

(19)

United States

(12)

Reissued Patent

Paul et al.

(10)

Patent Number:

US RE38,614 E

(45)

Date of Reissued Patent:

Oct. 5, 2004

(54)

INTERVERTEBRAL ALLOGRAFT SPACER

4,936,848 A

6/1990

Bagby

623/17

(List continued on next page.)

(75)

Inventors:

David C. Paul, Phoenixville, PA (US);

Hansjuerg W. Emch, Philadelphia, PA (US);

Beat Schenk, Attiswil (CH)

(73)

Assignee:

Synthes (U.S.A.), Paoli, PA (US)

(21)

Appl. No.:

10/225,282

(22)

Filed:

Aug. 22, 2002

Related U.S. Patent Documents

Reissue of:

(64)

Patent No.:

6,258,125

Issued:

Jul. 10, 2001

Appl. No.:

09/363,844

Filed:

Jul. 30, 1999

U.S. Applications:

(63)

Continuation-in-part of application No. 09/219,439, filed on Dec. 23, 1998, now Pat. No. 6,143,033.

(60)

Provisional application No. 60/095,425, filed on Aug. 5, 1998, provisional application No. 60/095,209, filed on Aug. 3, 1998, and provisional application No. 60/073,271, filed on Jan. 30, 1998.

(51)

Int. Cl.⁷

A61F 2/44

(52)

U.S. Cl.

623/17.11; 623/23.63; 623/925

(58)

Field of Search

623/16.11, 17.11, 623/17.15, 17.16

References Cited

U.S. PATENT DOCUMENTS

3,848,601 A

11/1974

Ma et al.

128/305

4,059,115 A

11/1977

Jumashev et al.

128/317

4,627,853 A

* 12/1986

Campbell et al.

128/898

4,678,470 A

* 7/1987

Nashef et al.

623/23.63

4,781,721 A

11/1988

Grundei

623/16

4,834,757 A

5/1989

Brantigan

623/17

4,858,603 A

8/1989

Clemow et al.

128/92 ZW

4,877,020 A

10/1989

Vich

128/92 V

4,932,973 A

6/1990

Gendler

623/16

FOREIGN PATENT DOCUMENTS

DE

29 10 627 A1

9/1980

DE

42 42 889 A1

6/1994

DE

44 23 257 A1

1/1996

DE

299 13 200 U1

10/1999

EP

0 505 634 A1

9/1992

EP

0 517 030 A2

12/1992

EP

538 183 A1 *

4/1993

EP

0 577 178 A1

1/1994

EP

0 639 351 A2

2/1995

EP

0 646 366 *

4/1995

(List continued on next page.)

OTHER PUBLICATIONS

Fred H. Albee, *Bone Graft Surgery in Disease, Injury and Deformity*, D. Appleton-Century Company, Inc., New York, 1940, pp. 22, 30, 114, 151, 155, 164, 212, 256-257, 311-313.

Fred H. Albee, "Bone Surgery With Machine Tools," *Scientific American*, Apr. 1936, pp. 178-181.

Fred H. Albee, *Bone-Graft Surgery*, W. B. Saunders Company, Philadelphia, Pennsylvania, 1915, pp. 145, 165-166, 171, 368-369.

Primary Examiner—David H. Willse

Assistant Examiner—Suzette J. Jackson

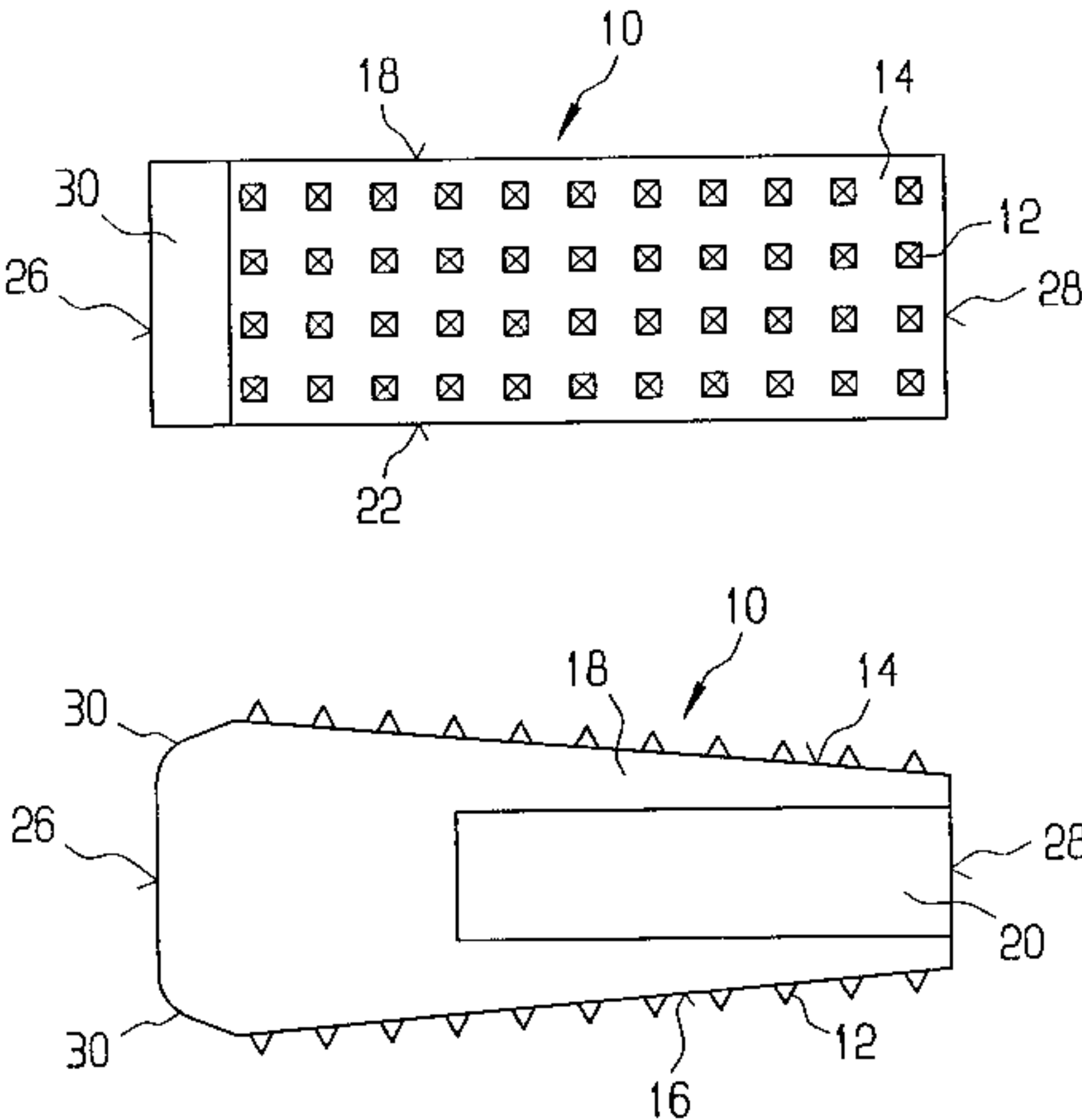
(74)

Attorney, Agent, or Firm—Jones Day

(57) ABSTRACT

An allogenic intervertebral implant for fusing vertebrae is disclosed. The implant is a piece of allogenic bone conforming in size and shape with a portion of an end plate of a vertebra. The implant has a wedge-shaped profile to restore disc height and the natural curvature of the spine. The top and bottom surfaces of the implant have a plurality of teeth to resist expulsion and provide initial stability. The implant according to the present invention provides initial stability need for fusion without stress shielding.

12 Claims, 7 Drawing Sheets



US RE38,614 E

Page 2

U.S. PATENT DOCUMENTS

4,950,296 A * 8/1990 McIntyre 623/23.63
 4,961,740 A 10/1990 Ray et al. 606/61
 5,026,373 A 6/1991 Ray et al. 606/61
 5,053,049 A * 10/1991 Campbell 623/23.63
 5,062,850 A 11/1991 MacMillan et al. 623/17
 5,092,893 A * 3/1992 Smith 606/61
 5,112,354 A 5/1992 Sires 623/16
 5,141,510 A 8/1992 Takagi et al. 623/16
 5,192,327 A 3/1993 Brantigan 623/17
 5,275,954 A * 1/1994 Wolfinbarger et al. 436/74
 5,298,254 A 3/1994 Prewett et al. 424/422
 5,306,303 A * 4/1994 Lynch 435/325
 5,306,308 A * 4/1994 Gross et al. 623/17.16
 5,306,309 A * 4/1994 Wagner et al. 623/17.16
 5,320,644 A 6/1994 Baumgartner 623/17
 5,401,269 A 3/1995 Buttner-Janz et al. ... 623/17.11
 5,405,391 A 4/1995 Hednerson et al. 623/17
 5,425,772 A * 6/1995 Brantigan 623/17.11
 5,439,684 A 8/1995 Prewett et al. 424/422
 5,443,514 A * 8/1995 Steffee 128/898
 5,458,638 A 10/1995 Kuslich et al. 623/17
 5,484,437 A 1/1996 Michelson 606/61
 5,489,307 A 2/1996 Kuslich et al. 623/17
 5,489,308 A 2/1996 Kuslich et al. 623/17
 5,514,180 A * 5/1996 Heggeness et al. 623/17.16
 5,522,899 A 6/1996 Michelson 623/17
 5,534,030 A * 7/1996 Navarro et al. 623/17.15
 5,554,191 A 9/1996 Lahille et al. 623/17
 5,556,379 A * 9/1996 Wolfinbarger 128/898
 5,571,190 A 11/1996 Ulrich et al. 623/17
 5,571,192 A 11/1996 Schonhöffer 623/17
 5,591,235 A 1/1997 Kuslich 623/17
 5,593,409 A 1/1997 Michelson 606/61
 5,609,635 A 3/1997 Michelson 623/17
 5,609,636 A 3/1997 Kohrs et al. 623/17
 5,609,637 A * 3/1997 Biedermann et al. 623/17.16
 5,645,598 A 7/1997 Brosnahan, III 623/17
 5,658,337 A * 8/1997 Kohrs et al. 623/17.11
 5,683,394 A 11/1997 Rinner 606/86
 5,683,463 A 11/1997 Godefroy et al. 623/17
 5,683,464 A * 11/1997 Wagner et al. 623/17.16
 5,702,449 A * 12/1997 McKay 623/17.16
 5,702,455 A * 12/1997 Saggar 623/17.15
 5,709,683 A 1/1998 Bagby 606/61
 5,716,415 A * 2/1998 Steffee 623/17.16
 5,722,977 A * 3/1998 Wilhelmy 606/84
 5,725,579 A * 3/1998 Fages et al. 128/898
 5,728,159 A * 3/1998 Stroeve et al. 623/23.5
 5,741,253 A * 4/1998 Michelson 606/61
 5,766,252 A 6/1998 Henry et al. 623/17
 5,766,253 A * 6/1998 Brosnahan, III 623/17.16
 5,776,199 A * 7/1998 Michelson 623/17.16
 5,782,830 A 7/1998 Farris 606/61
 5,785,710 A * 7/1998 Michelson 606/61
 5,797,871 A * 8/1998 Wolfinbarger, Jr. 604/500
 5,798,096 A 8/1998 Pavlyk 424/78.35
 5,814,084 A * 9/1998 Grivas et al. 623/23.48
 5,820,581 A * 10/1998 Wolfinbarger, Jr. 604/500
 5,865,845 A * 2/1999 Thalgott 623/17.16
 5,865,848 A * 2/1999 Baker 623/17.15
 5,885,299 A 3/1999 Winslow et al. 606/99
 5,888,222 A * 3/1999 Coates et al. 623/17.16
 5,888,224 A 3/1999 Beckers et al. 623/17
 5,888,227 A * 3/1999 Cottle 623/17.16
 5,895,426 A 4/1999 Scarborough et al. 623/17
 5,897,593 A * 4/1999 Kohrs et al. 623/17.16
 5,899,939 A * 5/1999 Boyce et al. 623/16.11
 5,899,941 A * 5/1999 Nishijima et al. 623/17.15
 5,904,719 A 5/1999 Errico et al. 623/17
 5,910,315 A 6/1999 Stevenson et al. 424/422
 5,968,098 A 10/1999 Winslow 623/17
 5,972,368 A * 10/1999 McKay 424/423

5,976,187 A 11/1999 Richelsoph 623/17
 5,984,922 A 11/1999 McKay 606/61
 5,984,967 A 11/1999 Zdeblick et al. 623/17
 5,989,289 A 11/1999 Coates et al. 623/17
 6,008,433 A 12/1999 Stone 623/16
 6,025,538 A * 2/2000 Yaccarino, III 128/898
 6,033,438 A * 3/2000 Bianchi et al. 623/17.16
 6,039,762 A 3/2000 McKay 623/17
 6,045,579 A * 4/2000 Hochshuler et al. 623/17.16
 6,045,580 A 4/2000 Scarborough et al. 623/17
 6,059,790 A 5/2000 Sand et al. 606/99
 6,080,158 A * 6/2000 Lin 606/61
 6,080,193 A * 6/2000 Hochshuler et al. 623/17.16
 6,090,998 A 7/2000 Grooms et al. 623/16
 6,096,080 A * 8/2000 Nicholson et al. 623/17.16
 6,096,081 A 8/2000 Grivas et al. 623/17.11
 6,111,164 A 8/2000 Rainey et al. 623/16
 6,143,033 A 11/2000 Paul et al. 623/17.11
 6,187,329 B1 2/2001 Agrawal et al. 424/426
 6,200,347 B1 3/2001 Anderson et al. 623/16.11
 6,206,923 B1 3/2001 Boyd et al. 623/17.11
 6,241,769 B1 6/2001 Nicholson et al. 623/17.11
 6,245,108 B1 6/2001 Biscup 623/17.11
 6,258,125 B1 7/2001 Paul et al. 623/17.11
 6,261,586 B1 7/2001 McKay 424/423
 6,270,528 B1 8/2001 McKay 623/17.11
 6,277,149 B1 8/2001 Boyle et al. 623/17.16
 6,371,988 B1 4/2002 Pafford et al. 623/17.11
 6,511,509 B1 1/2003 Ford et al. 623/23.5
 2001/0001129 A1 5/2001 McKay et al. 623/17.16
 2001/0010021 A1 7/2001 Boyd et al. 623/17.13
 2001/0014831 A1 8/2001 Scarborough 623/23.51
 2001/0016775 A1 8/2001 Scarborough et al. ... 623/17.16
 2001/0016777 A1 8/2001 Biscup 623/17.16
 2002/0091447 A1 7/2002 Shimp et al. 623/17.16
 2002/0106393 A1 8/2002 Bianchi et al. 424/423
 2002/0107570 A1 8/2002 Sybert et al. 623/13.17

FOREIGN PATENT DOCUMENTS

EP 0 966 930 A1 12/1999
 FR 2 717 068 * 9/1950
 FR 2 552 659 2/1995
 JP 6-14947 1/1994
 WO WO 94 262213 * 11/1994
 WO WO 95 08964 * 4/1995
 WO WO 9515133 * 6/1995
 WO WO 96/11642 4/1996
 WO WO 96/39988 12/1996
 WO WO 97/14378 * 4/1997
 WO WO 97/15248 * 5/1997
 WO WO 97/25945 * 7/1997
 WO WO 97/32547 * 9/1997
 WO WO 98/17209 * 4/1998
 WO WO 98/55052 * 12/1998
 WO WO 98/56319 * 12/1998
 WO WO 98/56433 * 12/1998
 WO WO 99/09914 * 3/1999
 WO WO 99/13806 * 3/1999
 WO WO 99/29271 6/1999
 WO WO 99/32055 7/1999
 WO WO 99/38461 8/1999
 WO WO 00/07527 2/2000
 WO WO 00/07528 2/2000
 WO WO 00/30568 6/2000
 WO WO 00/40177 7/2000
 WO WO 00/40179 7/2000
 WO WO 00/41654 7/2000
 WO WO 00/42954 7/2000
 WO WO 00/59412 10/2000
 WO WO 00/74607 12/2000
 WO WO 00/74608 12/2000
 WO WO 01/08611 A1 2/2001

* cited by examiner

FIG 1

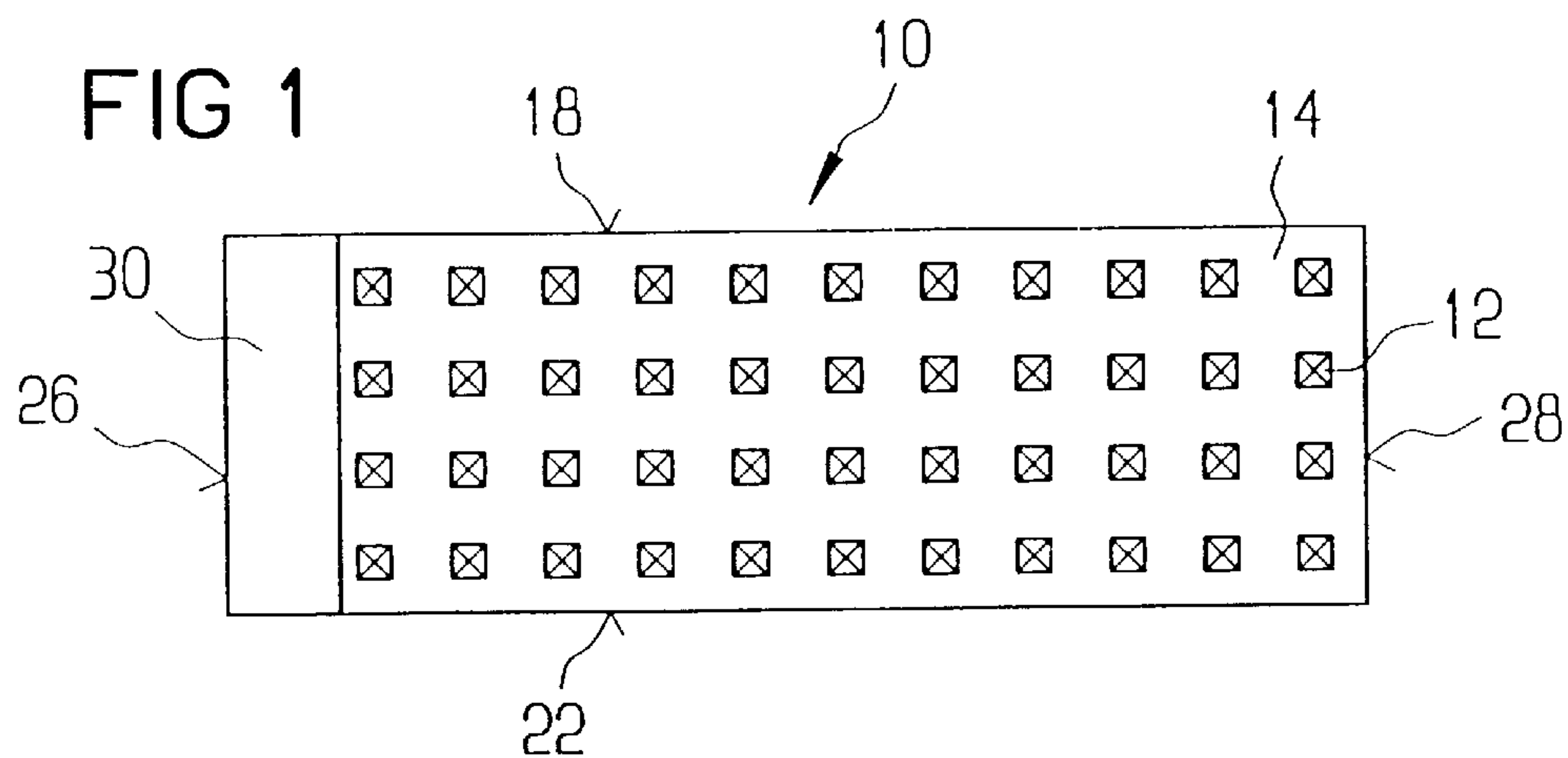


FIG 2

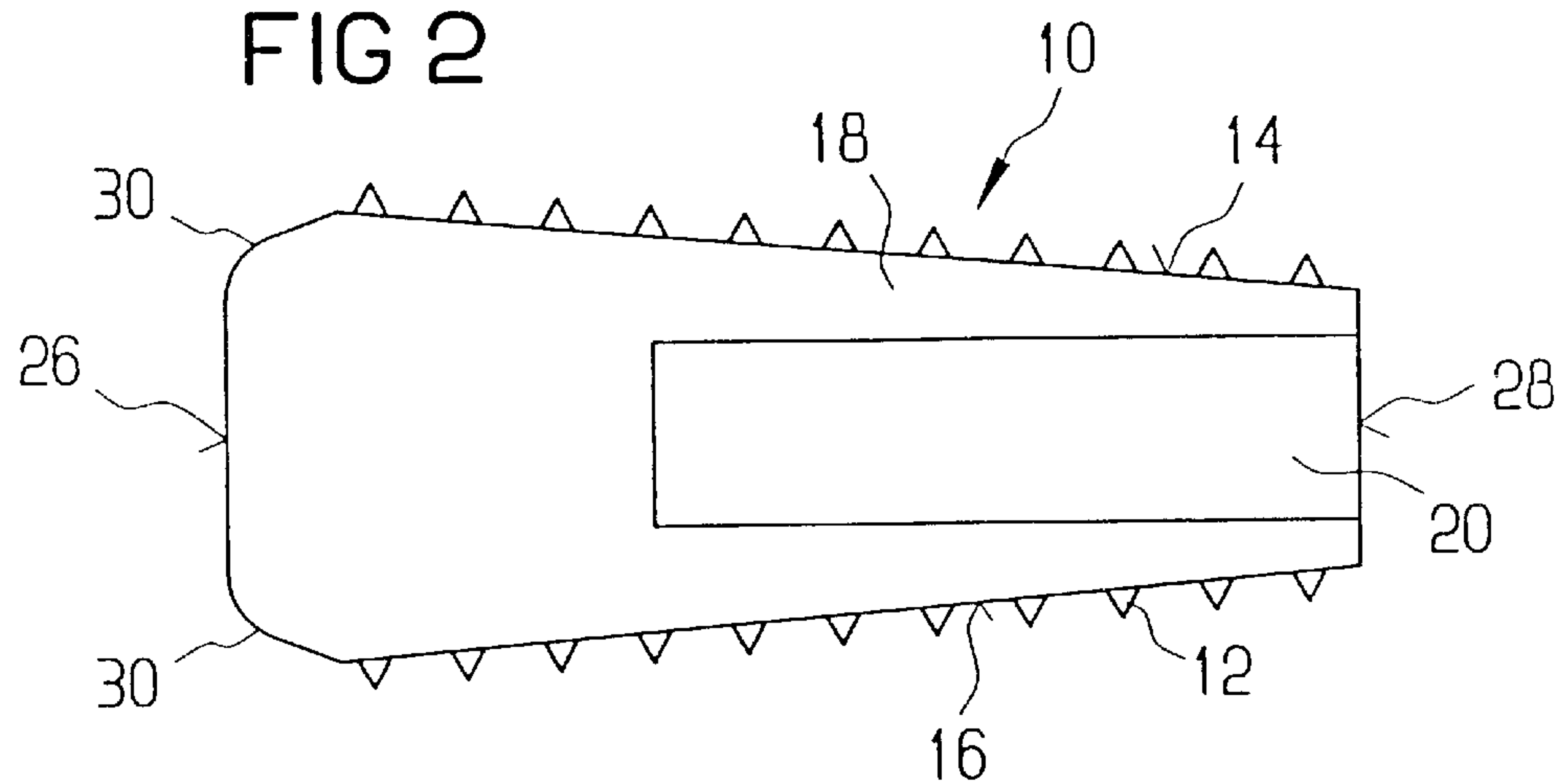


FIG 3

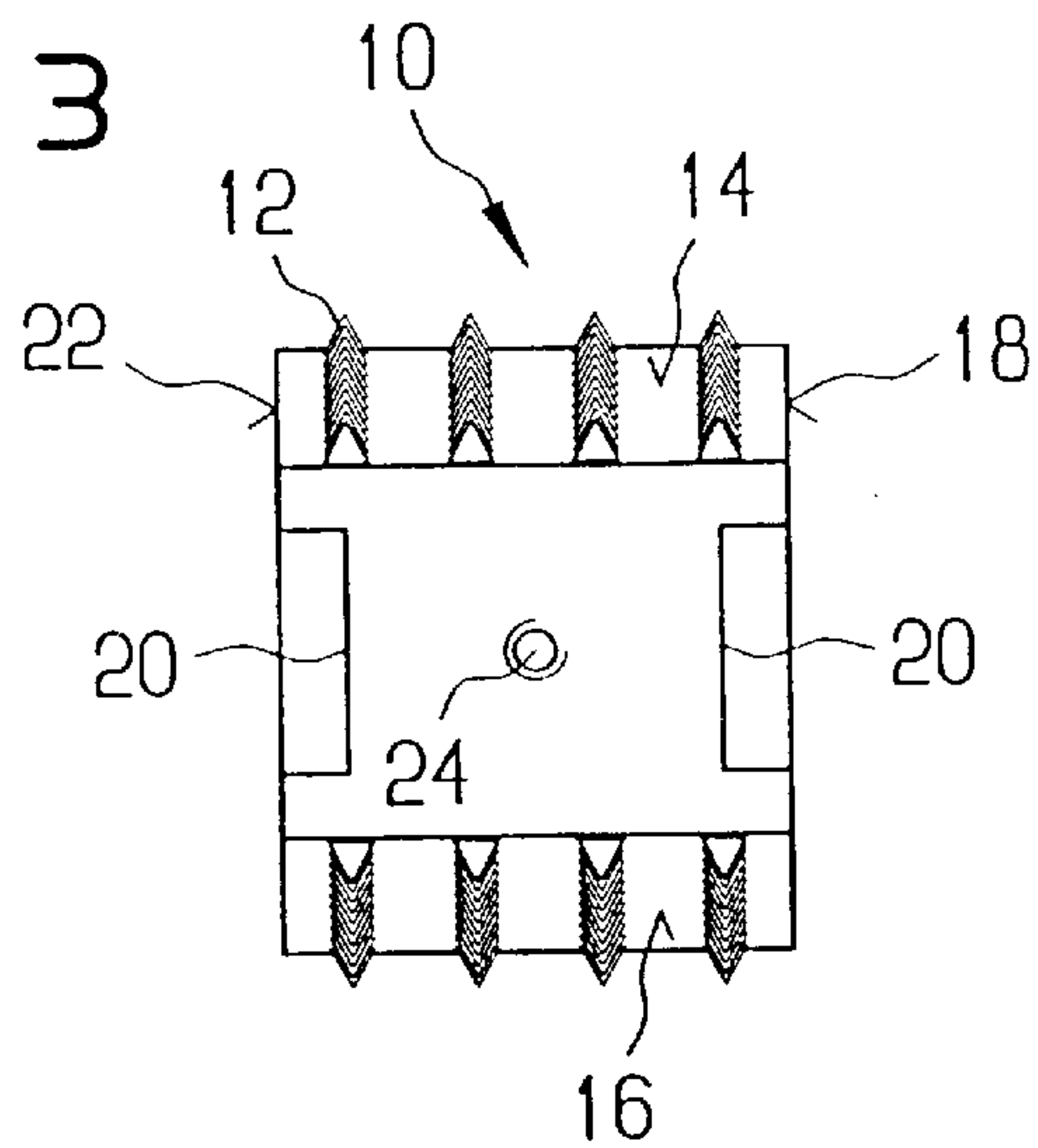


FIG 4

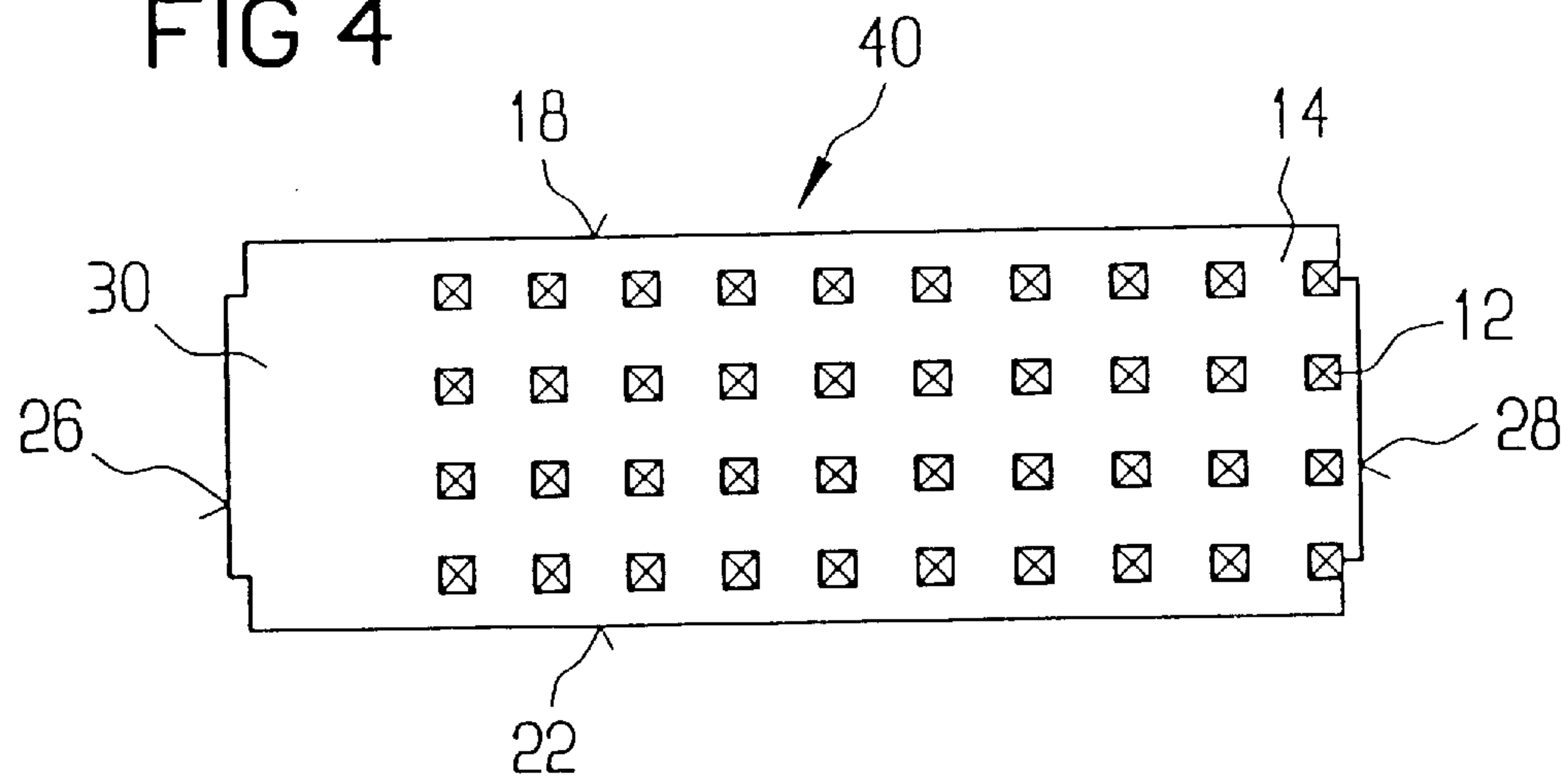


FIG 5

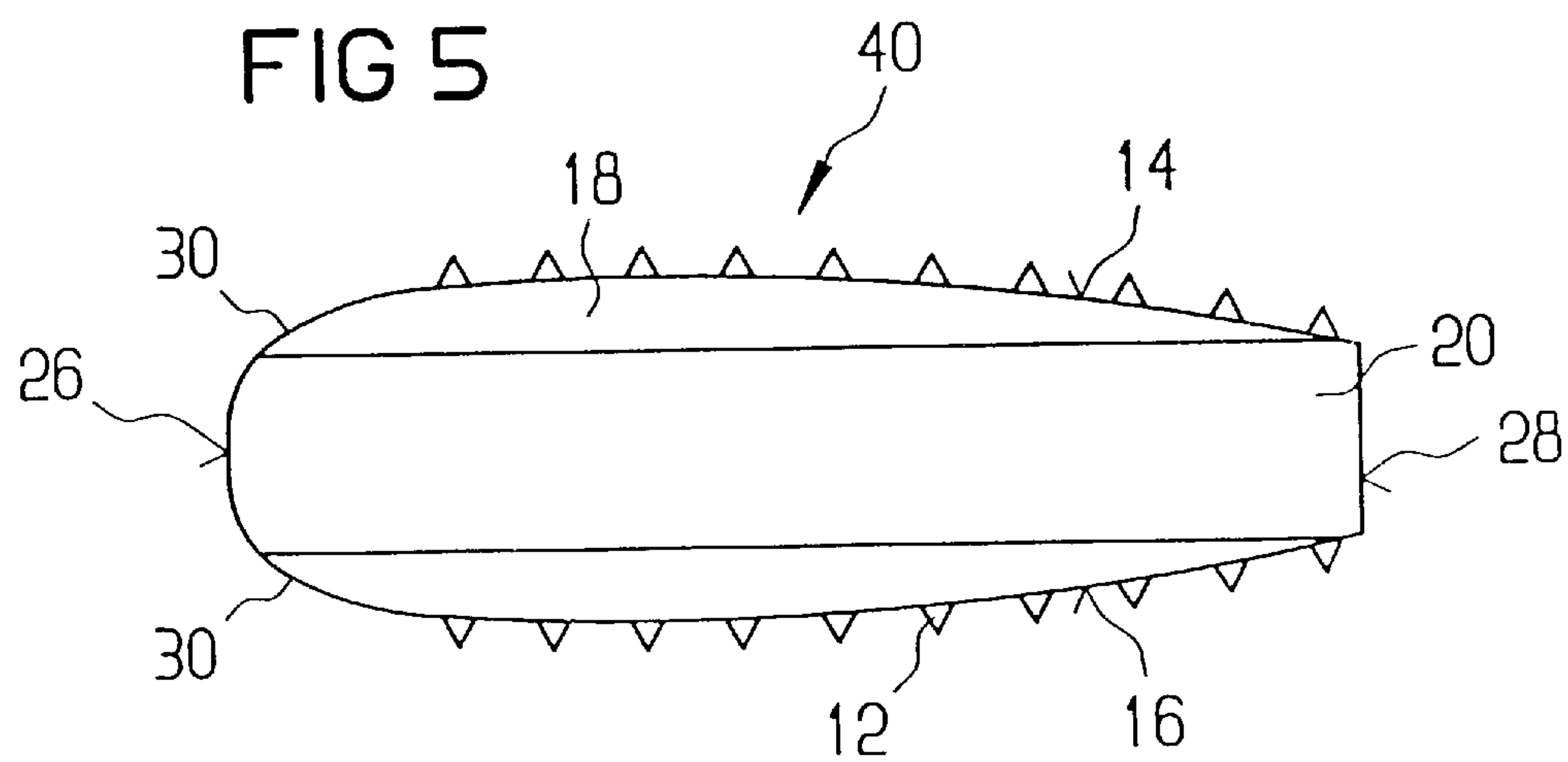


FIG 6

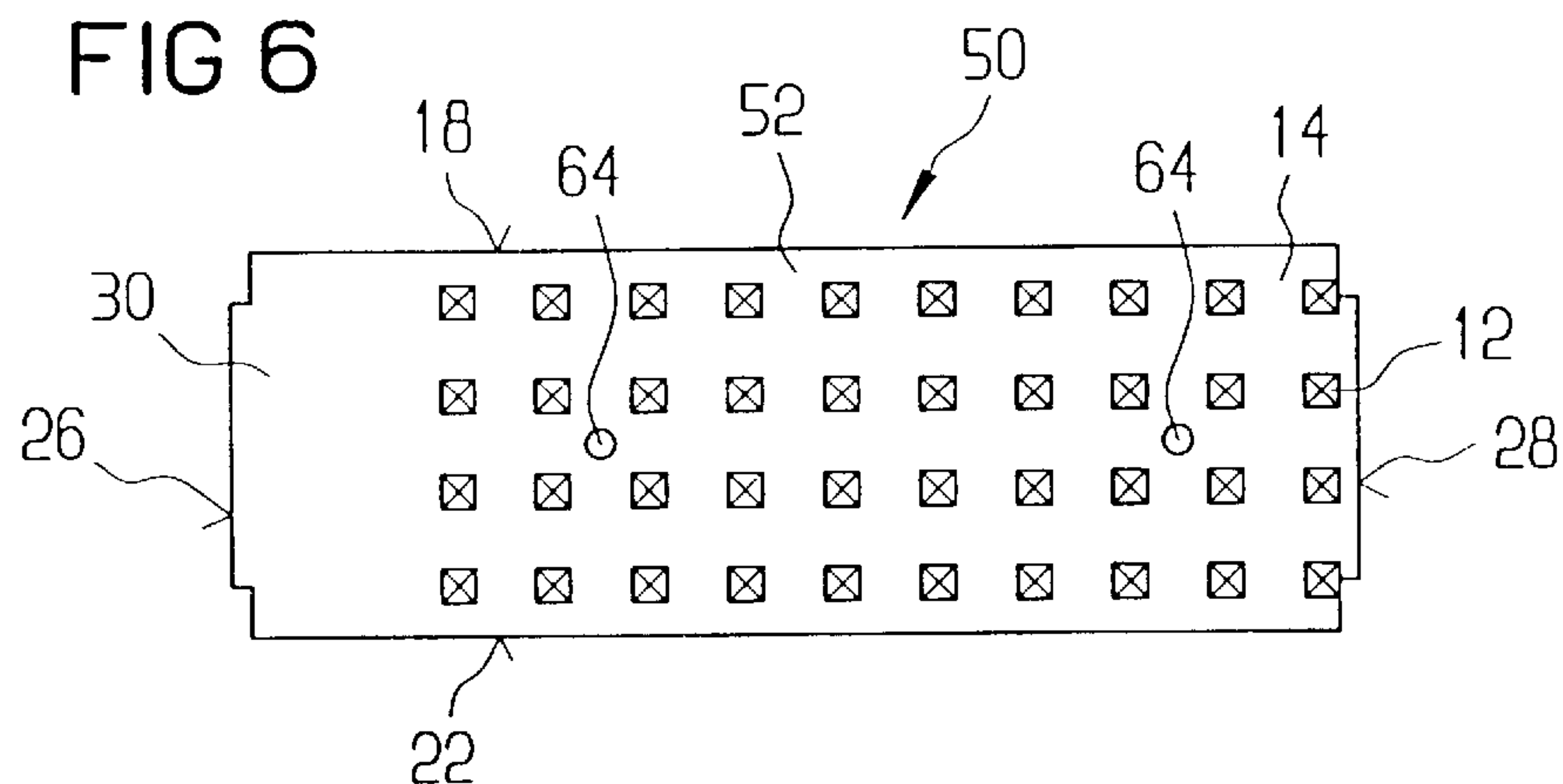


FIG 7

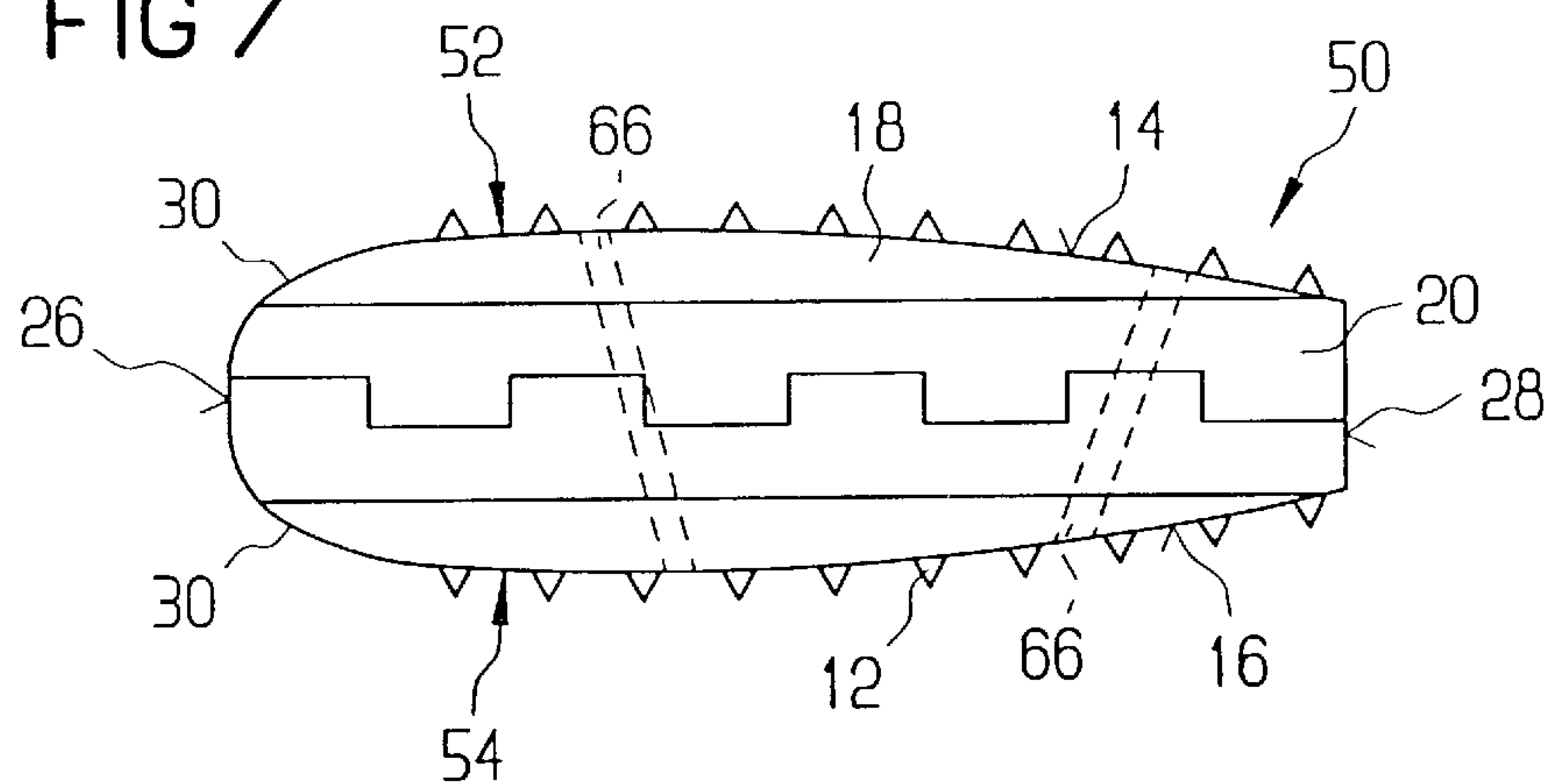


FIG 8A

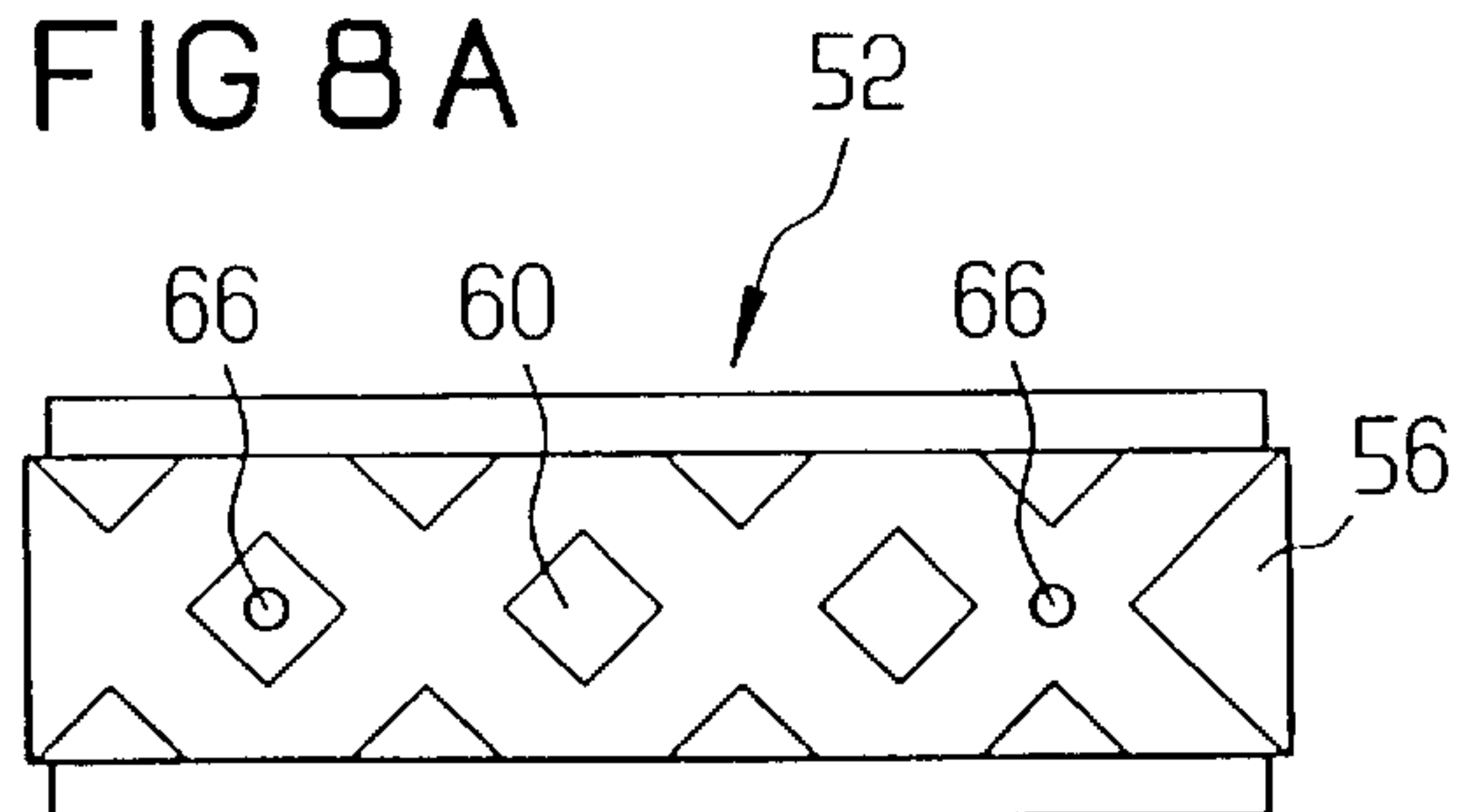


FIG 8B

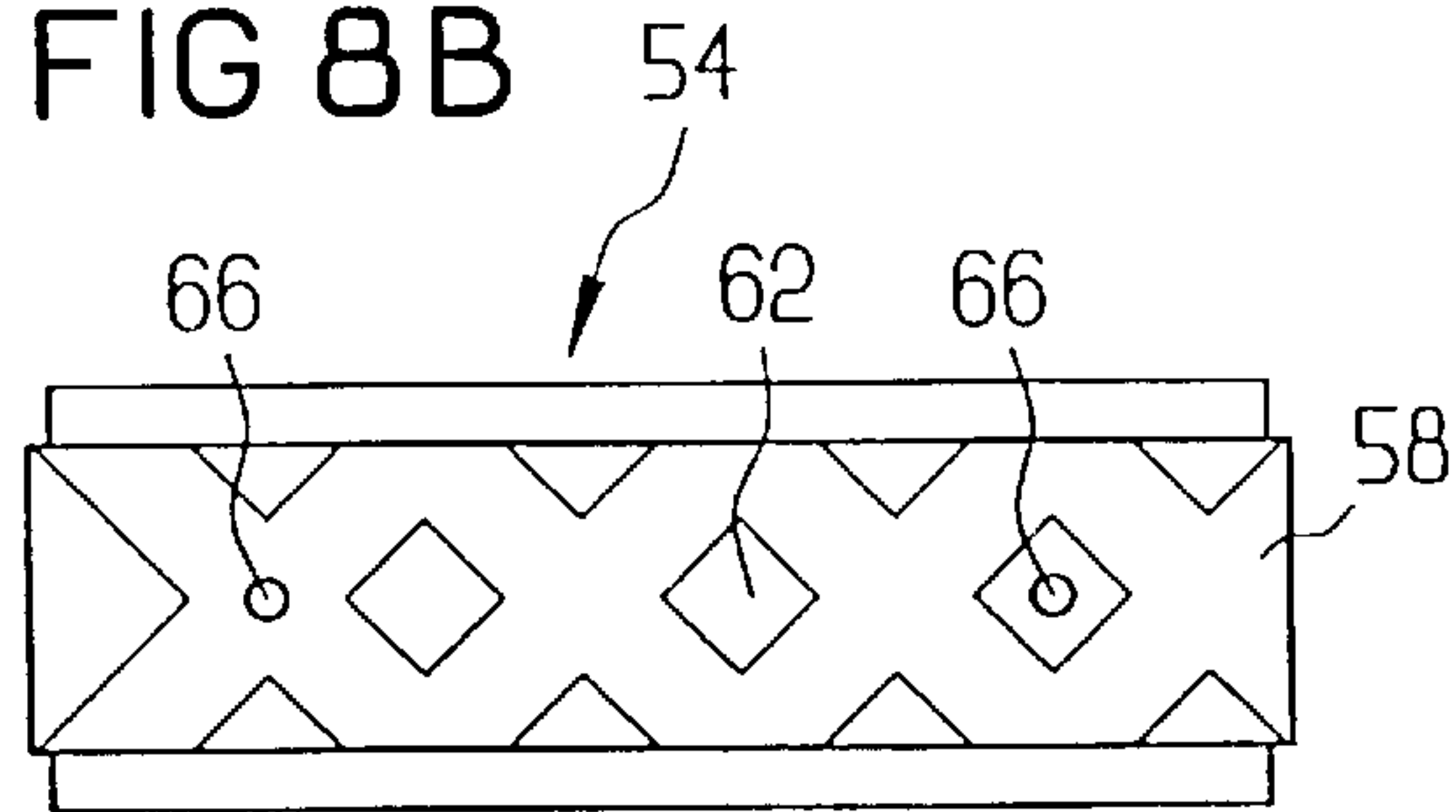


FIG 9

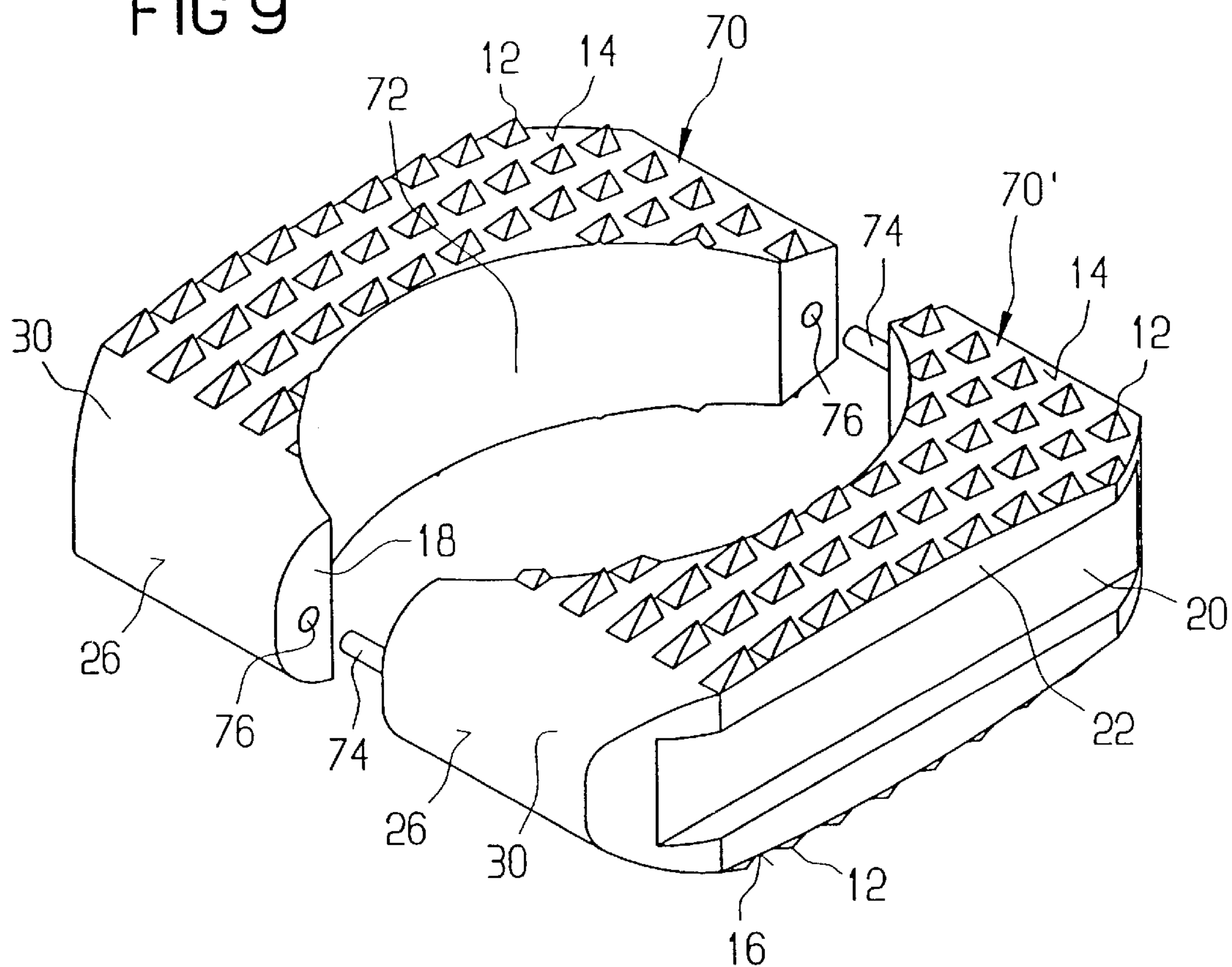


FIG 10A

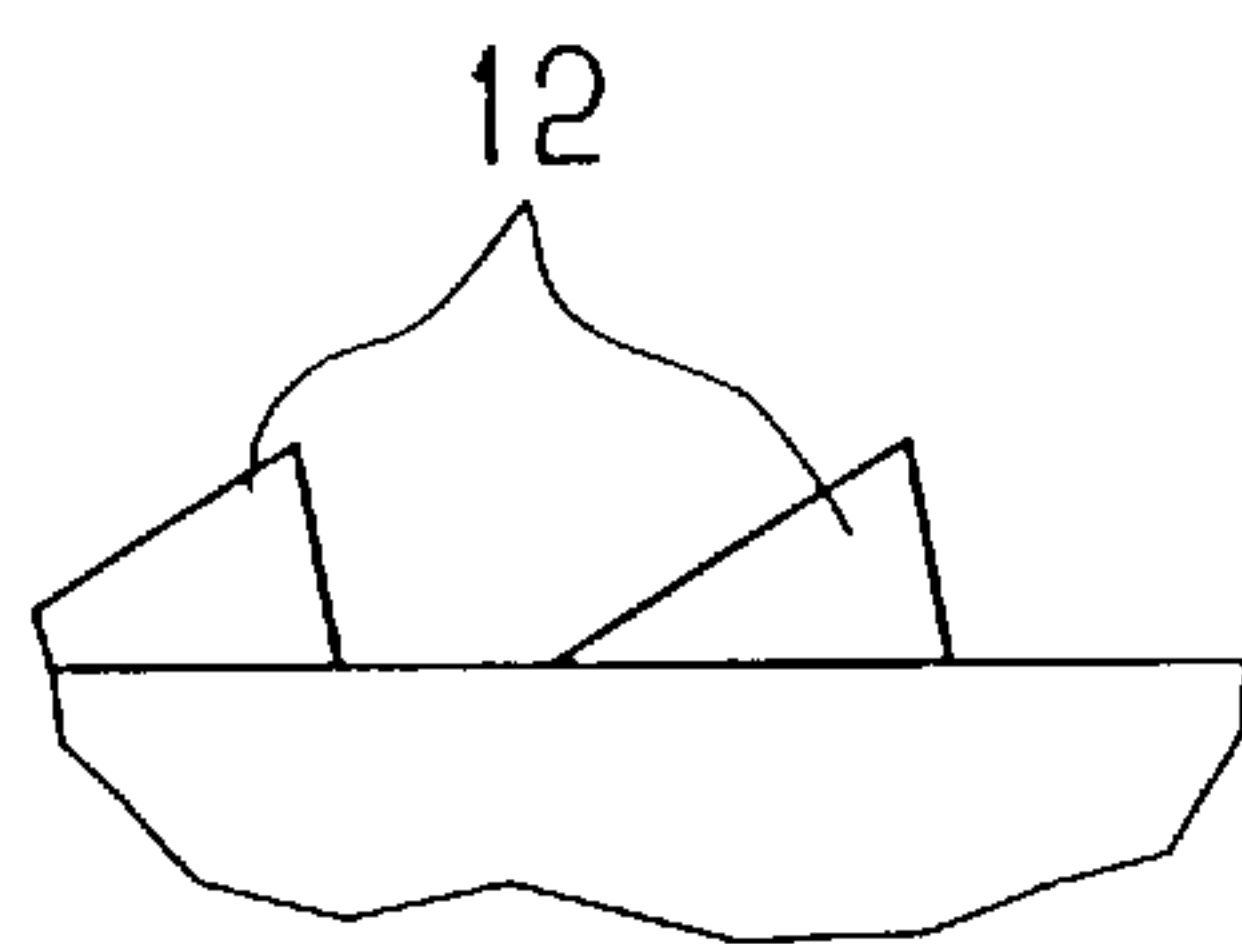


FIG 10B

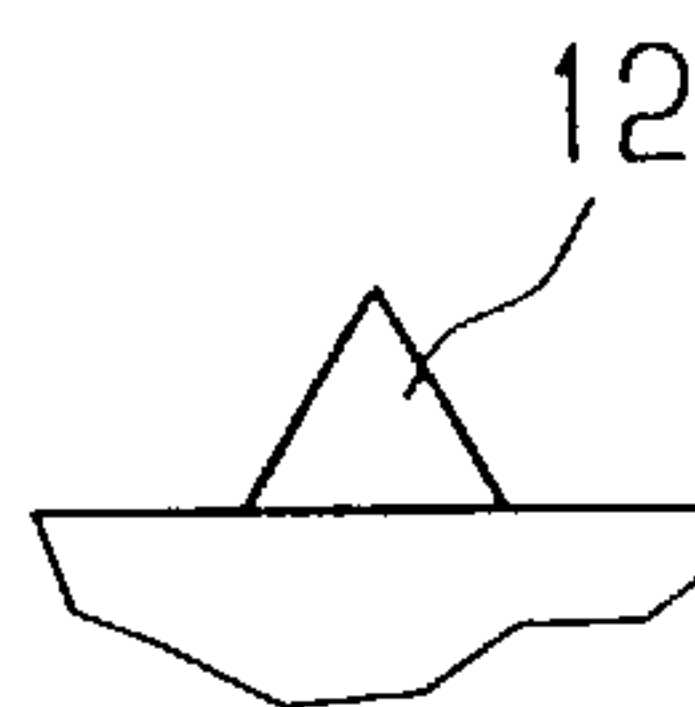


FIG 11

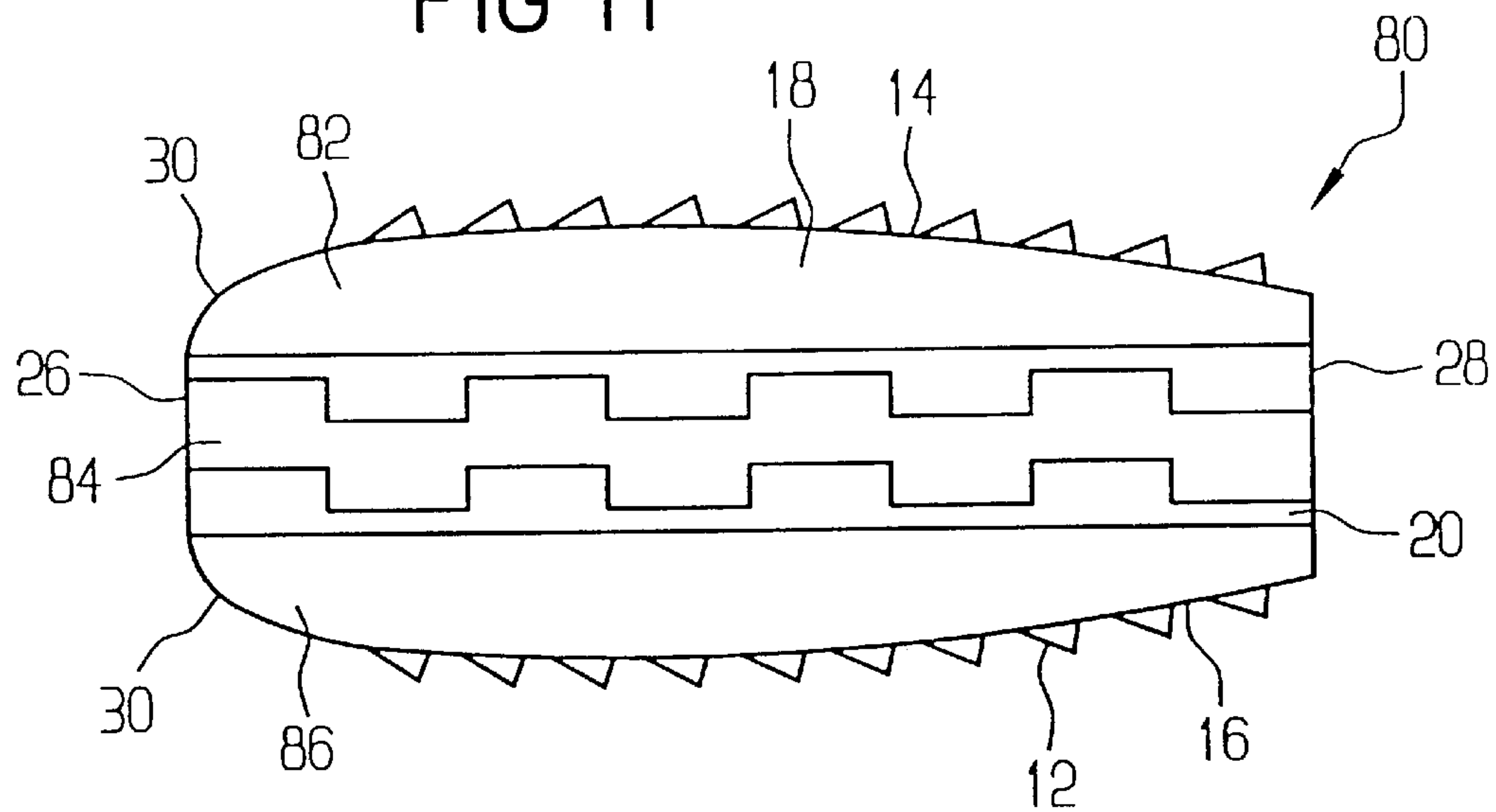


FIG 15

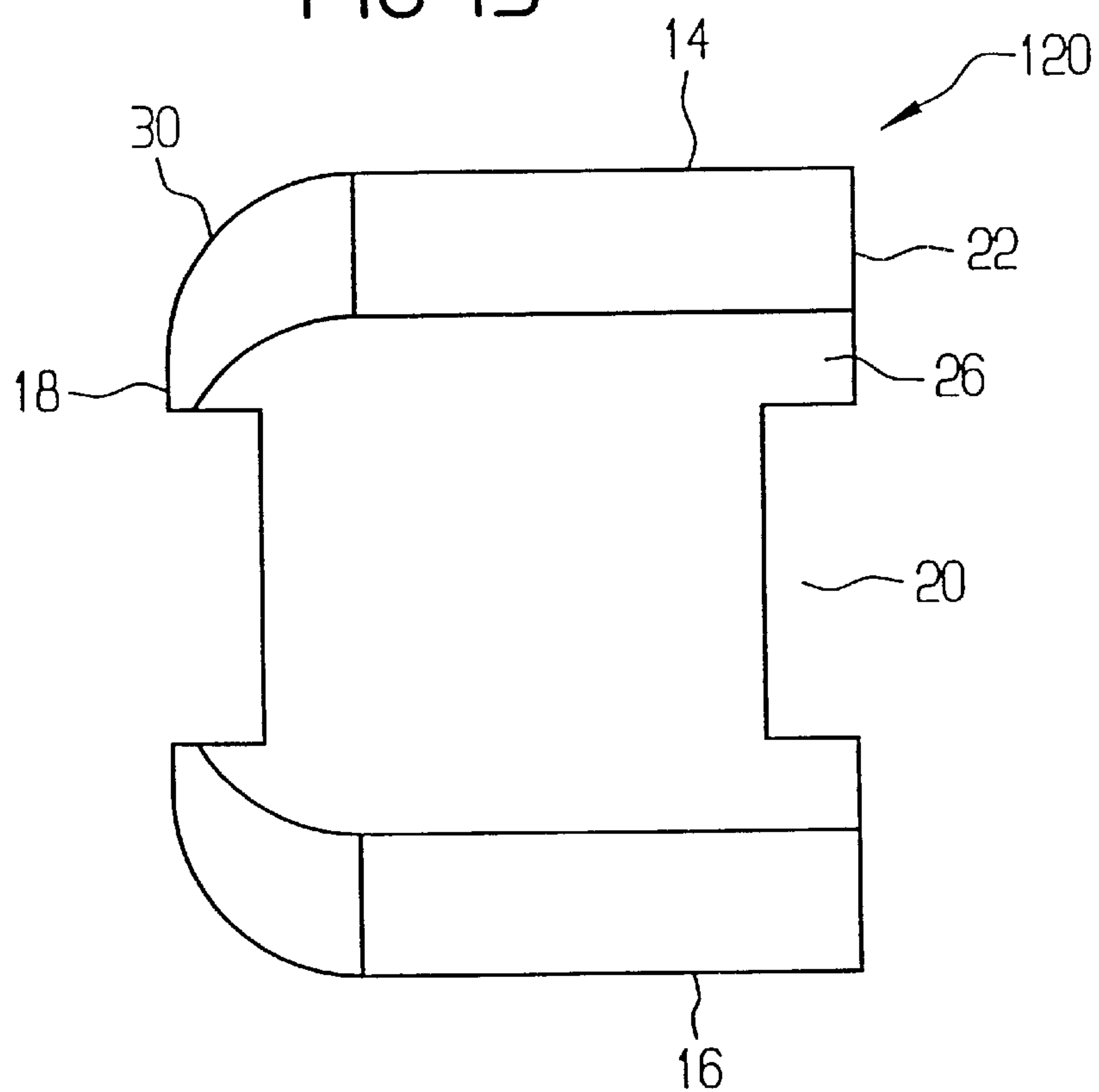


FIG 13

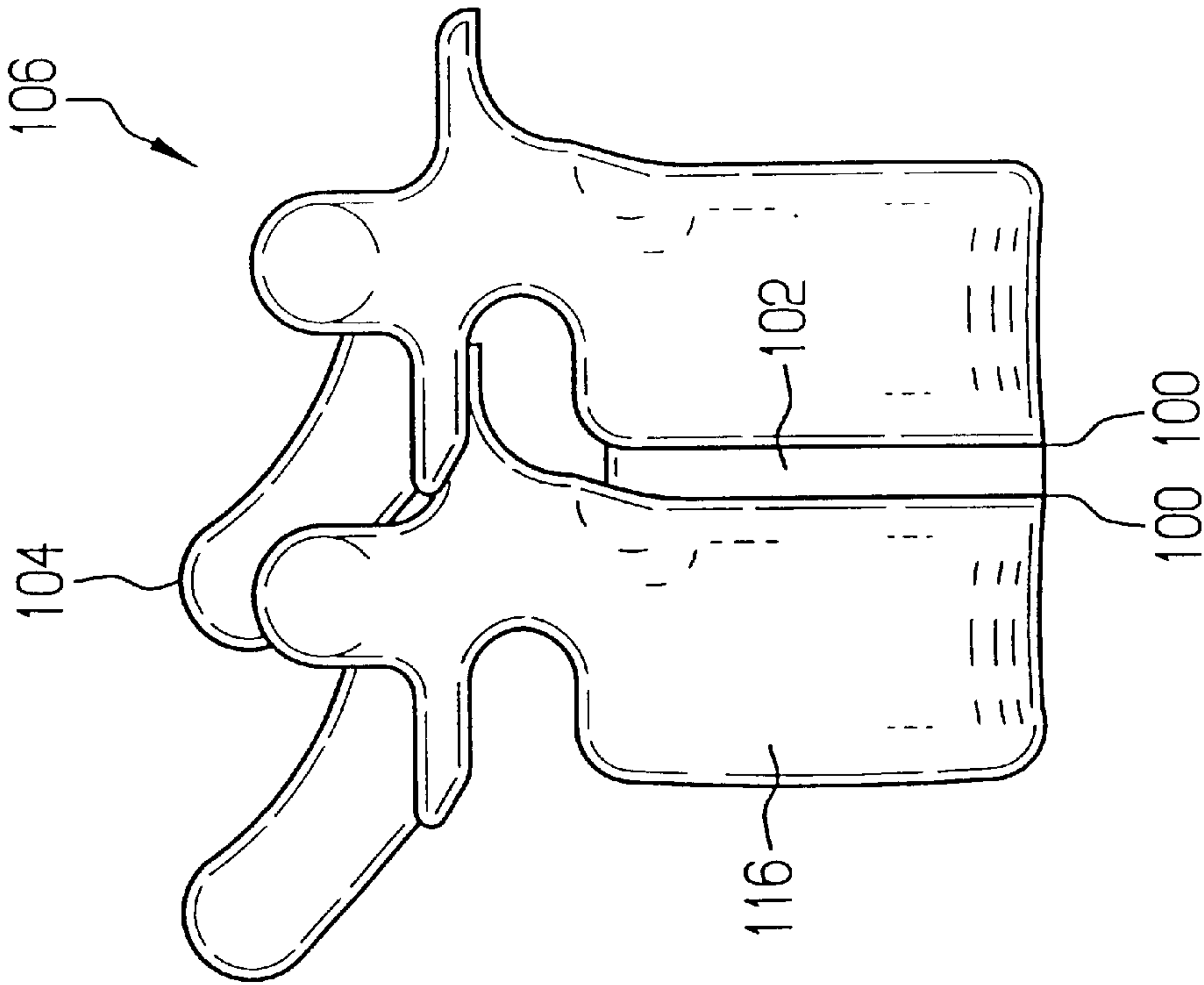


FIG 12

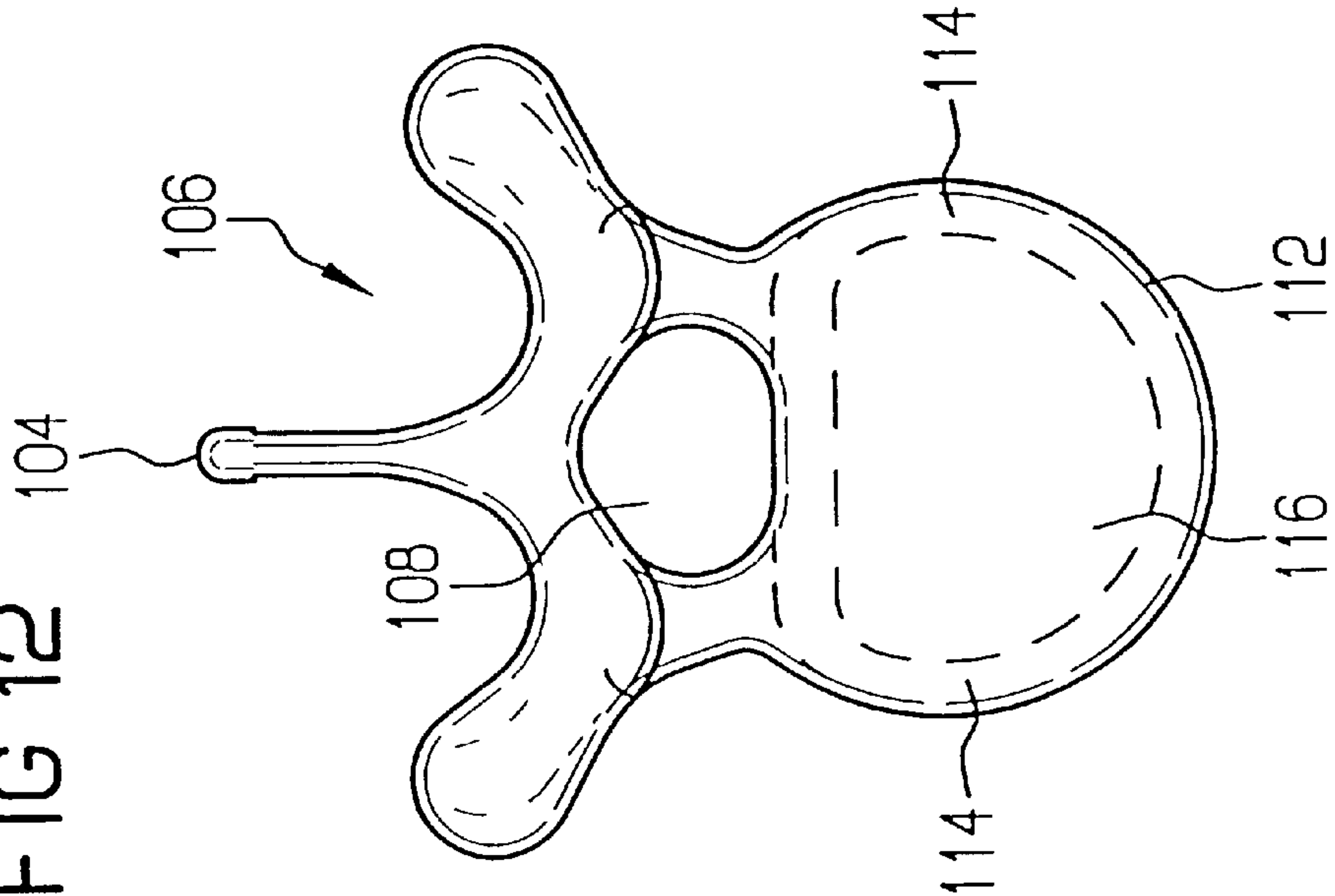
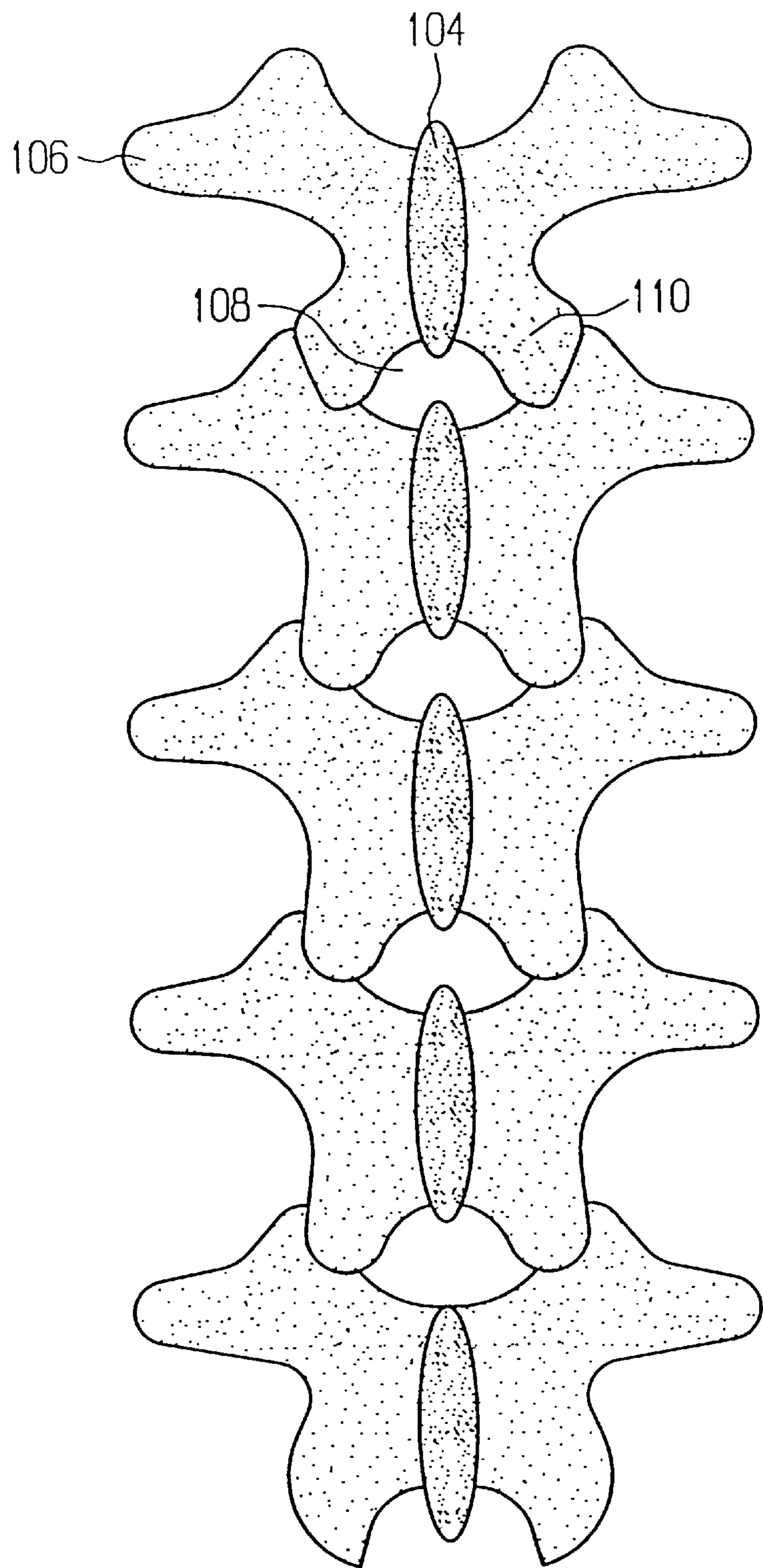


FIG 14



INTERVERTEBRAL ALLOGRAFT SPACER

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a reissue application of U.S. patent application Ser. No. 09/363,844, filed on Jul. 30, 1999, which is now U.S. Pat. No. 6,258,125 B1, which application is, in turn, a continuation-in-part of U.S. patent application Ser. No. 09/219,439, filed on Dec. 23, 1998, which is now U.S. Pat. No. 6,143,033. U.S. patent application Ser. No. 09/363,844 claims benefit to Provisional Application No. 60/095,209, filed on Aug. 3, 1998, under 35 U.S.C. § 119(e). U.S. patent application Ser. No. 09/219,439 claims benefit to Provisional Application No. 60/095,425, filed on Aug. 5, 1998, and claims benefit to Provisional Application No. 60/073,271, filed on Jan. 30, 1998, under 35 U.S.C. § 119(e).

FIELD OF THE INVENTION

The present invention is directed to an allogenic implant and, more particularly, to an allogenic intervertebral implant.

BACKGROUND OF THE INVENTION

A number of medical conditions such as compression of spinal cord nerve roots, degenerative disc disease, and spondylolisthesis can cause severe low back pain. Intervertebral fusion is a surgical method of alleviating low back pain. In posterior lumbar interbody fusion ("PLIF"), two adjacent vertebral bodies are fused together by removing the affected disc and inserting an implant that would allow for bone to grow between the two vertebral bodies to bridge the gap left by the disc removal.

A number of different implants and implant materials have been used in PLIF with varying success. Current implants used for PLIF include threaded titanium cages and allografts. Threaded titanium cages suffer from the disadvantage of requiring drilling and tapping of the vertebral end plates for insertion. In addition, the incidence of subsidence in long term use is not known. Due to MRI incompatibility of titanium, determining fusion is problematic. Finally, restoration of lordosis, i.e., the natural curvature of the lumbar spine is very difficult when a cylindrical titanium cage is used.

Allografts are sections of bone taken from a long bone of a donor. A cross section of the bone is taken and processed using known techniques to preserve the allograft until implantation and reduce the risk of an adverse immunological response when implanted. For example, U.S. Pat. No. 4,678,470 discloses a method for processing a bone grafting material which uses glutaraldehyde tanning to produce a non-antigenic, biocompatible material. Allografts have mechanical properties which are similar to the mechanical properties of vertebrae even after processing. This prevents stress shielding that occurs with metallic implants. They are also MRI compatible so that fusion can be more accurately ascertained and promote the formation of bone, i.e., osteoconductive. Although the osteoconductive nature of the allograft provides a biological interlocking between the allograft and the vertebrae for long term mechanical strength, initial and short term mechanical strength of the

interface between the allograft and the vertebrae are lacking as evidenced by the possibility of the allograft being expelled after implantation.

Currently commercially available allografts are simply sections of bone not specifically designed for use in PLIF. As a result, the fusion of the vertebral bodies does not occur in optimal anatomical position. A surgeon may do some minimal intraoperative shaping and sizing to customize the allograft for the patient's spinal anatomy. However, significant shaping and sizing of the allograft is not possible due to the nature of the allograft. Even if extensive shaping and sizing were possible, a surgeon's ability to manually shape and size the allograft to the desired dimensions is severely limited.

Most PLIF implants, whether threaded cages or allograft, are available in different sizes and have widths that vary with the implant height. For example, the width of a cylindrical cages will be substantially equivalent to the height. Although larger heights may be clinically indicated, wider implants are generally not desirable since increased width requires removal of more of the facet, which can lead to decreases stability, and more retraction of nerve roots, which can lead to temporary or permanent nerve damage.

As the discussion above illustrates, there is a need for an improved implant for fusing vertebrae.

SUMMARY OF THE INVENTION

The present invention relates to an allogenic intervertebral implant for use when surgical fusion of vertebral bodies is indicated. The implant comprises a piece of allogenic bone conforming in size and shape with a portion of an end plates of the vertebrae and has a wedge-shaped profile with a plurality of teeth located on top and bottom surfaces. The top and bottom surfaces can be flat planar surfaces or curved surfaces to mimic the topography of the end plates. The implant has a channel on at least one side for receiving a surgical tool. This channel runs in the anterior direction to accommodate a variety of surgical approaches. A threaded hole on the anterior, posterior, posterior-lateral, or lateral side can be provided for receiving a threaded arm of an insertion tool.

In another embodiment, the implant has an interior space for receiving an osteoconductive material to promote the formation of new bone.

In another embodiment, the implant is made of a plurality of interconnecting sections with mating sections. Preferably, the implant is made in two halves: a top portion having a top connecting surface and a bottom portion having a bottom connecting surface. The top connecting surface mates with the bottom connecting surface when the top and bottom portions are joined. The top and bottom portions have holes that align for receiving a pin to secure the top and bottom portions together. The pin can be made of allogenic bone.

In a different embodiment, the medial side of the implant has a scalloped edge such that when a first implant is implanted with a second implant with the medial sides facing each other, the scalloped edges define a cylindrical space.

The present invention also relates to a discrete spacer used in conjunction with any of the other embodiments of the implant. The spacer comprises a piece of allogenic bone conforming in size and shape with a portion of an end plates of the vertebrae and has a wedge-shaped profile with substantially smooth top and bottom surfaces. The intersecting regions between the top and bottom surfaces and at least one of the lateral sides and the intersecting regions between the

3

anterior and posterior sides and the same lateral side are curved surfaces to facilitate implantation of the spacer. Thus, the spacer can be implanted through an opening on one side of the spinal canal and moved with a surgical instrument to the contralateral side.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a first embodiment of the implant according to the present invention;

FIG. 2 is a side view of the implant of FIG. 1;

FIG. 3 is a back view of the implant of FIG. 1;

FIG. 4 is a top view of a second embodiment of the implant;

FIG. 5 is a side view of the implant of FIG. 4;

FIG. 6 is a top view of a third embodiment of the implant;

FIG. 7 is a side view of the implant of FIG. 6;

FIG. 8A is a top view of a top connecting surface of a top portion of the implant of FIG. 6;

FIG. 8B is a top view of a bottom connecting surface of a bottom portion of the implant of FIG. 6;

FIG. 9 is a perspective view of a fourth embodiment of the implant;

FIG. 10A is a side view of one embodiment of the teeth on the implant;

FIG. 10B is a side view of a second embodiment of the teeth of the implant;

FIG. 11 is a side view of an embodiment of the implant similar to the embodiment of FIGS. 6–8;

FIG. 12 is a top view of a vertebral bone characteristic of those of the cervical, thoracic, and lumbar spine;

FIG. 13 is a side view of sequentially aligned vertebral bones, such as are found in the cervical, thoracic, or lumbar spine;

FIG. 14 is a posterior view of a sequence of vertebrae; and

FIG. 15 is an end view of another embodiment of the implant.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a top view of a first embodiment of intervertebral allograft spacer or implant 10 according to the present invention. Implant 10 conforms in size and shape with a portion of end plates of the vertebrae between which implant 10 is to be implanted. Because implant 10 is an allograft, implant 10 promotes the formation of new bone to fuse the two vertebral bodies together. Although implant 10 will probably be predominantly used in the lumbar region of the spine, implant 10 can be configured for implantation in any region of the spine. Implant 10 has a plurality of teeth 12 on superior and inferior surfaces 14, 16 which provide a mechanical interlock between implant 10 and the end plates. Teeth 12 provide the mechanical interlock by penetrating the end plates. The initial mechanical stability afforded by teeth 12 minimizes the risk of post-operative expulsion of implant 10. Teeth 12 can be pyramid-shaped (FIG. 10A). Preferably, the angle formed from the tip of the base is approximately 60°. Alternatively, teeth 12 have a saw tooth shape with the saw tooth running in the anterior-posterior direction (FIG. 10B).

As shown in FIG. 2 and FIG. 3, a first lateral side 18 has a channel 20 and a second lateral side 22 also has a channel 20. Channels 20 are sized to receive a surgical instrument such as an inserter for implantation of implant 10. If the

4

inserter has a threaded arm, implant 10 can be provided with a threaded hole 24. In FIG. 2, channel 20 is shown extended only partially along first lateral side 18. Channel 20 can extend along the entire length of first lateral side 18 as shown in the embodiment of FIG. 5. In FIG. 3, channels 20 are shown on both first and second lateral sides 18, 22. It should be noted that implant 10 can also have no channels or channels on one lateral side only as shown in the embodiment of FIG. 9.

The dimensions of implant 10 can be varied to accommodate a patient's anatomy. Typically, implant 10 would have a width between 6–15 mm (in the medial-lateral direction), a length between 15–30 mm (in the anterior-posterior direction), and a height between 4–30 mm (maximum height in the superior-inferior direction). The size of implant 10 allows implant 10 to be implanted using conventional open surgical procedures or minimally invasive procedures, such as laparoscopic surgery. Additionally, because the width is kept to a restricted size range and does not necessarily increase with implant height, taller implants can be used without requiring wider implants. Thus, facet removal and retraction of nerve roots can remain minimal.

In order to restore the natural curvature of the spine after the affected disc has been removed, implant 10 has a wedge-shaped profile. As shown in FIG. 2, this wedge shape results from a gradual decrease in height from an anterior side 26 to a posterior side 28. In anatomical terms, the natural curvature of the lumbar spine is referred to as lordosis. When implant 10 is to be used in the lumbar region, the angle formed by the wedge should be approximately between 4.2° and 15° so that the wedge shape is a lordotic shape which mimics the anatomy of the lumbar spine.

In order to facilitate insertion of implant 10, anterior side 26 transitions to superior and inferior surfaces 14, 16 with rounded edges 30. Rounded edges 30 enable implant 10 to slide between the end plates while minimizing the necessary distraction of the end plates.

Although implant 10 is typically a solid piece of allogenic bone, implant 10 can be provided with a hollow interior to form an interior space. This interior space can be filled with bone chips or any other osteoconductive material to further promote the formation of new bone.

FIG. 4 shows a top view of a second embodiment of an implant 40 according to the present invention. In general, most of the structure of implant 40 is like or comparable to the structure of implant 10. Accordingly, discussion of the like components is not believed necessary. The superior and inferior surfaces 14, 16 of implant 10 are flat planar surfaces. As seen best in FIG. 5, superior and inferior surfaces 14, 16 of implant 40 are curved surfaces which still retain the wedge-shaped profile. The curved surfaces of superior and inferior surfaces 14, 16 of implant 40 are a mirror-image of the topography of the vertebral end plates. Thus, the curved surfaces conform to the contours of the end plates.

FIG. 6 shows a top view of a third embodiment of an implant 50 according to the present invention. In general, most of the structure of implant 50 is like or comparable to the structure of implants 10, 40. Accordingly, discussion of the like components is not believed necessary. As best seen in FIG. 7, implant 50 comprises a top portion 52 joined to a bottom portion 54. As it may be difficult to obtain a single section of allogenic bone from which implant 50 is to be made, fabricating implant 50 in two pieces, i.e. top and bottom portions 52, 54, allows smaller sections of allogenic bone to be used. A top connecting surface 56 and a bottom connecting surface 58 define the interface between top and

5

bottom portions **52, 54**. As shown in FIGS. **8A** and **8B**, top and bottom surfaces **56, 58** have ridges **60** that mate with grooves **62** to interlock top and bottom portions **52, 54**. Preferably, ridges **60** and grooves **62** are formed by milling top and bottom surfaces **56, 58** in a first direction and then milling a second time with top and bottom surfaces **56, 58** oriented 90° with respect to the first direction.

A pin **64** passing through aligned holes **66** in top and bottom portions **52, 54** serves to retain top and bottom portions **52, 54** together. Although pin **64** can be made of any biocompatible material, pin **64** is preferably made of allogenic bone. The number and orientation of pins **64** can be varied.

FIG. **11** shows an embodiment of an implant **80** which, like implant **50**, is made in multiple pieces. In general, most of the structure of implant **80** is like or comparable to the structure of implants **10, 40, 50**. Accordingly, discussion of the like components is not believed necessary. Implant **80** has a top portion **82**, a middle portion **84**, and a bottom portion **86**. As was the case for implant **80**, the surfaces between the portions are mating surfaces with interlocking surface features, such as ridges and grooves. One or more pins preferably hold top, middle, and bottom portions **82, 84, 86** together.

FIG. **9** shows a perspective view of a fourth embodiment of a first implant **70** according to the present invention. A second implant **70'**, which is substantially similar to first implant **70**, is also shown. In general, most of the structure of first and second implants **70, 70'** is like or comparable to the structure of implants **10, 40, 50**. Accordingly, discussion of the like components is not believed necessary. First lateral sides **18** of first and second implants **70, 70'** are scalloped to have a C-shape. When first and second implants **70, 70'** are placed side by side with the first lateral sides **18** facing each other, a cylindrical space **72** is formed. When first and second implants **70, 70'** are implanted together, cylindrical space **72** can be filled with osteoconductive material to help promote the formation of new bone. First and second implants **70, 70'** can be provided with locking pins **74** which engage apertures **76** to maintain the spatial relationship between first and second implants **70, 70'**.

The use of the implant according to the present invention will now be described with reference to FIGS. **12-14** and using posterior lumbar interbody fusion as an example. As the implant according to the present invention conforms in size and shape to a portion of end plates **100**, preoperative planning is recommended for proper sizing. Determine the appropriate implant height by measuring adjacent intervertebral discs **102** on a lateral radiograph. The implant must be seated firmly with a tight fit between end plates **100** when the segment is fully distracted. The tallest possible implant should be used to maximize segmental stability. Due to variability in degrees of magnification from radiographs, the measurements are only an estimate.

With the patient in a prone position on a lumbar frame, radiographic equipment can assist in confirming the precise intraoperative position of the implant. The surgeon incises and dissects the skin from the midline laterally and locates spinous process **104**, lamina **106**, dura **108**, and nerve roots of the appropriate level(s). As much as facets **110** as possible should be preserved to provide stability to the intervertebral segment. The surgeon performs a laminotomy to the medial aspect of facet **110** and reflects dura **108** to expose an approximately 13 mm window to the disc space. Disc **102** is removed through the window until only anterior **112** and lateral **114** annulus remain. The superficial layers of the

6

entire cartilaginous end plates **100** are also removed to expose bleeding bone. Excessive removal of the subchondral bone may weaken the anterior column. Furthermore, if the entire end plate is removed, this may result in subsidence and a loss of segmental stability.

Distraction can be done with either a surgical distractor or a trial spacer implant. In the first method, the distractor blades are placed into the disc space lateral to dura **108**. The curve on the neck of the distractor should be oriented toward the midline. The distractor blades should be completely inserted into the disc space so that the ridges at the end of the blades rest on vertebral body **116**. Fluoroscopy can assist in confirming that the distractor blades are parallel to end plates **100**. Correct placement will angle the handles of the distractor cranially, particularly at L5-S1. The handle of the distractor is squeezed to distract the innerspace. The distraction is secured by tightening the speed nut on the handle.

Using the preoperatively determined size, a trial spacer is inserted in the contralateral disc space with gentle impaction. Fluoroscopy and tactile judgement can assist in confirming the fit of the trial spacer until a secure fit is achieved. Using either the slots or threader hole on the implant, the selected implant is inserted in the contralateral disc space. Alternatively, the channels on the implant allow distraction and insertion to occur on the same side. Regardless of the side the implant is inserted in, autogenous cancellous bone or a bone substitute should be placed in the anterior and medial aspect of the vertebral disc space prior to placement of the second implant. The distractor is removed and a second implant of the same height as the first implant is inserted into the space, using gentle impaction as before. Preferably, the implants are recessed 2-4 mm beyond the posterior rim of the vertebral body.

As previously noted, the implant according to the present invention can be inserted using minimally invasive procedures. In some of these procedures, only one side of the spinal cord needs to be approached. This minimizes muscle stripping, scar tissue in the canal, and nerve root retraction and handling. In clinical situations in which bilateral implant placement is required, proper implantation on the side opposite the incision can be difficult. FIG. **15** shows a beveled spacer **120** that facilitates placement on the side contralateral to the incision. In general and unless otherwise described, most of the structure of beveled spacer **120** is like or comparable to the structure of implants **10, 40, 50**, and **80**. Accordingly, discussion of the like components is not believed necessary. First lateral side **18** transitions to superior and inferior surfaces **14, 16** with rounded edges **30**. First lateral side **18** also transitions to anterior and posterior sides **26, 28** with rounded edges **30**. Additionally, spacer **120** has no teeth. The lack of teeth and rounded edges **30** enable spacer **120** to slide between the end plate and across the evacuated disc space (from one lateral annulus to the other) to the contralateral side. As first lateral side **18** is the side that must promote movement of spacer **120**, the use of rounded edges **30** on second lateral side **22** is optionally. Once spacer **120** has been placed on the side contralateral to the single incision using a surgical instrument to push spacer **120**, bone graft or other osteoconductive material is packed in the disc space. Finally, an implant (any of implant **10, 40, 50, 70**, or **70'** can be used) is implanted in the side proximal to the incision.

While it is apparent that the illustrative embodiments of the invention herein disclosed fulfill the objectives stated above, it will be appreciated that numerous modifications and other embodiments may be devised by those skilled in the art. Therefore, it will be understood that the appended

7

claims are intended to cover all such modifications and embodiments which come within the spirit and scope of the present invention.

What is claimed is:

1. An intervertebral implant comprising a piece of allo- 5
genic bone conforming in size and shape with a portion of an end plate of a vertebra and having a wedge-shaped profile, wherein top and bottom surfaces of the implant have a plurality of teeth in combination with a discrete spacer comprising a piece of allogenic bone conforming in size and 10
shape with a second portion of an end plate of a vertebra and having a wedge-shaped profile, wherein top and bottom surfaces of the [second member] *discrete spacer* are sub-
stantially smooth and regions between top and bottom 15
surfaces and anterior and lateral sides of the spacer have curved edges to facilitate implantation of the spacer.

2. The implant of claim 1, wherein at least one side has a channel for receiving a surgical instrument.

3. The implant of claim 1, wherein the channel runs in an anterior-posterior direction.

4. The implant of claim 1, wherein the teeth have a pyramid shape.

8

5. The implant of claim 1, wherein the teeth have a saw tooth shape.

6. The implant of claim 1, wherein at least one side of the implant has at least one hole for attachment of an inserter.

7. The implant of claim 6, wherein the at least one hole is threaded.

8. The implant of claim 6, wherein the at least one hole is provided in an anterior, posterior, posterior-lateral, or lateral side.

9. The implant of claim 1, wherein the top and bottom surfaces are defined by flat planar surfaces.

10. The implant of claim 9, wherein a region between the top and bottom surfaces and an anterior side of the implant is a curved edge to facilitate implantation of the implant.

11. The implant of claim 1, wherein the top and bottom surfaces are defined by curved surfaces, said curved surfaces contoured to mimic surfaces of the end plates of the vertebrae.

12. The implant of claim 1, wherein the implant has an 20
interior space for receiving an osteoconductive material.

* * * * *