** in place by using an insertion tool (not shown) to screw the cage **20** into position. Once the cage is properly aligned, the end cap **48** is removed so that bone growth inducing material can be packed into the internal cavity **28** of the cage body **22**, whereupon the end cap **48** is tightly replaced.

As can now be appreciated, the inventive cage **20** prevents bone growth into areas adjacent the non-perforated zones when the fusion cage is in place. Because the posterior 5-10 mm of the cage is non-perforated, including, importantly, the end cap, bony overgrowth is inhibited in areas immediately adjacent the posteriorly located neural tissues. In similar fashion, lateral overgrowth of bone is impeded by the second and third non-perforated zones. Desired growth through the vertebral interspace, however, is facilitated via the perforated zones.

It should be understood to be within the ordinary skill of one in the art to modify the placement of the various perforated and non-perforated zones as warranted by orthopaedic considerations to achieve desired bone growth and preclude unwanted bone growth. It is also within the ordinary skill of one in the art to modify the aforedescribed device for anterior insertion procedures by providing a removable end cap on the anterior end of the cage body and reversing the thread direction on the outside surface of the cage body.

As mentioned above, it is also advantageous for a surgeon to have the ability to selectively occlude apertures in the cage wall to prevent bone growth in undesired directions. Now referring to FIGS. 5-8, to achieve this object, and in accordance with another embodiment of the present invention, there is provided a spine fusion cage **120** having an outer cage body **122** with a posterior end **124** and an anterior end **126** and defining an internal cavity **128** and a longitudinal axis **130**. The outer cage body **122** has an outer surface **132** and a plurality of radial apertures **134** extending through the outer surface **132** in communication with the internal cavity **128** in a pattern covering a substantial portion of the outer surface **132** of the cage body **122**. An inner cage body **136** into which is placed bone growth inducing substances is disposed within the internal cavity **128** of the outer cage body **122** and is positioned as to form an annulus **138** between the inner wall surface **140** of the outer cage body **122** and the outer wall surface **142** of the inner cage body **136**. The inner cage body **136** likewise has a plurality of radial apertures **144** extending through its outer surface **142** so as to establish communication with the annulus **138** and the outer surface **132** of the outer cage body **122**. A solid end closure **146** having opposed occluding surfaces **148**, **150** suitable for introduction into the annulus **138** serves to establish one or more desired zones or patterns of occluded apertures amongst the plurality of apertures in the outer cage body **122**, thereby obstructing bone growth in undesired directions.

More specifically, as shown in FIG. 7 end closure **146** is comprised of a non-perforated cap or closure means **152** having occluding surfaces **148** and **150** extending therefrom. Such surfaces may be of sufficient length to extend to the bottom of the cage member **120** as shown in FIG. 5 or may be of a more limited length so as to occlude only a portion of the apertures **134** in the outer cage body **122**. The end closure **146** may be constructed so as to provide a top circumferential crown portion **154** and between the occluding surfaces **148**, **150** a shoulder **156** which may engage a rib means **158**, **160** as shown in FIG. 8 to act as a longitudinal stop and to limit the degree of rotation which can be made by occluding surfaces **148**, **150** so as to maintain the selected occlusion pattern. When positioned within the annulus **138** of the fusion cage **120**, the occluding surfaces **148**, **150** serve to close openings in the posterior end of the cage **120** as well as to occlude openings which are in a lateral position so as to effect bone growth through the apertures

in the caudal and cephalad directions when placed in the desired position between two vertebrae. Various interchangeable forms of end closures may be provided, for example having differently shaped and dimensioned occluding surfaces, so as to provide for the surgeon a selection which meets objectives according to various orthopaedic exigencies. It is also within the scope of this invention that the shape and dimensions of the occluding surfaces may be modifiable by the surgeon, such as if the occluding surfaces comprise a surgical plastic adapted to be cut or trimmed to achieve a desired configuration. In this manner, a cage possessing a full pattern of apertures can be used as a "universal" cage in combination with one of a wide selection of end closures or a modifiable end closure to achieve any desired patterned of perforation.

The end closure **146** can be threaded or otherwise designed to effect the closure of the posterior end of the cage **120** and may be provided with securing means such as square or hex-shaped recess **162** which can be used with a socket wrench to tightly position the end closure **146** in the posterior end of the fusion cage **120**. In complementary fashion, threads may be provided at the posterior end of the cage **120** to receive a threaded end closure **146** or it can be so adapted that the end closure **146**, when not threaded, can be simply snapped into place to effect the desired closing of the fusion cage **120**.

A thread **164** may be provided as part of the outer surface **132** of the fusion cage **120**. Such a thread can be replaced with a plurality of discrete threads or a plurality of projections, ridges, protrusions, barbs or spurs and be within the spirit and scope of the invention.

In assembly of the fusion cage of this embodiment of the invention, following introduction of the selected biologic material into the internal cavity **128** within the inner cage body **136**, the annulus **138** remains clear so as to easily accept end closure **146** within the annulus **138** while the biologic materials are retained in the internal cavity **128**. Through the dimensioning, shaping and rotation of occluding surfaces **148**, **150** there is achieved an occlusion of apertures so as to define the desired pattern of apertures through which bone growth is to be permitted.

In keeping with the teachings of the present invention, there is further provided a novel closure for conventional spine fusion cages which can be used with little or no

modification to presently available fusion cages in preventing bone growth into undesirable areas. This embodiment involves providing a means for the occlusion of selected apertures in currently available fusion cages, such as to those commonly referred to as Brantigan, BAK and Ray cages, so that bone growth is directed only toward the vertebral bodies and away from the spinal canal and nerve roots.

Making reference now to FIGS. 9-11, there is illustrated an end closure **220** for effecting the closure of the posterior end **222** of a conventional fusion cage body **224** while establishing a desired occlusion pattern of apertures in the wall of the cage body **224**, which cage possesses apertures **226** substantially entirely thereabout. The end closure **220** comprises a non-perforated sealing member **228** to effect the closure of the posterior end **222** of the cage body **224** and one or more occluding surfaces **230, 231** extending from the sealing member **228** essentially parallel to the longitudinal axis **230** of the cage body **224** so as to establish one or more desired zones or patterns of occluded apertures amongst the plurality of apertures in the cage body **224**. Reference is made to the disclosure provided above with respect to the aforedescribed end closure **146,** which disclosure is equally applicable to end closure **220** and further recitation is believed unnecessary. Suffice it to say that the prior described end closure **146** may be made adaptable to conventional fusion cages so as to achieve the objectives of the present invention.

As depicted in FIG. 12, if desired the conventional type of fusion cage can be so modified as to provide ribs **232, 234** in association with the inner surface of the posterior end of the cage according to the teachings herein. FIG. 12 provides a top view of the fusion cage of FIG. 11 along the line 12-12 which shows the placement of the ribs **232** and **234** to accommodate occluding surfaces **230, 231** of the end closure **220**.

Referring now to FIG. 13, an exploded view of an embodiment of an inventive cage **300** is shown having an end cap **302** and an end cap **304** having an orifice **306**. Orifice **306** is preferably sealed with a plug **308**, e.g. a silicone plug or a plug of another material capable of being penetrated by a syringe needle. A carrier **310** for bone growth accelerants, such as bone morphogenic proteins, is located in the interior of cage **300**. A preferred carrier **310** is a sponge type material. In use, the cage **300** is desirable because cage **300** may be located within a patient prior to loading cage **300** with bone

growth accelerants. Locating cage **300** prior to loading the bone growth accelerant prevents bone growth accelerant from inadvertently contacting areas of the patient that are not intended to experience bone growth. After the cage **300** is located, bone growth accelerant may be carefully administered via a syringe needle, which is pushed through plug **308**. Once the syringe needle has penetrated plug **308**, bone growth accelerant may be delivered to the carrier **310**, e.g. sponge. In this way, the risks associated with locating a cage **300** filled with bone growth accelerant are minimized.

While the invention has been described with a certain degree of particularity, it is understood that the invention is not limited to the embodiment(s) set for herein for purposes of exemplification, but is to be limited only by the scope of the attached claim or claims, including the full range of equivalency to which each element thereof is entitled.

WHAT IS CLAIMED IS:

1. An interbody spine fusion cage for promoting fusion between adjacent bone structures, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface and a plurality of apertures extending through the outer surface in communication with the internal cavity, the outer surface comprising a preselected pattern of perforated and non-perforated areas, wherein, upon implantation, a perforated area is in contact with an adjacent bone structure while all areas of the cage body not in contact with adjacent bone structure are imperforate; and

a non-perforated end closure at each end of said cage body, at least one of the end closures being movable so as to provide access to the internal cavity.

2. The cage according to claim 1, further comprising an upper perforated area for locating adjacent an upper bone structure to be fused and a lower perforated area for locating adjacent a lower bone structure to be fused, wherein said upper perforated area and said lower perforated area are separated exclusively by non-perforated areas.

3. The cage according to claim 1, wherein:

said non-perforated zones are on lateral sides of the cage and extend in opposing relation from the posterior end toward the anterior end; and

said perforated areas comprise two opposed perforated areas oriented so that upon insertion the perforated areas are adjacent the bone structures to be fused.

4. An apparatus for insertion into a vertebral interspace between adjacent vertebral bodies to facilitate arthrodesis between bone structures of the adjacent vertebral bodies while preventing bony overgrowth toward neural elements, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface and a plurality of apertures

extending through the outer surface in communication with the internal cavity in areas of the outer surface which, upon implantation of the apparatus, allow for arthrodesis between the bone structures;

wherein areas of the cage body directed toward neural elements upon implantation of the apparatus are not in communication with the internal cavity so as prevent bony overgrowth toward the neural elements.

5. The apparatus of claim 4, further comprising:

means on the cage body for aiding insertion of the cage body between adjacent vertebral bodies.

6. The apparatus of claim 4, further comprising:

a non-perforated removable end cap securable to the posterior end of the cage body.

7. In a body having vertebral bodies defining a central canal, a spinal cord located in the central canal, neural elements branching out from said spinal cord through openings between the vertebral bodies, an arthrodesis facilitating therapeutic combination comprising:

a cage body inserted between the adjacent vertebral bodies, said cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface that forms a periphery of said cage body, said outer surface having at least one aperture formed therein;

a longitudinal occluded area on said cage body, said occluded area for preventing communication between said internal cavity and said outer surface; and

wherein said longitudinal occluded area shields the neural elements from said internal cavity.

8. An apparatus for insertion between adjacent vertebral bodies to facilitate arthrodesis between bone structures of the adjacent vertebral bodies while preventing bony overgrowth toward neural elements, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface that forms a periphery of said cage body, said outer surface having a plurality of apertures formed therein;

wherein one of said posterior end and said anterior end is a non-perforate surface and one of said posterior end and said anterior end is an open end;

an end closure for locating at said open end of said cage body, said end closure having a longitudinal occluding surface for selectively occluding a longitudinal portion of said apertures of said cage body, said longitudinal occluding surface sized to provide an occluded portion of sufficient size to prevent bone growth from impinging on neural tissue when said cage body is inserted between adjacent vertebral bodies.

9. An interbody spine fusion cage for promoting fusion between adjacent bone structures, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface and a plurality of apertures extending through the outer surface in communication with the internal cavity, the outer surface comprising a preselected pattern of perforated and non-perforated zones; and

a non-perforated end closure at each end of said cage body, at least one of the end closures being movable so as to provide access to the internal cavity; and wherein

the preselected pattern comprises at least a first non-perforated zone extending from the posterior end of the cage body for a length of 5-10 mm toward the anterior end of the cage body, wherein said cage body is imperforate except for where said cage body defines at least one opening, said at least one opening is in contact with an adjacent bone structure upon implantation.

10. The cage according to claim 9, wherein the preselected pattern further includes at least a

second non-perforated zone extending from the first zone further toward the anterior end of the cage body on a lateral side of the cage body wherein said second non-perforated zone comprises at least 25% of a circumference of said cage body.

11. The cage according to claim 9, wherein the preselected pattern further includes:

second and third non-perforated zones on the lateral sides of the cage extending in opposing relation from the first zone further toward the anterior end;

two opposed perforated zones oriented so that upon insertion the perforated zones adjacent the bone structures to be fused; and

wherein said second and third non-perforated zones each comprise at least 25% of a circumference of said cage body.

12. An interbody spine fusion cage for promoting fusion between adjacent bone structures, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface and a plurality of apertures extending through the outer surface in communication with the internal cavity;

a non-perforated end closure at each end of said cage body, at least one of the end closures being movable so as to provide access to the internal cavity; and wherein

the movable end closure has at least one aperture occluding surface extending therefrom, the surface being suitable for introduction into the internal cavity to establish a desired pattern of occluded apertures.

13. The cage according to claim 12, further comprising:

a second cage body having a posterior end and an anterior end and being disposed within the internal cavity of the other cage body and so positioned as to form an annulus therebetween, the outer surface of the second cage body having a plurality of radial apertures extending therethrough so as to establish communication with the annulus; and wherein

the occluding surface of the movable end closure being suitable for introduction into the annulus to establish a desired pattern of occluded apertures.

14. End closure means for effecting the closure of the posterior end of a fusion cage while establishing a desired occlusion pattern of apertures in the wall of the fusion cage which comprises:

a first sealing member to effect the closure of the posterior end of the internal cavity of said fusion cage; and

at least one occluding surface extending from the sealing member and essentially parallel to the longitudinal axis of the fusion cage so as to establish a predetermined pattern of occlusion of the apertures in the wall of the fusion cage.

15. The end closure means according to claim 14, further comprising a pair of opposed occluding surfaces so spaced as to occlude laterally positioned apertures along the wall of the fusion cage.

16. An apparatus for insertion into a vertebral interspace between adjacent vertebral bodies to facilitate arthrodesis between bone structures of the adjacent vertebral bodies while preventing bony overgrowth toward neural elements, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface and a plurality of apertures extending through the outer surface in communication with the internal cavity in areas of the outer surface which, upon implantation of the apparatus, allow for arthrodesis between the bone structures;

wherein areas of the cage body directed toward neural elements upon implantation of the apparatus are not in communication with the internal cavity so as prevent bony overgrowth toward the neural elements.

17. The apparatus of claim 16, further comprising:

means on the cage body for aiding insertion of the cage body between adjacent vertebral bodies.

18. The apparatus of claim 16, further comprising:

a non-perforated removable end cap securable to the posterior end of the cage body.

19. An arthrodesis facilitating therapeutic combination comprising:

adjacent vertebral bodies defining a central canal;

a spinal cord located in said central canal;

neural elements branching out from said spinal cord through openings between said vertebral bodies;

a cage body inserted between said adjacent vertebral bodies, said cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface that forms a periphery of said cage body, said outer surface having at least one aperture formed therein;

a longitudinal occluded area on said cage body, said occluded area for preventing communication between said internal cavity and said outer surface; and

wherein said longitudinal occluded area shields said neural elements from said internal cavity.

20. An apparatus for insertion between adjacent vertebral bodies to facilitate arthrodesis between

bone structures of the adjacent vertebral bodies while preventing bony overgrowth toward neural elements, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface that forms a periphery of said cage body, said outer surface having a plurality of apertures formed therein;

wherein one of said posterior end and said anterior end is a non-perforate surface and one of said posterior end and said anterior end is an open end;

an end closure for locating at said open end of said cage body, said end closure having a longitudinal occluding surface for selectively occluding a longitudinal portion of said apertures of said cage body, said longitudinal occluding surface sized such that said occluded longitudinal portion of said apertures have a width of at least 1/4 of the periphery of said cage body, thereby providing an occluded portion of sufficient size to prevent bone growth from impinging on neural tissue when inserted between adjacent vertebral bodies.

21. An interbody spine fusion cage for promoting fusion between adjacent bone structures, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity, the cage body further having an outer surface and a plurality of apertures extending through the outer surface in communication with the internal cavity, the outer surface comprising a preselected pattern of perforated and non-perforated zones; and

a first end closure at a first end of said cage body;

a second end closure having an orifice therein, said second end closure at a second end of said cage body, at least one of said first end closure and said second end closure being removable so as to provide access to the internal cavity; and

a plug located in said orifice, said plug capable of being penetrated by a syringe needle for administering a bone growth accelerant to said internal cavity.

22. The interbody spine fusion cage according to claim 21 wherein:

the preselected pattern comprises at least a first non-perforated zone extending from the posterior end of the cage body for a length of 5-10 mm toward the anterior end of the cage body and at least one perforated zone positioned upon the outer surface of the cage body so as to be juxtaposed one of the bone structures upon implantation.

23. An apparatus for insertion into a vertebral interspace between adjacent vertebral bodies to facilitate arthrodesis between bone structures of the adjacent vertebral bodies, comprising:

a cage body having a posterior end and an anterior end and defining an internal cavity;

an end cap located at one end of said cage body, said end cap having an orifice therein; and

a plug located in said orifice, said plug capable of being penetrated by a syringe needle.

24. The apparatus according to claim 23 further comprising:

a carrier material located in said internal cavity for receiving bone growth accelerant through said plug.

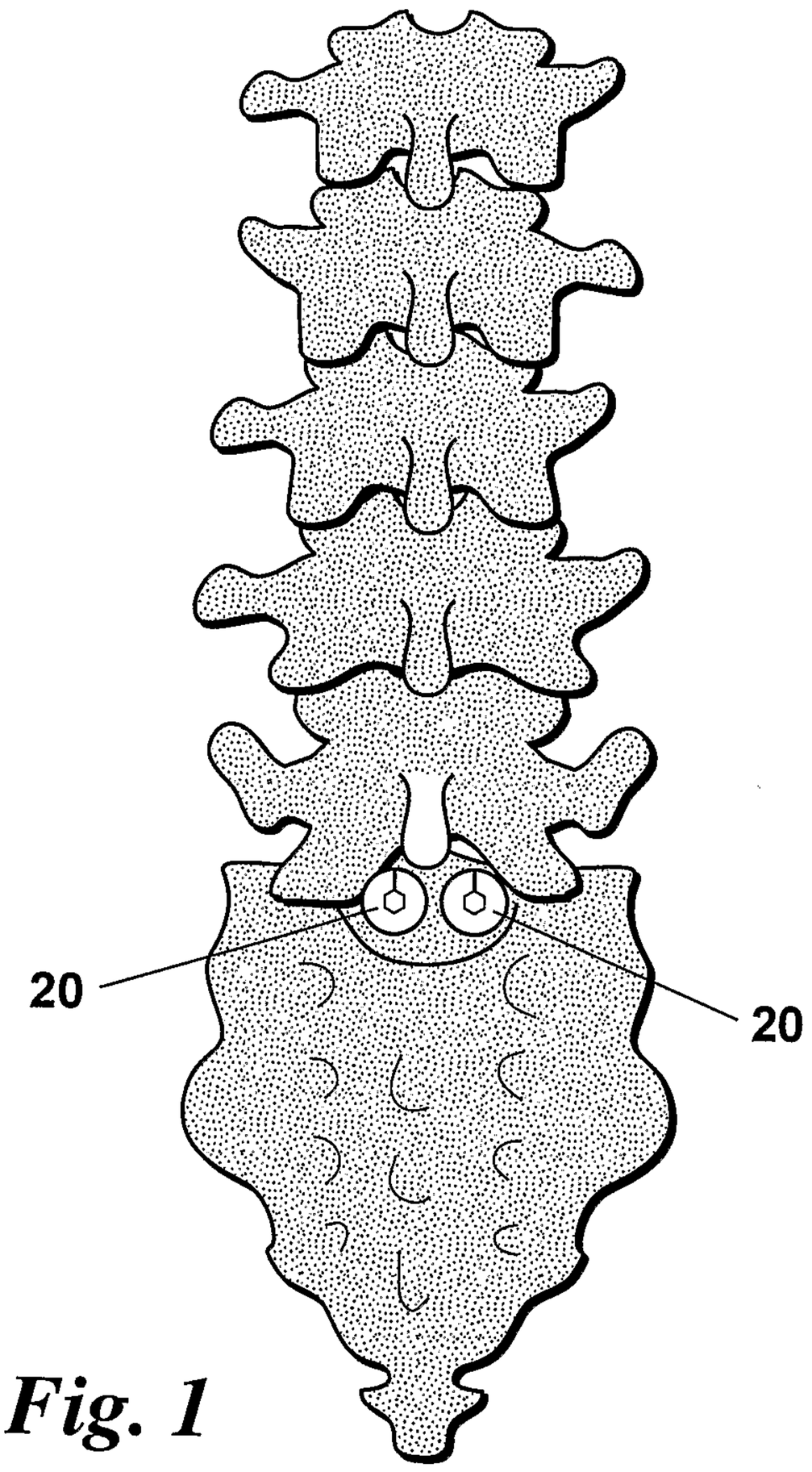


*Fig. 1*

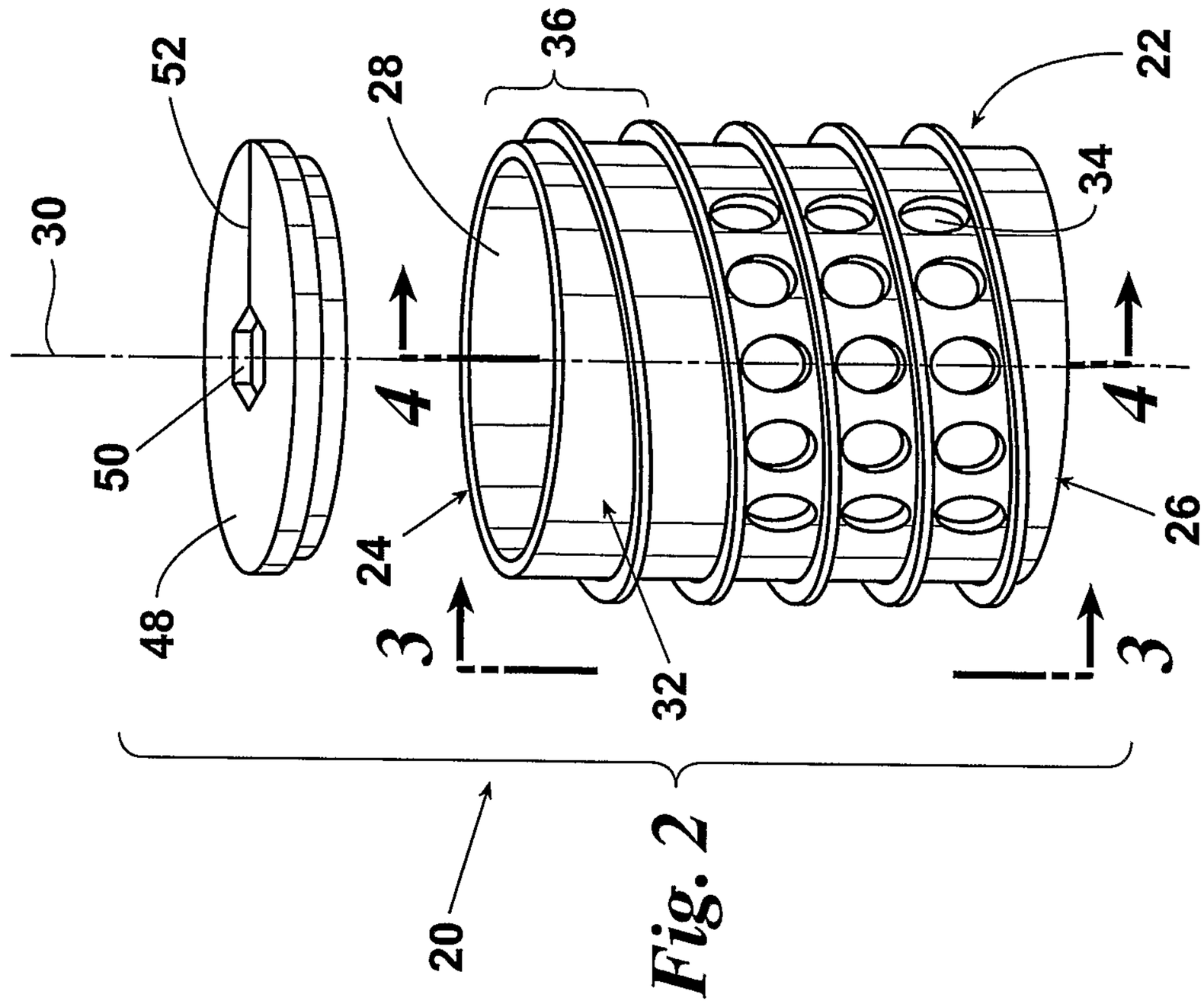


*Fig. 2*

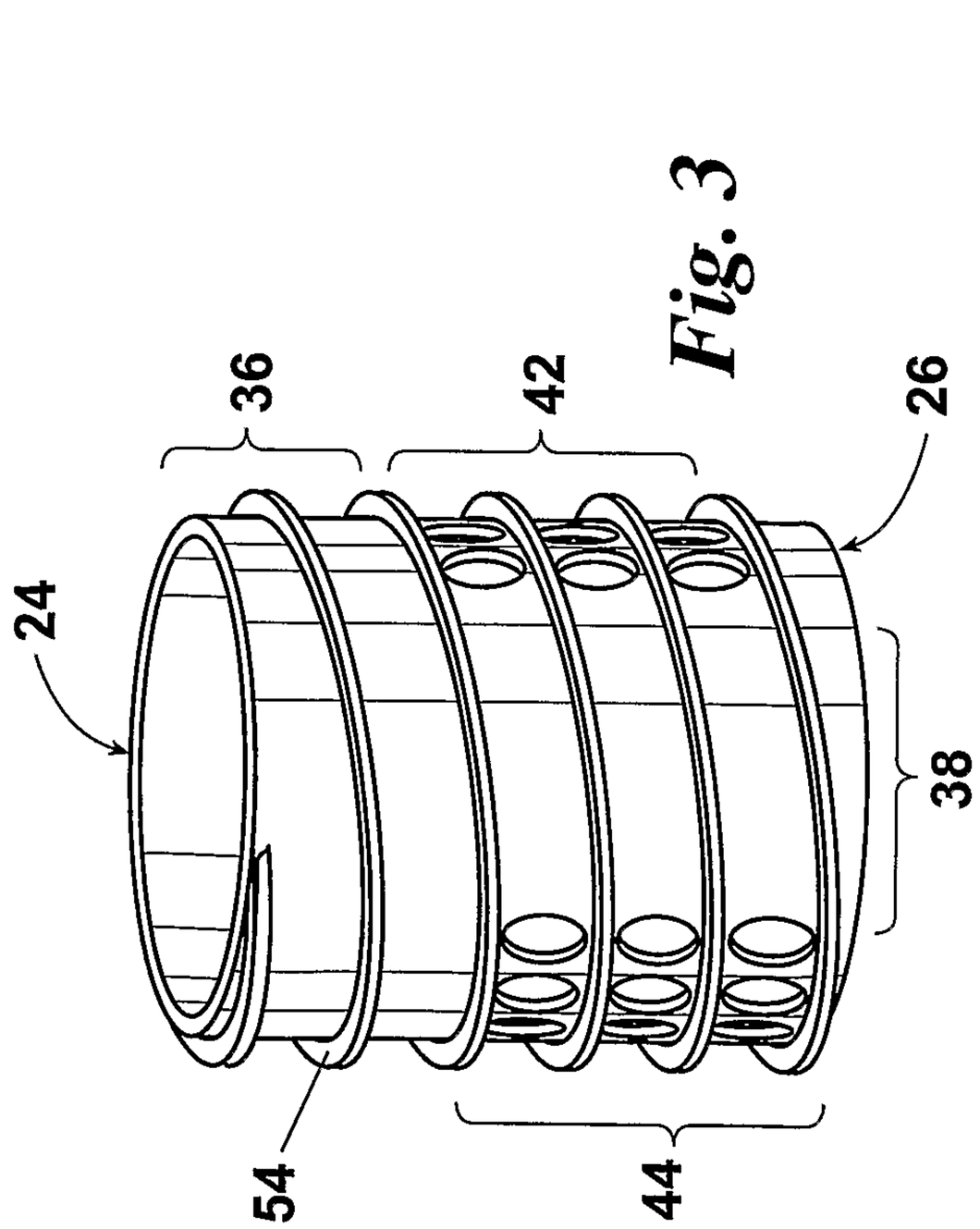


*Fig. 3*

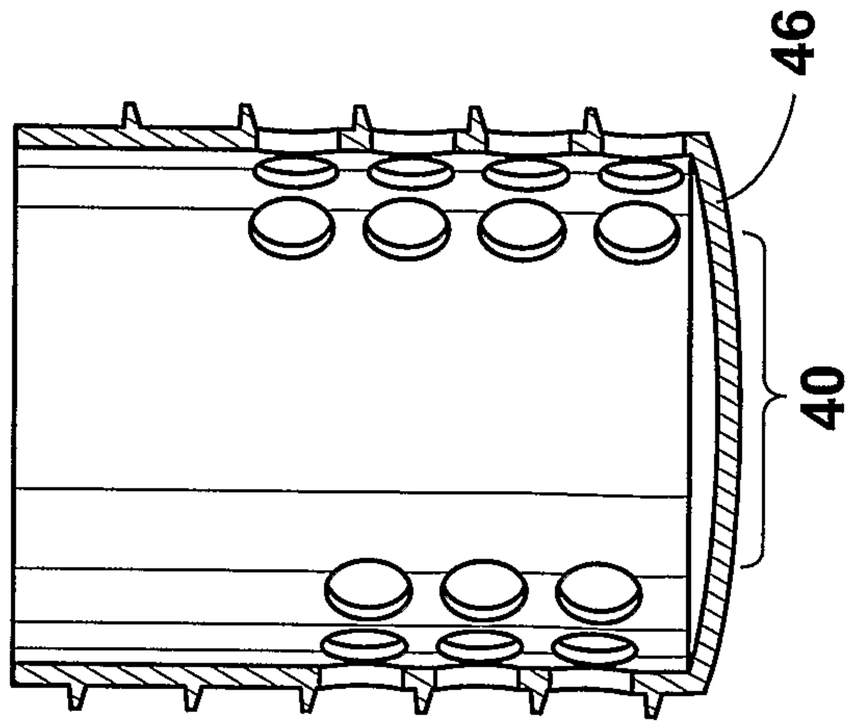


*Fig. 4*

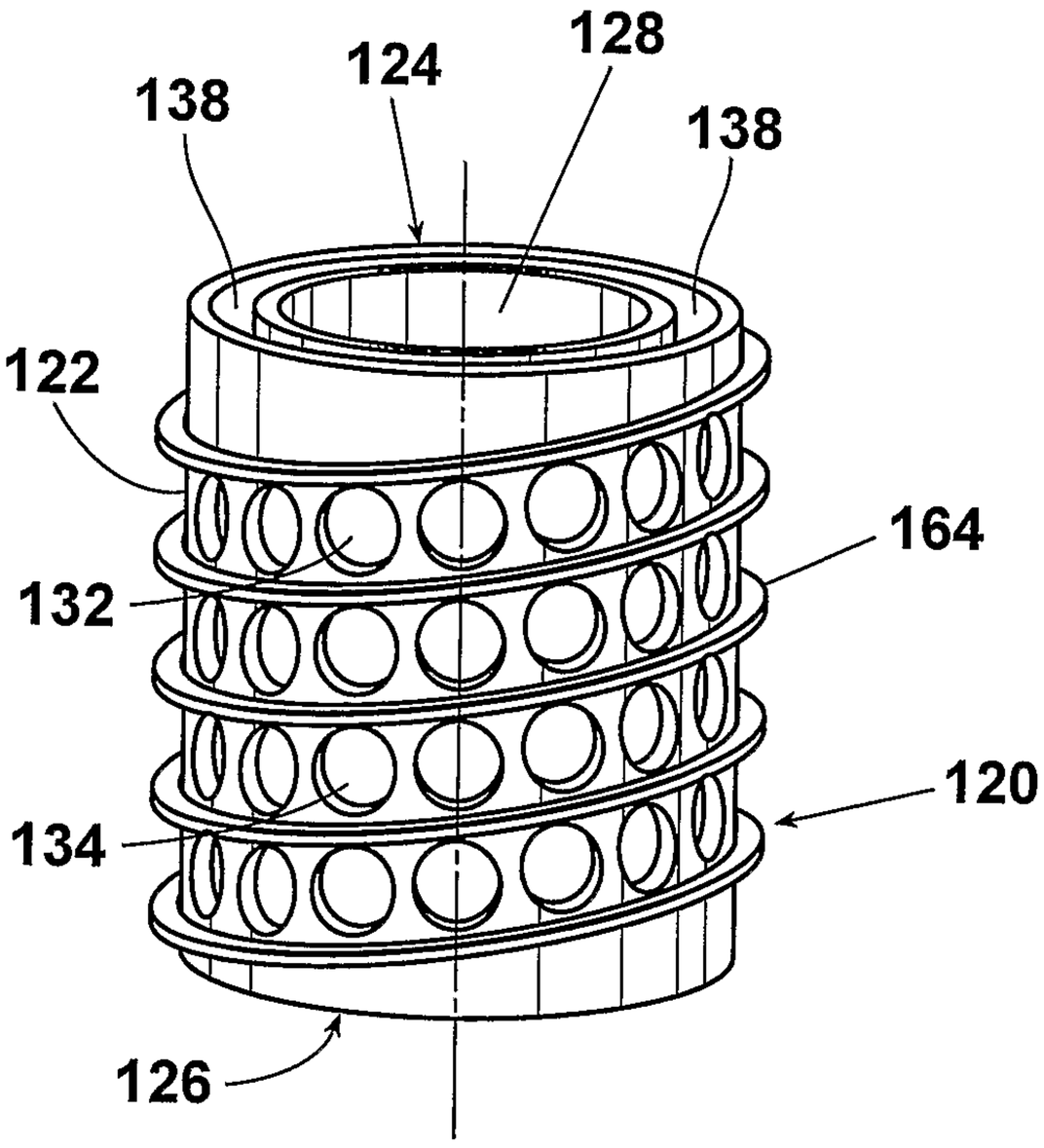


*Fig. 5*

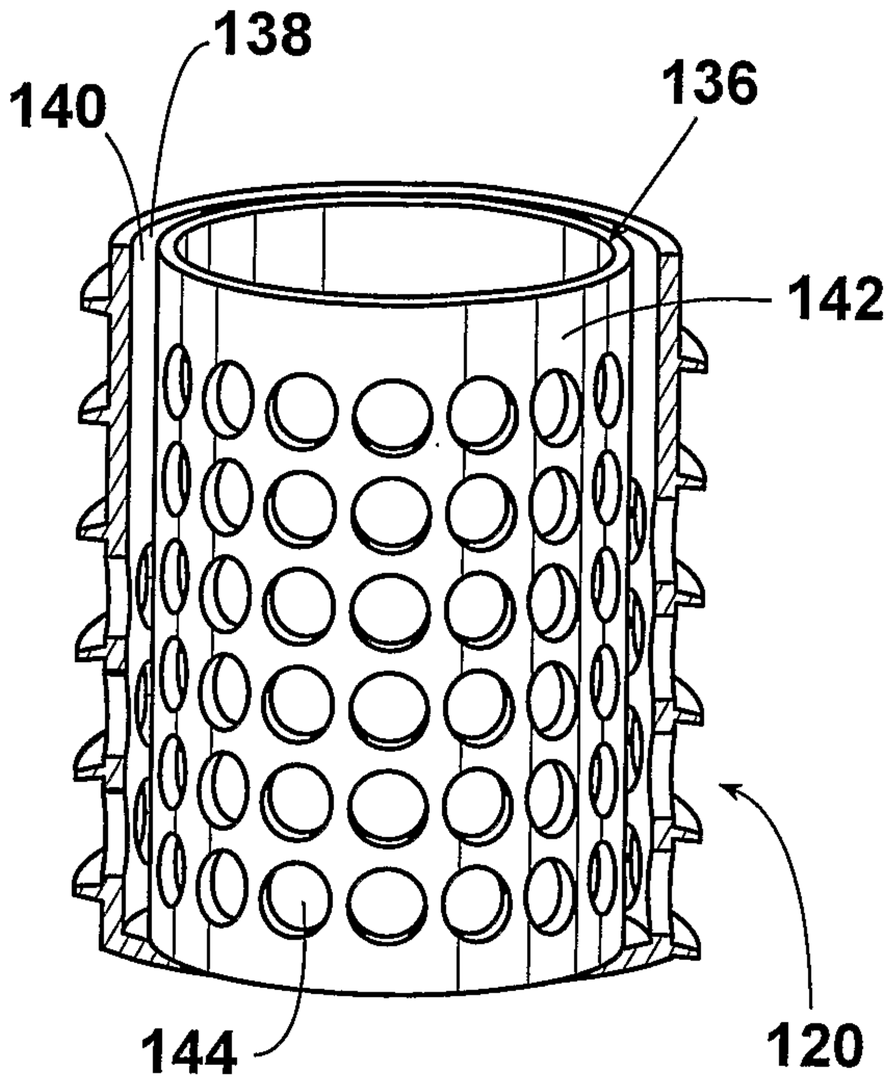


*Fig. 6*

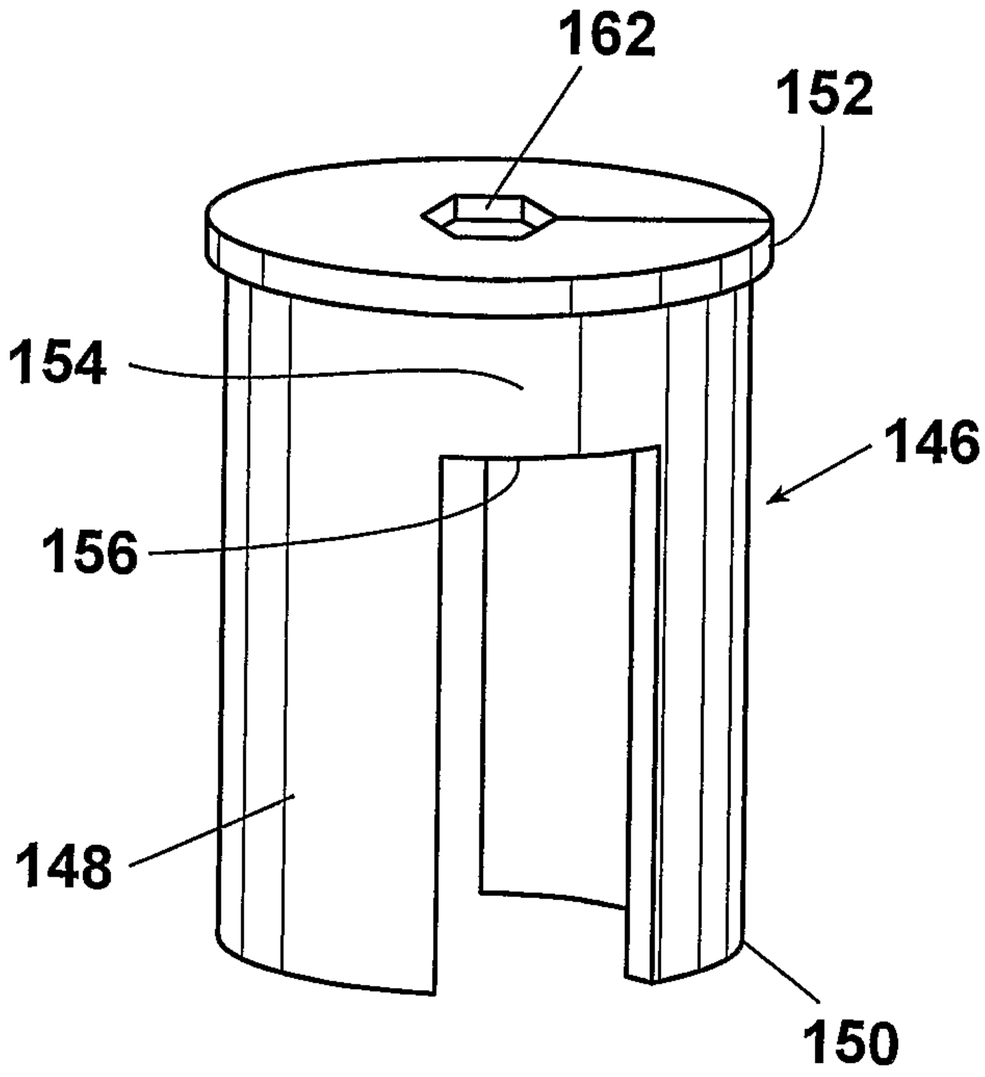


*Fig. 7*

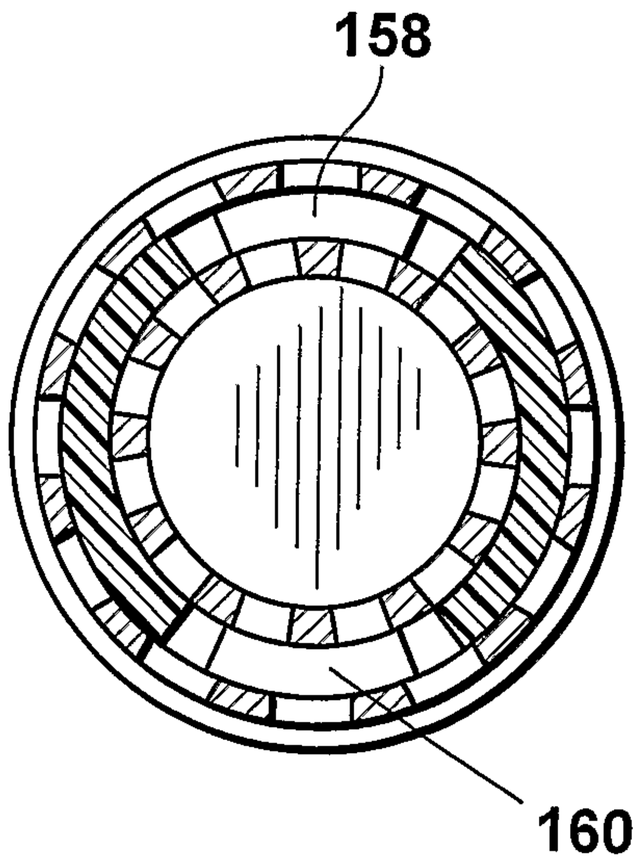


*Fig. 8*

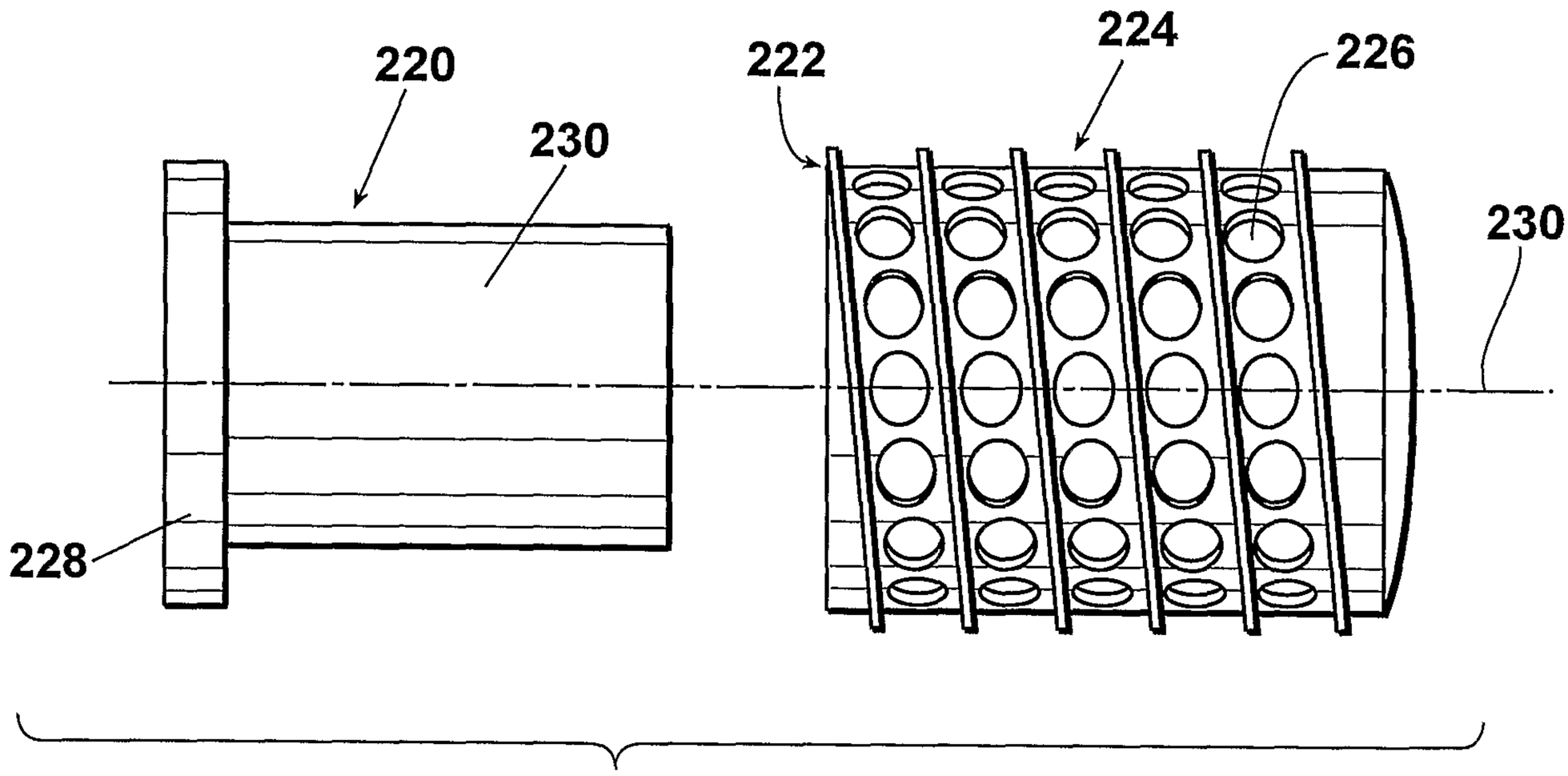


*Fig. 9*

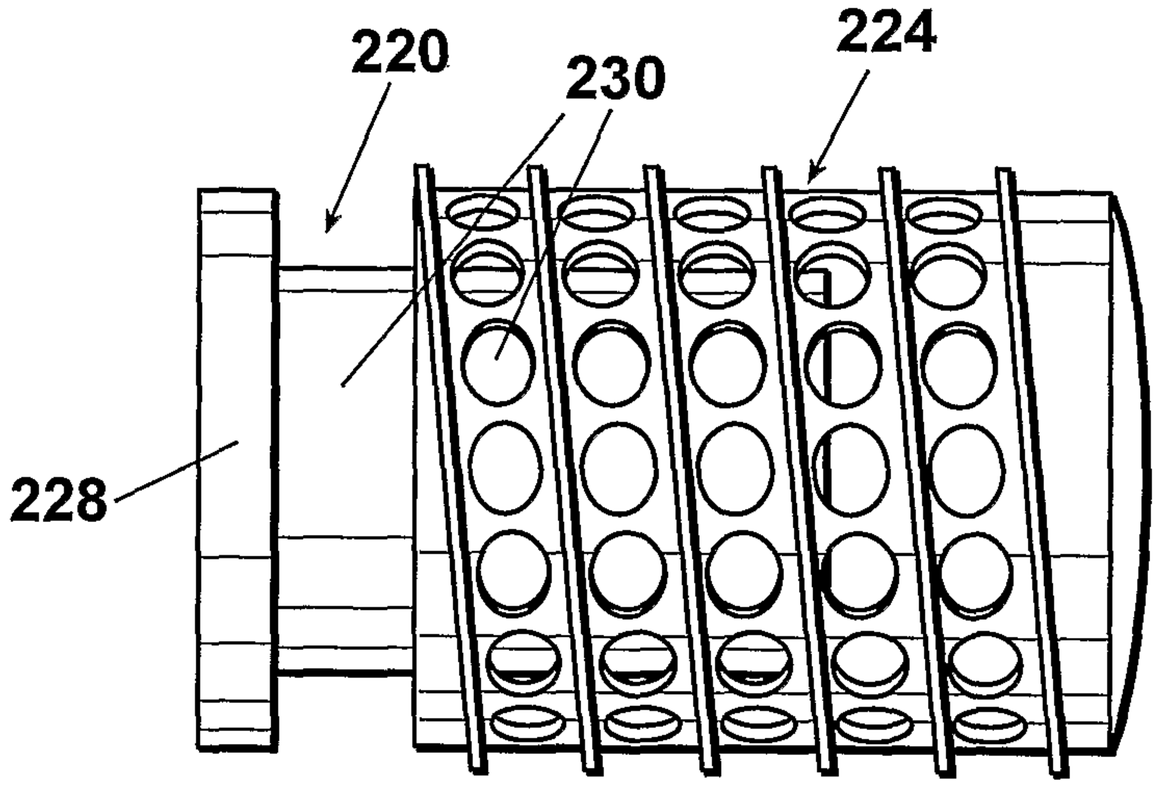


*Fig. 10*

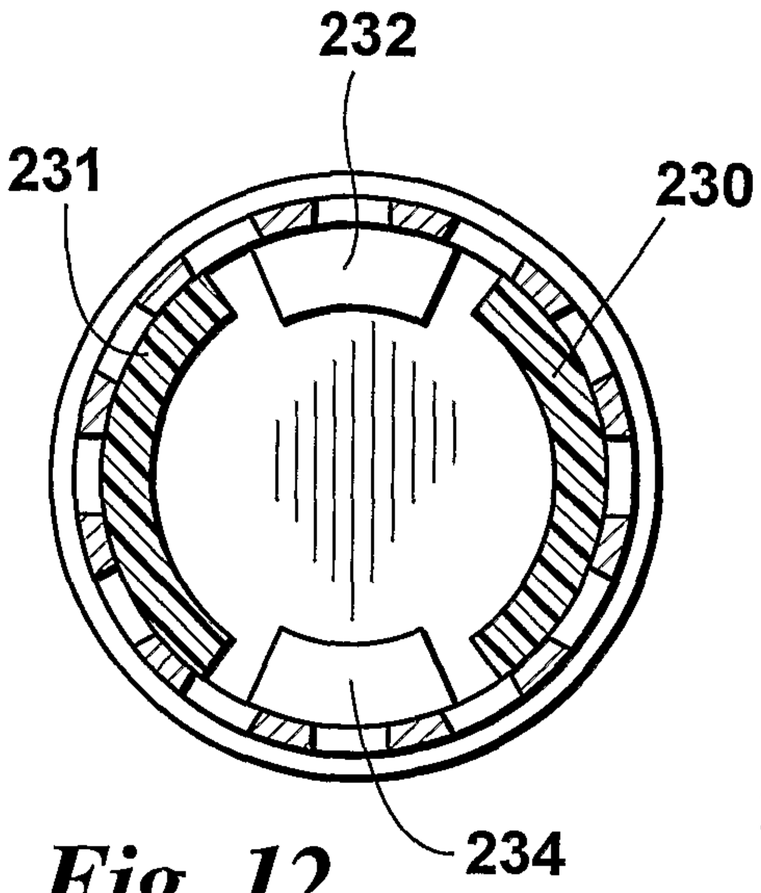


*Fig. 12*

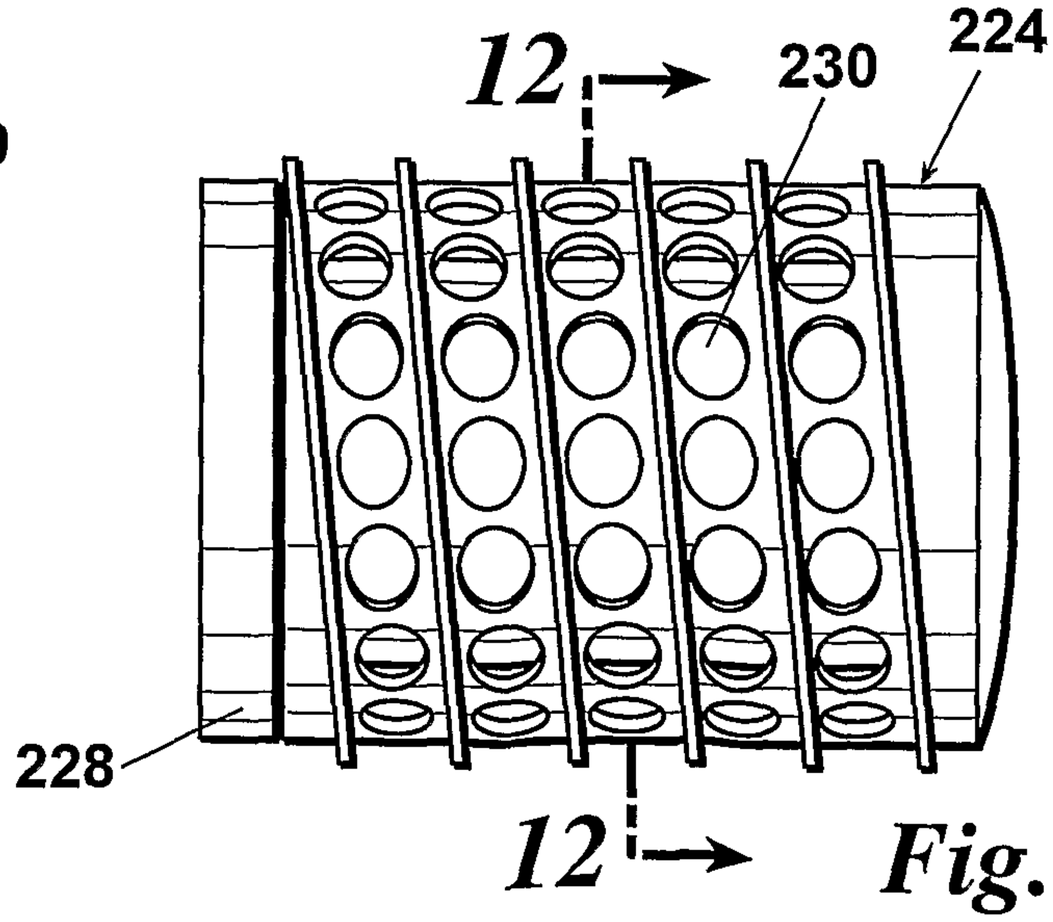


*Fig. 11*

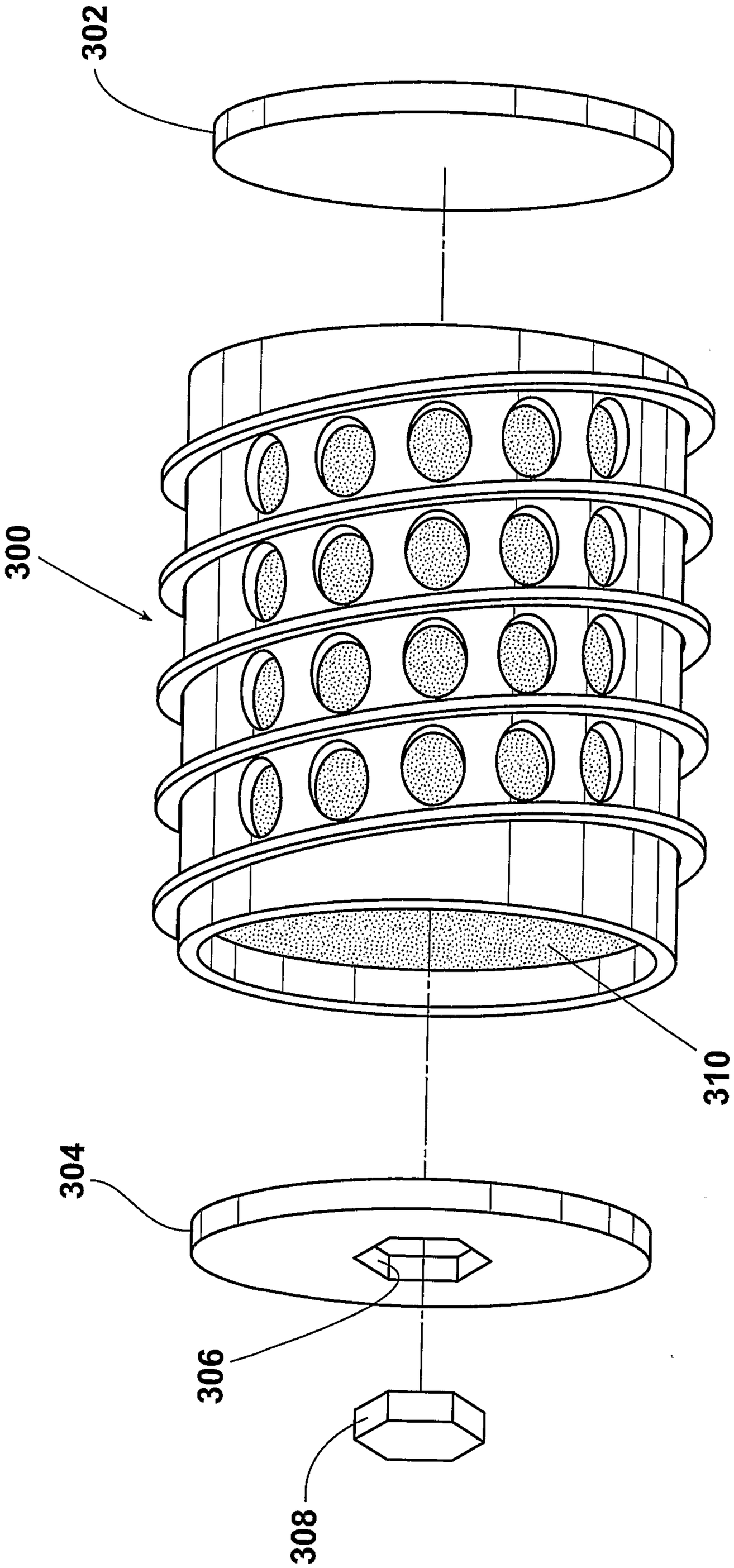


*Fig. 13*