Filed on behalf of RTI Surgical, Inc.

By: Herbert D. Hart III
David D. Headrick
Steven J. Hampton
Gregory C. Schodde
Scott P. McBride
Peter J. Lish
McAndrews, Held & Malloy, Ltd.
500 West Madison Street
Chicago, Illinois 60661
Tel.: (312) 775-8000
Fax: (312) 775-8100
Email: hhart@mcandrews-ip.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

RTI SURGICAL, INC.,
Petitioner

v.

LIFENET HEALTH,
Patent Owner

Case IPR2019-00570
Patent No. 8,182,532

PETITION FOR *INTER PARTES* REVIEW

TABLE OF CONTENTS

PETITIONER'S EXHIBIT LIST

EX.	DESCRIPTION
1001	U.S. Patent No. 8,182,532 ("the 532 patent")
1002	U.S. Patent No. 6,458,158 ("the 158 patent")
1003	U.S. Patent Application Publication No. 2002/0138143 A1 ("Grooms")
1004	U.S. Patent Application No. 08/920,630 ("Grooms priority document")
1005	U.S. Patent No. 4,950,296 ("McIntyre")
1006	U.S. Patent No. 6,258,125 ("Paul")
1007	U.S. Provisional Patent Application No. 60/095,209 ("Paul priority document")
1008	U.S. Patent No. 5,989,289 ("Coates")
1009	Wolter et al., "Bone Transplantation in the Area of the Vertebral Column," Scientific and Clinical Aspects of Bone Transplantation, Springer Verlag 1987
1010	English Translation of Wolter et al., "Bone Transplantation in the Area of the Vertebral Column," Scientific and Clinical Aspects of Bone Transplantation, Springer Verlag 1987
1011	U.S. Patent No. 6,123,731 ("Boyce")
1012	Reserved
1013	Portions of the File History from the 532 patent
1014	Reserved
1015	Declaration of Michael C. Sherman
1016	Declaration of Jeffrey Scott Fischgrund, M.D.
1017	U.S. Patent No. 5,961,554 ("Janson")
1018	Daniel. J. Miller and Michael G.Vitale, *Russell A. Hibbs: Pioneer of spinal fusion*, 40 SPINE 1311 (2015)
1019	Robert A. Robinson and George W. Smith, *Anterolateral cervical disc removal and interbody fusion for cervical disc syndrome*, 95 BULLETIN OF THE JOHNS HOPKINS HOSPITAL 223 (1955)

EX.	DESCRIPTION
1020	U.S. Patent No. 6,025,538 (“Yaccarino”)

I. Introduction

RTI Surgical, Inc., petitions for *inter partes* review of claims 4 and 6-21 of U.S. Patent No. 8,182,532 ("the 532 patent"; Ex. 1001). The claims of the 532 patent are directed to "composite" spinal bone grafts formed by pieces of cortical bone and either cancellous bone (independent claim 4) or an osteoconductive substance (independent claim 12). The grafts are held together by one or more bone pins (claim 4) or mechanical connectors (claim 12).

Composite bone grafts existed before the priority date of the 532 patent. U.S. Patent Application Publication No. 2002/0138143 A1 ("Grooms"; Ex. 1003) published on August 27, 1997 discloses a spinal bone graft comprising two cortical bone halves held together by bone pins that form and surround a canal that may be filled by one or more osteoconductive materials. *See* Ex. 1003, Abstract, ¶¶ 48-49, 57, Figs. 7A-B, 8A. Similarly, U.S. Patent No. 6,258,125 titled "Intervertebral Allograft Spacer" ("Paul"; Ex. 1006), which is prior art as of August 3, 1998, discloses a spinal bone graft comprising two cortical bone parts that also are held together by pins and form and surround a central cavity that may be filled by an osteoconductive material. Ex. 1006, 4:21-25, 39-63, 5:8-23, Fig. 9. Much earlier, the 1987 publication "Bone Transplantation in the Area of the Vertebral Column" by Wolter et al. ("Wolter"; Ex. 1009) discloses a "composite" spinal bone graft comprising multiple distinct bone pieces fastened to one another to form alternating layers of cortical bone and cancellous bone (a known osteoconducive material) that are held together by a metal bone screw. Ex. 1010, 5, Fig. 1e. *None of these three prior art references were cited during prosecution of the 532 patent.*

All of these references disclose composite grafts of the sort claimed in the 532 patent. To the extent that challenged claims of the 532 patent are not anticipated, they recite known and obvious variants of the composite grafts disclosed by Grooms, Paul, and/or Wolter. Accordingly, there is at least a reasonable likelihood that claims 4 and 6-21 of the 532 patent are unpatentable over (1) Grooms, either alone or in combination with one or more secondary references disclosing known and obvious features of spinal bone grafts; (2) Paul, either alone or in combination with one or more such secondary references; and (3) Wolter, either alone or in combination with one or more such secondary references, all as described in detail in this petition.

II. Mandatory notices

Real parties-in-interest: RTI Surgical, Inc. is the real party-in-interest.

Related matters: The following judicial matter would also be affected by a decision in the proceedings: *LifeNet Health v. RTI Surgical, Inc.,* Case No. 1:18-cv-00146 (N.D. Fla.), filed June 27, 2018. The 532 patent is one of two related patents, and five total patents, asserted against Petitioner in that case. The related patent is U.S. Patent No. 6,458,158 ("the 158 patent"; Ex. 1002). Both the 532 and the 158 patents are entitled "Composite Bone Graft, Method of Making and Using Same" and claim priority to the same U.S. patent application. Petitioner is challenging the 158 patent on similar grounds in IPR2019-00569.

Lead and backup counsel:

Lead Counsel	Backup Counsel
Herbert D. Hart III Registration No. 30,063 McAndrews, Held & Malloy, Ltd. 500 West Madison Street, 34th Floor Chicago, Illinois 60661 Tel.: (312) 775-8000 Email: hhart@mcandrews-ip.com	David D. Headrick Registration No. 40,642 McAndrews, Held & Malloy, Ltd. 500 West Madison Street, 34th Floor Chicago, IL 60661 Telephone: (312) 775-8000 Email: dheadrick@mcandrews-ip.com
	Steven J. Hampton Registration No. 33,707 McAndrews, Held & Malloy, Ltd. 500 West Madison Street, 34th Floor Chicago, IL 60661 Telephone: (312) 775-8000 Email: shampton@mcandrews-ip.com
	Gregory C. Schodde Registration No. 36,668 McAndrews, Held & Malloy, Ltd. 500 West Madison Street, 34th Floor Chicago, Illinois 60661 Tel.: (312) 775-8000 Email: gschodde@mcandrews-ip.com
	Scott P. McBride Registration No. 42,853 McAndrews, Held & Malloy, Ltd. 500 West Madison Street, 34th Floor Chicago, Illinois 60661 Tel.: (312) 775-8000 Email: smcbride@mcandrews-ip.com

Lead Counsel	Backup Counsel
	Peter J. Lish Registration No. 59,383 McAndrews, Held & Malloy, Ltd. 500 West Madison Street, 34th Floor Chicago, IL 60661 Telephone: (312) 775-8000 Email: plish@mcandrews-ip.com

Service Information: Petitioner consents to service by email at: RTI532IPR@mcandrews-ip.com.

III. Grounds for standing

The 532 patent is available for *inter partes* review, and Petitioner is not barred or estopped from requesting an *inter partes* review challenging claims 4 and 6-21 on the grounds identified in this Petition.

IV. Identification of challenge

Petitioner identifies the following grounds of unpatentability:

Ground 1: Claims 12-21 are obvious over U.S. Patent Application Publication No. 2002/0138143 A1, "Cortical Bone Cervical Smith-Robinson Fusion Implant" ("Grooms"; Ex. 1003), which is prior art under 35 U.S.C. 102(e) as of August 27, 1997.

Ground 2: Claims 4 and 6-11 are obvious over Grooms in view of U.S. Patent No. 4,950,296, "Bone Grafting Units," granted August 21, 1990 ("McIntyre"; Ex. 1005), which is prior art under 35 U.S.C. 102(b).

Ground 3: Claims 12 and 20 are anticipated by or obvious over U.S. Patent No. 6,258,125, "Intervertebral Allograft Spacer" ("Paul"; Ex. 1006), which is prior art under 35 U.S.C. 102(e) as of August 3, 1998.

Ground 4: Claims 13-19 are obvious over Paul in view of U.S. Patent No. 5,989,289, "Bone Grafts" ("Coates"; Ex. 1008), which is prior art under 35 U.S.C. 102(e) as of October 9, 1997.

Ground 5: Claims 4, 6-9, and 11 are obvious over Paul in view of McIntyre and Coates.

Ground 6: Claims 12 and 20 are anticipated by Wolter et al., "Bone Transplantation in the Area of the Vertebral Column," Scientific and Clinical Aspects of Bone Transplantation, Springer Verlag 1987 ("Wolter"; Ex. 1009), which is prior art under 35 U.S.C. 102(b).

Ground 7: Claims 12 and 20 are obvious over Wolter in view of Grooms, Paul, or Coates.

Ground 8: Claims 4 and 6-11 are obvious over Wolter in view of Grooms.

Ground 9: Claims 4, 6-9, and 11 are obvious over Wolter in view of Paul and Coates.

V. The 532 patent

A. Subject matter of the 532 patent

The 532 patent relates generally to bone grafts used for spinal fusion. Ex. 1001, 1:15-20. Spinal fusion means inducing bone growth that causes adjacent vertebrae of the spine to fuse into a single bony structure. Ex. 1016, ¶21 (Declaration of Dr. Jeffery Fischgrund (orthopaedic surgeon and Chairman of the Department of Orthopaedic Surgery at the Oakland University William Beaumont School of Medicine)). Spinal fusion is used in surgical replacement of an intervertebral disc with an implant as treatment of an injury or disease of the spine. *Id.*, ¶23. Bone growth is induced to secure the implant to the adjacent vertebrae thereby fusing the vertebrae. *Id.* An implant that is formed of bone is referred to as a bone graft. *Id.*, ¶24. Bone grafts cause a patient's body to generate new bone that replaces the bone of the graft. *Id.*, ¶26.

Spinal fusion implants support the load on the spine and induce bone formation. *Id.*, ¶¶27, 28. Bone grafts have long been made of both cortical and cancellous bone. *Id.*, ¶ 29. Cortical bone is the solid bone at the surface of a bone that can support loads. *Id.*, ¶29. Cancellous bone is the porous bone found inside a bone. *Id*. Cancellous bone in an implant causes new bone formation faster than cortical bone. *Id.*, ¶29-31.

The 532 patent is directed to composite bone grafts, which are bone grafts made up of two or more distinct bone portions. Ex. 1001, 1:15-20. According to the 532 patent, the prior use of bone grafts for such procedures was "limited in part by the physical size of a cortical bone graft." *Id.*, 1:48-58. Bone grafts were often excluded for use in surgery, according to the 532 patent, because "cortical bone obtained from a cadaver source fashioned into struts is not wide enough for optimum load bearing." *Id.* By assembling composite bone grafts from multiple bone portions, the 532 patent alleges to have "enable[d] the use of bone grafts for applications normally suited for only non-bone prosthetic implants" and to have "solve[d] the problem of graft failure by providing a composite bone graft which can be appropriately sized for any application out of for example, strong cortical bone. . . ." *Id.*, 2:3-11.

The 532 patent states that the success of a bone graft depends on whether the graft (1) is cellularized, *i.e.,* fused to the adjacent vertebrae, and (2) remains at the implant site, *i.e.,* is not extruded. *Id.*, 1:59-2:2. Accordingly, the grafts of the 532 patent contain an osteogenic material that "promotes the ingrowth of patient bone at an implantation site." *Id.,* 2:3-11, 4:19-52.

B. Independent claims of the 532 patent

Claim 12

Claim 12 may be considered to have four claim elements as identified by the colored highlighting of that claim below:

> **12**. A load-bearing composite spinal bone graft for implantation into a host, the load-bearing composite graft comprising:
> a first cortical bone portion comprising one or more textured surfaces configured to contact a portion of the host bone;
> a second cortical bone portion comprising one or more textured surfaces configured to contact a portion of the host bone;
> one or more osteoconductive substances disposed between said first cortical bone portion and said second cortical bone portion and configured to contact a portion of the host bone to form a graft unit;
> one or more non-adhesive mechanical connectors for holding together said load-bearing spinal bone graft unit, said spinal bone graft being configured for implantation into the anterior spinal column of the host.

Element 1 Element 2 Element 3 Element 4

Those elements are:

- ***Element 1 (load-bearing spinal bone graft):*** The graft is a load-bearing bone graft configured for implantation into the anterior spinal column of a host ("*A load-bearing [composite] spinal bone graft for implantation into a host, the load-bearing [composite] graft comprising*" Ex. 1001, 47:51-53, "*said spinal bone graft being configured for implantation into the anterior spinal column of the host*" *Id.*, 47:66-67);

- ***Element 2 (cortical-osteoconductive-cortical composite)***: The graft is a composite comprising a first cortical bone portion, a second cortical bone portion, and one or more osteoconductive substances disposed between the first and second cortical bone portions ("*composite* spinal bone graft" *Id.*, 47:51, "*a first cortical bone portion*" *Id.*, 47:54, "*a second cortical bone portion*" *Id.*, 47:57, "*one or more osteoconductive substances disposed between said first cortical bone portion and said second cortical bone portion . . . to form a graft unit*" *Id.*, 47:60-63);
- ***Element 3 (textured surfaces, contact with host bone)***: The graft is configured so that one or more textured surfaces of the first and second cortical bone portions and the one or more osteoconductive substances each contact a portion of the host bone ("*a first cortical bone portion comprising one or more textured surfaces configured to contact a portion of the host bone*" *Id.*, 47:54-56, "*a second cortical bone portion comprising one or more textured surfaces configured to contact a portion of the host bone*" *Id.*, 47:57-59, "*one or more osteoconductive substances . . . configured to contact a portion of the host bone*" *Id.*, 47:60-63);

- ***Element 4 (mechanical connector)***: The graft comprises one or more non-adhesive mechanical connectors for holding the graft together ("*one or more non-adhesive mechanical connectors for holding together said load-bearing spinal graft unit*" *Id.*, 47:64-65).

Claim 4

Claim 4 may be considered to have six claim elements as identified by the colored highlighting of that claim below:

4. A composite spinal bone graft comprising:
a graft unit having one or more through-holes configured to accommodate one or more pins, said graft unit comprising:
a first plate-like cortical bone portion configured to contact a portion of the host bone;
a second plate-like cortical bone portion configured to contact a portion of the host bone;
a plate-like cancellous bone portion disposed between said first plate-like cortical bone portion and said second plate-like cortical bone portion and configured to contact a portion of the host bone to form said graft unit; and
one or more cortical bone pins connecting bone portions of said bone graft unit, said composite spinal bone graft having a shape selected from the group consisting of a parallelepiped, a parallel block, a square block, a trapezoid wedge, a cylinder, a flattened curved block, a tapered cylinder, and a polyhedron,
wherein said composite spinal bone graft comprises one or more textured surfaces comprising a plurality of closely spaced continuous protrusions in a linear arrangement and said spinal bone graft is configured for implantation into the anterior spinal column of the host.

Element 1 Element 2 Element 3 Element 4 Element 5 Element 6

Those elements are:

- ***Element 1 (spinal bone graft)***: The graft is a bone graft configured for implantation into the anterior spinal column of a host ("*A [composite] spinal bone graft comprising*" Ex. 1001, 46:48, "*said spinal bone graft is configured for implantation into the anterior spinal column of the host*" *Id.*, 47:2-3);
- ***Element 2 (cortical-cancellous-cortical composite)***: The graft is a composite comprising a first plate-like cortical bone portion, a second plate-like cortical bone portion, and a plate-like cancellous bone portion disposed between the first and second cortical bone portions ("*a composite spinal bone graft*" *Id.*, 46:48, "*a first plate-like cortical bone portion*" *Id.*, 46:52, "*a second plate-like cortical bone portion*" *Id.*, 46:54, and "*a plate-like cancellous bone portion disposed between said first plate-like cortical bone portion and said second plate-like cortical bone portion . . . to form said graft unit*" *Id.*, 46:56-58);
- ***Element 3 (contact with host bone)***: The first and second cortical bone portions and the cancellous bone portion are each configured to contact a portion of the host bone ("*a first plate-like cortical bone portion configured to contact a portion of the host bone*" *Id.*, 46:52-53, "*a second plate-like*

cortical bone portion configured to contact a portion of the host bone" *Id.*, 46:54-55, "*a plate-like cancellous bone portion. . . configured to contact a portion of the host bone*" *Id.*, 46:56-59);

- ***Element 4 (bone pins)***: The graft comprises one or more through-holes configured to accommodate one or more pins and one or more cortical bone pins connecting bone portions of the graft ("*a graft unit having one or more through-holes configured to accommodate one or more pins*" *Id.*, 46:49-51, "*and one or more cortical bone pins connecting bone portions of said bone graft unit*" *Id.*, 46:60-61);
- ***Element 5 (textured surfaces)***: The graft comprises one or more textured surfaces comprising a plurality of closely spaced continuous protrusions in a linear arrangement ("*wherein said composite spinal bone graft comprises one or more textured surfaces comprising a plurality of closely spaced continuous protrusions in a linear arrangement*" Ex. 1001, 46:66-47:1);
- ***Element 6 (shape of graft)***: The graft has a shape selected from the group consisting of a parallelepiped, a parallel block, a square block, a trapezoid wedge, a cylinder, a flattened curved block, a tapered cylinder, and a polyhedron ("*said composite spinal bone graft having a shape selected from the group consisting of a parallelepiped, a parallel block, a square block, a*

trapezoid wedge, a cylinder, a flattened curved block, a tapered cylinder, and a polyhedron" Ex. 1001, 46:61-65).

C. Prosecution history of the 532 patent

The application from which the 532 patent issued was filed in 2004. The 532 patent claims priority to a number of other applications, the earliest of which was filed on January 5, 1999.[1]

The claims of the application were rejected six times, primarily over a reference known as Boyce. Ex. 1013, 1-11, 24-36, 52-61, 74-83, 98-108, and 123-133; *see also* Ex. 1011 ("Boyce"). Patent Owner finally overcame the rejections by (1) amending the claims to recite that the graft is "load-bearing" and comprises textured surfaces for implantation into the anterior spinal column and (2) arguing that because a cited Boyce graft was allegedly not a "load-bearing" graft implanted into the anterior spinal column, it would not have been obvious to provide it with the textured surfaces taught by secondary references. Ex. 1013, 136-147, 148-149.

D. Person of ordinary skill in the art

The art that is relevant to the 532 patent is design of spinal bone grafts. *See* Ex. 1015, ¶¶16, 17 (Declaration of Michael C. Sherman). A person of ordinary

[1] For purposes of this Petition, therefore, Petitioner considers January 5, 1999 to be the alleged date of invention.

skill in the art of the 532 patent at the time of the alleged invention would typically have had at least a bachelor's degree in mechanical, biomechanical, or biomedical engineering or a closely-related discipline, as well as 5-10 years of experience designing and developing orthopedic implants and/or spinal interbody devices and/or bone graft substitutes. Alternatively, such a person would typically have had an advanced degree (master's or doctorate) in one of the above-identified fields, as well as 3-5 years of experience; or would be a practicing orthopedic surgeon with at least five years of experience. *See* Ex. 1015, ¶22.

E. Claim construction

The 532 specification includes a subsection titled "Definitions." Ex. 1001, 10:58-62. The following claim terms, the meaning of which may be relevant to this proceeding, are defined by the 532 patent:

Composite: "a bone graft which is made up of two or more distinct bone portions." *Id.*, 12:26-28.

Load-bearing: "a non-demineralized bone product for implantation in a patient at a site where the bone graft will be expected to withstand some level of physical load(s)." *Id.*, 14:3-7.

Polyhedron: "a solid formed by plane faces, preferably formed by six faces." *Id.*, 14:65-67.

Textured: "a composite bone graft having one or more textured surfaces . . . where the surface can be any surface or a portion of any surface including a natural surface and/or a cut surface" and "preferably includ[ing] a plurality of protrusions provided on the surface of a portion thereof." *Id.*, 15:29-40.

In addition to these expressly defined terms, certain claims of the 532 patent use the term "plate-like," which is neither defined by the patent nor used in the specification to describe any embodiment. The term "plate-like" as used by the claims patent should therefore be given its ordinary meaning, in view of the specification of the 532 patent, to a person of ordinary skill in the art and this meaning is "a generally flat portion" of a spinal graft. Ex. 1015, ¶¶33-39 (citing relative dimensions in 532 patent specification and use of "plate-like" in prior art Jansen patent (Ex. 1017)).

VI. Summary of the prior art

The Grounds presented in this Petition can be divided into three groups based on their primary references:

- Grounds 1 and 2 based on Grooms;
- Grounds 3 to 5 based on Paul; and
- Grounds 6 to 9 based on Wolter.

Each primary reference discloses (1) a load-bearing bone graft for implantation into the anterior spinal column, (2) that is a composite bone graft, (3) that includes an osteoconductive substance to promote bone growth, (4) that has textured surfaces configured to contact adjacent vertebrae to hold the graft in place, and (5) is held together with a mechanical connector.

A. Grooms

Grooms is a publication of U.S. patent application 09/905,683, filed July 16, 2001, which is a continuation of application 09/701,933, filed August 25, 1998, and a continuation-in-part of application 08/920,630, filed August 30, 1997 ("the 630 application"). For the portion of its disclosure supported by the written description of the 630 application, Grooms is entitled to August 30, 1997 as a prior art date under 35 U.S.C. 102(e). *See* 35 U.S.C. 102(e) (pre-AIA). Each citation to Grooms will be to both Grooms itself (Ex. 1003) and the 630 application (Ex. 1004). Neither Grooms nor any of the applications to which it claims priority were cited during the prosecution of the 532 patent.

Grooms discloses implants, *i.e.,* bone grafts, for use in cervical vertebral fusion procedures commonly known in the art as Smith-Robinson procedures. Ex. 1003, Abstract; Ex. 1004, 1:6-10. Smith-Robinson procedures are anterior spinal fusions in which an implant is inserted into a space between adjacent vertebrae to provide support and induce fusion of the vertebrae. Ex. 1003, ¶5; Ex. 1004, 1:14-

23. The implant may be either autograft or allograft.[2] Ex. 1003, ¶24, Ex. 1004, 4:1-2.

The Grooms implant provides a central canal, which may be packed with osteogenic materials to expedite vertebral fusion and allow bone ingrowth. Ex. 1003, Abstract; Ex. 1004, 2:20-25. Those osteogenic materials may include allograft bone, autograft bone, Grafton®, bone powder, bone derivatives, bone morphogenic protein (purified or recombinant), antibiotic, bioactive glass, hydroxyapatite, bioactive ceramics, or combinations thereof. Ex. 1003, ¶57; Ex. 1004, 18:21-27. An example of such an implant is shown in Figure 1A, reproduced below.

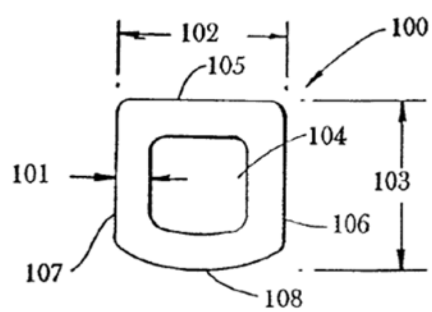


Fig. 1A

[2] Bone obtained from the patient is referred to as autologous bone and a graft made of autologous bone is an autograft. Bone from a donor is allogenic bone and a graft made of allogenic bone is an allograft. Ex. 1015, ¶73, Ex. 1016, ¶25.

Grooms also discloses that the implants may be assembled from component parts. Ex. 1003, ¶49; Ex. 1004, 17:22-18:6. As depicted by Figures 8A and 8B, two halves of an implant may be procured from cortical bone and then juxtaposed to form a unitary implant. *Id.*

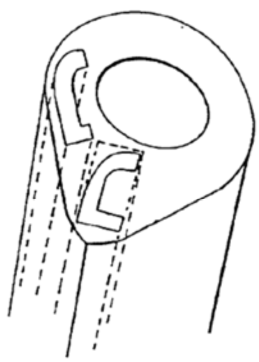


Fig. 8B

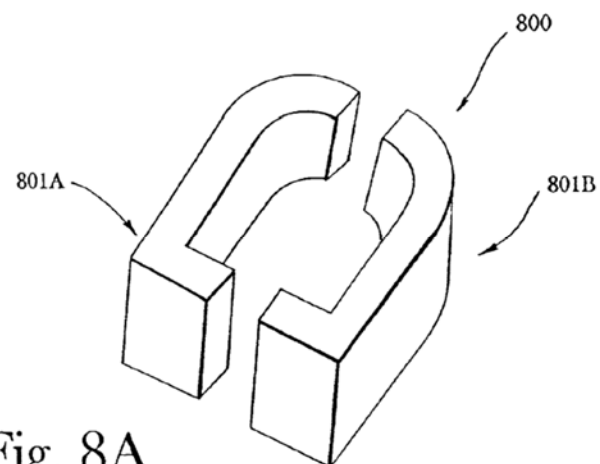


Fig. 8A

The two halves may be maintained in contact by forming holes in each and forcing pins through the holes. *Id.*; *see also* Ex. 1003, ¶48; Ex. 1004, 17:10-12 (stating that the pins may be made of cortical bone, resorbable but strong biocompatible synthetic material, or metal).

Further, the top and bottom surfaces of the graft are inscribed with continuous, linear teeth angled toward the anterior face of the graft. Ex. 1003, ¶34; Ex. 1004, 9:21-10:6, 15: 7-9; *id.*, Figs. 1C-1D.

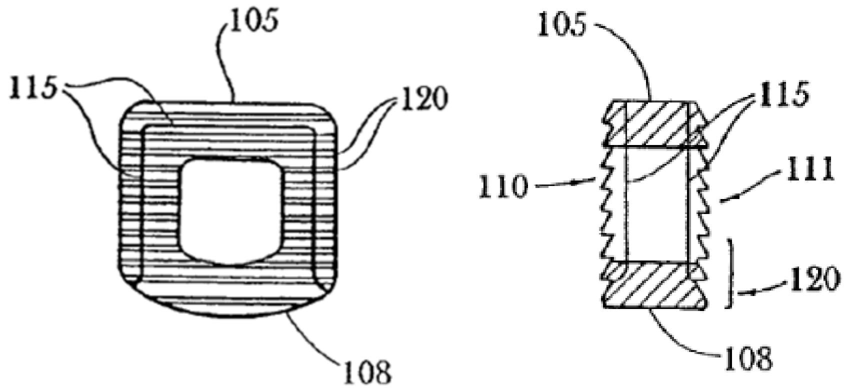


Fig. 1C Fig. 1D

These teeth serve to retain the graft within the spine. Ex. 1003, ¶33; Ex. 1004, 8:21-9:4.

B. Paul

Paul is the U.S. patent that granted from application 09/363,844, filed July 30, 1999, and which claims priority to provisional application 60/095,209, filed August 3, 1998 ("the 209 application"). For disclosure supported by the written description of the 209 application, Paul is entitled to August 3, 1998, as a prior art date under 35 U.S.C. 102(e). *See* 35 U.S.C. 102(e) (pre-AIA). To demonstrate that the disclosure of Paul referred to in this Petition is entitled to the 1998 prior art date, each citation to Paul will be to both Paul itself (Ex. 1006) and the 209 application (Ex. 1007). Paul was not cited during the prosecution of the 532 patent.

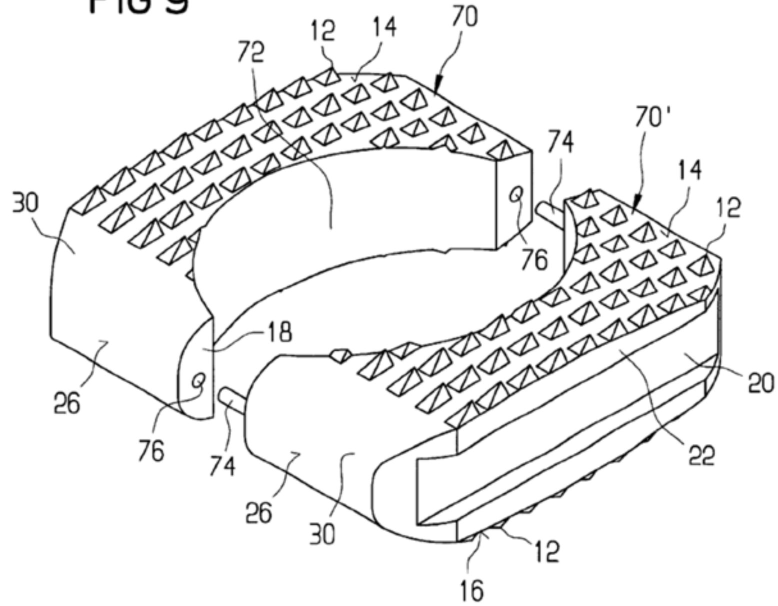
Paul discloses an intervertebral implant made of allogenic bone. Ex. 1006, Abstract; Ex. 1007, 1:4-6. The implant is designed for posterior lumbar interbody fusion ("PLIF"), in which an implant is inserted in a space between two vertebral bodies, the implant allowing for bone growth and fusion between the vertebral bodies. Ex. 1006, 1:14-2:9; Ex. 1007, 1:9-2:24. In a PLIF procedure, the spine is approached from the posterior aspect (back) of the patient and the implant is placed into the anterior spinal column. Ex. 1015, ¶94.

One of ordinary skill in the art in January 1999 and earlier would have recognized that the PLIF graft implants disclosed by Paul are cortical bone. Ex. 1015, ¶¶96, 97. This understanding is confirmed by the source of the bone, the load that the implants carry, and the shaping of parts of the graft to interlock with each other. *Id.*, ¶¶96-98.

Paul discloses that the implant may be made of multiple portions, such as two halves. Ex. 1006, 2:30-38; Ex. 1007, 3:7-14. The portions may be secured together by inserting a pin, such as a pin made of bone, into aligned holes in each portion. *Id.* The implant may also include an interior space for receiving an osteoconductive material, which promotes the formation of new bone. Ex. 1006, 2:27-29, 4:21-25; Ex. 1007, 3:4-6, 5:27-31.

One such implant is shown in Figure 9, reproduced below:

FIG 9



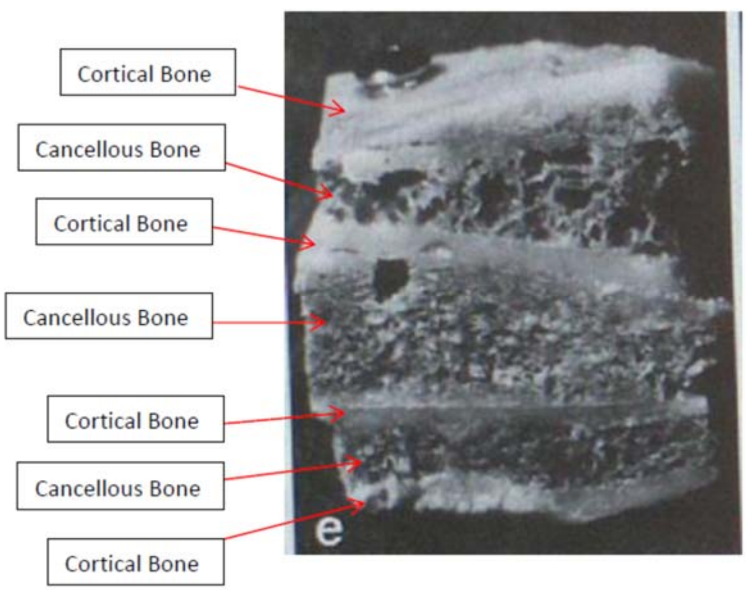
The implant shown above is made of two C-shaped halves placed side-by-side to form a central space. Ex. 1006, 5:8-23; Ex. 1007, 6:33-7:13. To assemble the implant, locking pins are inserted into apertures formed within each half and the space is filled with an osteoconductive material. *Id.*

As shown above, the Paul graft has a plurality of teeth on its top and bottom surfaces. Ex. 1006, 3:27-46; Ex. 1007, 4:7-26. The teeth penetrate adjacent vertebrae and prevent post-operative expulsion of the graft. *Id.*

C. Wolter

Wolter is a German paper titled "Bone Transplantation in the Area of the Vertebral Column" that was published in 1987. Wolter is prior art under 35 U.S.C. 102(b). All references to Wolter are to the English-language translation of the original German document, Ex. 1010. Wolter was not cited during the prosecution of the 532 patent.

Wolter discloses a "composite corticospongial block" or "sandwich block" implant comprising layers of corticospongial bone pieces united into a fixed block by one or two screws. Ex. 1010, 5. The term "corticospongial" refers to a piece that contains both cortical bone and spongiosa, *i.e.,* cancellous, bone. *See* Ex. 1015, ¶45. Figure 1e shows a composite corticospongial block formed by bone pieces placed together to create a block having alternating layers of cortical and cancellous bone. Figure 1e is reproduced below and annotated to identify the alternating layers:



See Ex. 1015, ¶46. Because the assembled block is shaped to a desired size using an oscillating surgical saw, the surfaces of the Wolter graft, including the vertebral-engaging surfaces are textured. Ex. 1015, ¶¶ 48-49 (describing saw and texturing). Wolter describes the successful implantation of the composite block shown above in the anterior spine. Ex. 1015, ¶50, 51.

VII. Ground 1: Claims 12-21 are obvious over Grooms

A. Claim 12

As shown below, Grooms discloses each of the four elements of claim 12. *See* §VI.A, Grooms teaches that the substance between the two cortical bone portions is an *osteogenic* substance that may be an *osteoconductive* substance.[3] As explained below, it would have been obvious to one of ordinary skill to have selected one of the osteoconductive substances disclosed by Grooms to dispose between the two cortical bone portions, as those substances were known to promote bone growth important for a successful spinal fusion. Ex. 1015, ¶¶81, 114.

---

[3] An osteogenic substance is any substance that promotes the formation of bone, which includes both "osteoconductive" substances (that provide a scaffold for the growth of new bone) and "osteoinductive" substances (that chemically stimulate new bone formation). *See* Ex. 1015, ¶¶30-32, 81.

Element 1 (load-bearing spinal bone graft)

Grooms discloses bone implants, *i.e.*, grafts, for implantation in a space between adjacent cervical vertebrae to provide support and induce fusion of the vertebrae. *See* §VI.A. A person of ordinary skill would have understood that the bone in the Grooms graft is not demineralized (as required by the definition of "load bearing" in the specification), *see* Ex. 1015, ¶74, or at least would have found it obvious to use non-demineralized bone, which was (and is) well known to be stronger. *Id.*, ¶28. Thus, a person of ordinary skill in the art would have understood that Grooms discloses or renders obvious a load-bearing bone graft configured for implantation into the anterior spinal column of a host, as recited in claim 12. *See* Ex. 1015, ¶109.

Element 2 (cortical-osteoconductive-cortical composite)

Grooms discloses that the graft may be assembled from two cortical bone halves, *i.e.*, first and second portions that are brought into juxtaposition and fastened to each other to form a unitary graft. *See* §VI.A.

Grooms also teaches that the graft has a central canal packed with osteogenic materials that may include allograft bone, autograft bone, Grafton®, bone powder, bone derivatives, bone morphogenic protein (purified or recombinant), antibiotics, bioactive glass, hydroxyapatite, bioactive ceramics, or combinations thereof. *See* §VI.A. According to the 532 patent, at least hydroxyapatite, bioactive glass (i.e., bioglass), and bioactive ceramics (i.e., bioceramics) are osteoconductive materials. Ex. 1001, 14:29-41, claim 13; *see also* Ex. 1015, ¶82, 114. Allograft and autograft bone were (and are) well-known osteoconductive materials. Ex. 1015, ¶83. Accordingly, it would have been obvious to a person of ordinary skill in the art to have selected one or more of the osteoconductive substances from among those disclosed by Grooms to pack within the central canal. *Id.*, ¶114.

Based on Grooms, therefore, it would have been obvious to a person of ordinary skill in the art to have prepared a composite graft comprising a first cortical bone portion, a second cortical bone portion, and one or more osteoconductive substances disposed between the first and second cortical bone portions, such as that shown in annotated Figure 8A, below.

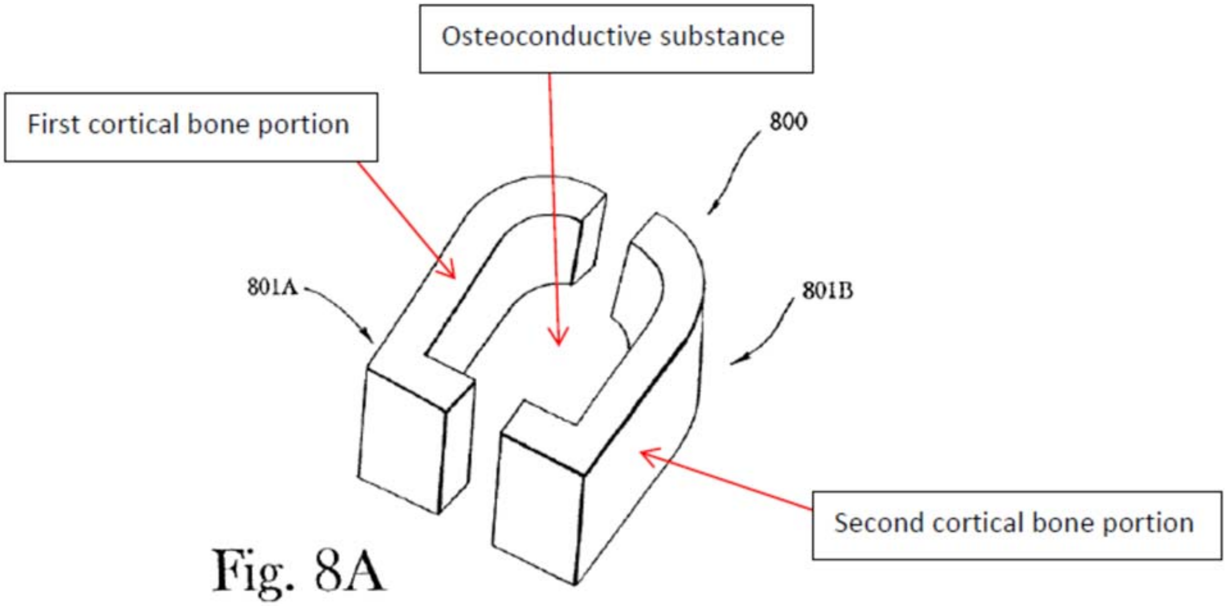


Fig. 8A

Ex. 1015, ¶¶111-114.

Element 3 (textured surfaces, contact with host bone)

The top and bottom surfaces of the implant disclosed by Grooms have teeth (as shown by Figs. 1C and 1D) that contact the bone of adjacent vertebrae. *See* §VI.A, Ex 1015, ¶71, 72. The top and bottom surfaces of the implant shown in Fig 8A also contact the bone of adjacent vertebrae. Ex. 1015, ¶¶75, 85, 111.

The osteoconductive substances that Grooms discloses may be packed in the central canal to promote bone growth include both osteoinductive and osteoconductive materials. §VI.A, Ex. 1015, ¶¶ 80-83. Those materials necessarily contact the bone of adjacent vertebrae. Ex. 1015, ¶ 112.

Grooms also teaches that the top and bottom surfaces of the graft that contact adjacent vertebrae are inscribed with teeth that are angled to retain the graft in the spine. *See* §VI.A. Grooms discloses that those teeth may be formed in the surfaces of the embodiment shown by Fig. 8A that contact adjacent vertebrae. Ex. 1015, ¶111.

Accordingly, Grooms discloses that the surfaces of the first and second cortical bone portions configured to contact a portion of the host bone are textured. *See* Ex. 1015, ¶¶85, 111.

Element 4 (mechanical connector)

Grooms teaches that the two halves of the graft shown in Figure 8A may be maintained in contact by forming holes in each half and forcing pins through the holes. *See* §VI.A. Grooms discloses that the graft comprises one or more non-adhesive mechanical connectors for holding the graft together. *See* Ex. 1015, ¶110.

For all the reasons stated, the subject matter as a whole of claim 12 would have been obvious to one of ordinary skill in the art at the time of the invention of the 532 patent. *See* Ex. 1015, ¶115.

B. Claim 13

Claim 13 recites that the osteoconductive substance of claim 12 is one of hydroxyapatite, collagen, polymeric matrix materials, bioglass, bioceramics, resorbable biomaterials, bioabsorbable polymers, plastic matrix, stainless steel, titanium or cobalt-chromium-molybdenum alloy matrix.

As described in §VII.A, (*Element 2*), Grooms teaches hydroxyapatite, bioactive glass (i.e., bioglass), and/or bioactive ceramics (i.e., bioceramics) among the materials to be packed in the central canal of its grafts. Ex. 1003, ¶57; Ex. 1004, 18:21-27. It would have been obvious to a person of ordinary skill in the art to have selected one of those substances for the same purpose and to achieve the same advantages described by Grooms. *See* Ex. 1015, ¶¶80-81, 118-19.

C. Claims 14-15

Claim 14 recites that the graft of claim 13 further comprises one or more osteoinductive substances. Claim 15 depends from claim 14 and recites that those osteoinductive substances are selected from the group consisting of autograft bone, allograft bone, cortical bone, demineralized cortical bone, cancellous bone, demineralized cancellous bone, and collagen.

As described in §VII.A, (*Element 2*), Grooms teaches packing the canal of the implant with identified materials "or combinations thereof." As set out by §VII.B, Grooms discloses osteoconductive materials recited by claim 13. Grooms also discloses osteoinductive materials as recited by claim 15, including autograft bone and allograft bone. In view of Grooms' teaching that "combinations" of identified materials may be packed in the canal of the implant, it would have been obvious to a person of ordinary skill in the art to have selected allograft and/or autograft bone as disclosed by Grooms to pack within the central canal of the implant disclosed by Grooms in combination with the osteoconductive materials disclosed by Grooms and recited by claim 13 for the same purpose and to achieve the same advantages described by Grooms. *See* Ex. 1015, ¶¶122-24, 127-28.

D. Claims 16-19

Claims 16 and 17 recite that the graft of claims 13 and 14 further comprises one or more pharmaceutically active agents. Claims 18 and 19 recite that the pharmaceutically active agent is a growth factor (claim 18) and a growth factor that is either bone morphogenic protein or transforming growth factor (claim 19).

As described in §VII.A, (*Element 2*), Grooms teaches materials to be packed in the central canal of its grafts to promote bone growth, including bone morphogenic protein, "or combinations thereof." Ex. 1003, ¶57; Ex. 1004, 18:21-27. In addition to one or more of the substances recited in claims 13 and 14, it would have been obvious to a person of ordinary skill in the art to have also selected bone morphogenic protein to pack in the central canal in Grooms in combination with other substances for the same purpose and to achieve the same advantages described by Grooms. *See* Ex. 1015, ¶¶136-39.

E. Claims 20-21

Claim 20 recites that mechanical connector in the graft of claim 12 comprises one or more biocompatible materials selected from the group consisting of cortical bone, stainless steel, titanium, cobalt-chromium-molybdenum alloy, and plastic. Claim 21 recites that the plastic selected from the group consisting of nylon, polycarbonate, polypropylene, polyacetal, polyethylene, polysulfone, bioabsorbable polymer, and a combination thereof.

As described in §VII.A, (*Element 5*), Grooms teaches that the graft may be held together by pins made of cortical bone, resorbable but strong biocompatible synthetic material, or metal. Ex. 1003, ¶¶48-49; Ex. 1004, 17:10-18:6. It therefore would have been obvious to a person of ordinary skill in the art to have used pins made of cortical bone (claim 20) or bioabsorbable polymer (claim 21) in the graft of Grooms for the same purpose and to achieve the same advantages described by Grooms. *See* Ex. 1015, ¶¶141-50.

VIII. Ground 2: Claims 4 and 6-11 are obvious over Grooms in view of McIntyre

A. Claim 4

As explained below, Grooms discloses most of the six elements of claim 4 (*see* §V.A). Although Grooms discloses that the central canal of Grooms graft may be packed with an osteogenic material such as allograft bone, it does not specifically describe packing of the central canal with a plate-like cancellous bone portion, as recited in element 2. McIntyre, however, discloses spinal fusion bone grafts in which a cancellous bone plug is fitted into a central cavity of a cortical shell. As explained below, it would have been obvious to one of ordinary skill to have fit the cancellous bone plug of McIntyre into the canal of the Grooms graft, as cancellous bone was known (and disclosed by McIntyre) to be an osteogenic material of the sort taught by Grooms.

Element 1 (spinal bone graft)

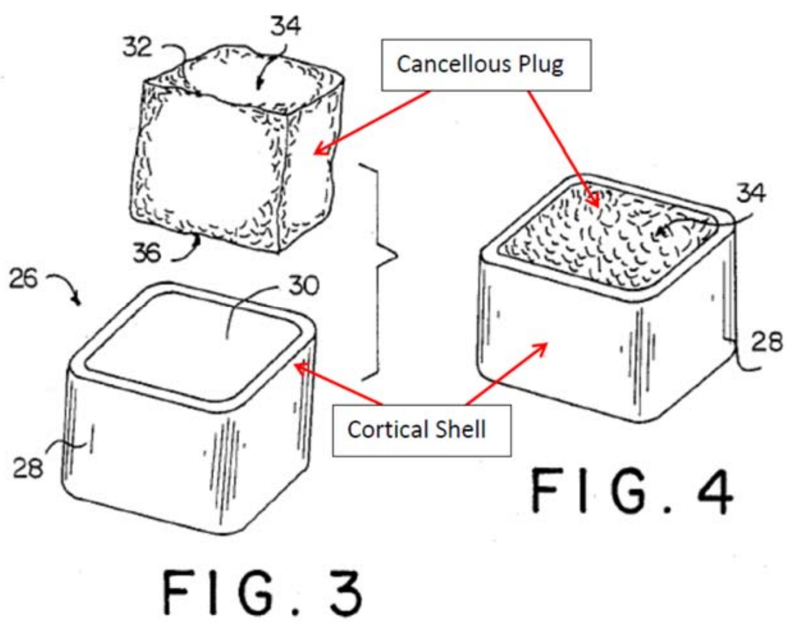
As described in §VII.A, (*Element 1*), Grooms discloses bone grafts for use in anterior cervical spinal fusions known as Smith-Robinson procedures. Ex. 1003, ¶5, 10; Ex. 1004, 1:14-23, 2:20-25. Thus, Grooms discloses a bone graft configured for implantation into the anterior spinal column of a host. *See* Ex. 1015, ¶¶68-70, 152.

Element 2 (cortical-cancellous-cortical composite)

As described in §VII.A, (*Element 2*), Grooms discloses that the graft may be assembled from component parts of cortical bone, *i.e.,* from first and second cortical bone units. Ex. 1003, ¶49; Ex. 1004, 17:22-18:6. Moreover, a person of ordinary skill in the art would have recognized and considered each of the first and second cortical portions to be plate-like because they are generally flat portions of a spinal graft. *See* Ex. 1015, ¶¶155, 33-39.

Grooms also teaches that the graft has a central canal packed with osteogenic materials, including, for example, allograft bone. Ex. 1003, ¶57; Ex. 1004, 18:21-27. Grooms does not expressly disclose the packing of the central canal with a "plate-like cancellous bone portion."

McIntyre also discloses bone grafts for use in anterior cervical fusions. Ex. 1005, 2:14-16, 2:22-29. The bone grafts of McIntyre comprise a cortical shell having a central cavity into which a cancellous plug is fitted. Ex. 1005, Abstract, Figures 3-4 (reproduced below):



See Ex. 1015, ¶58

McIntyre describes the cancellous plug as highly osteogenic, calling it "the most suitable matrix for rapid bone regeneration and repair." Ex. 1005, 1:43-50. McIntyre states that the cancellous plug "is most suitable for bone regeneration" and contributes to "maximize the chances of a successful transplant." *Id.*, 1:43-64; 3:32-36.

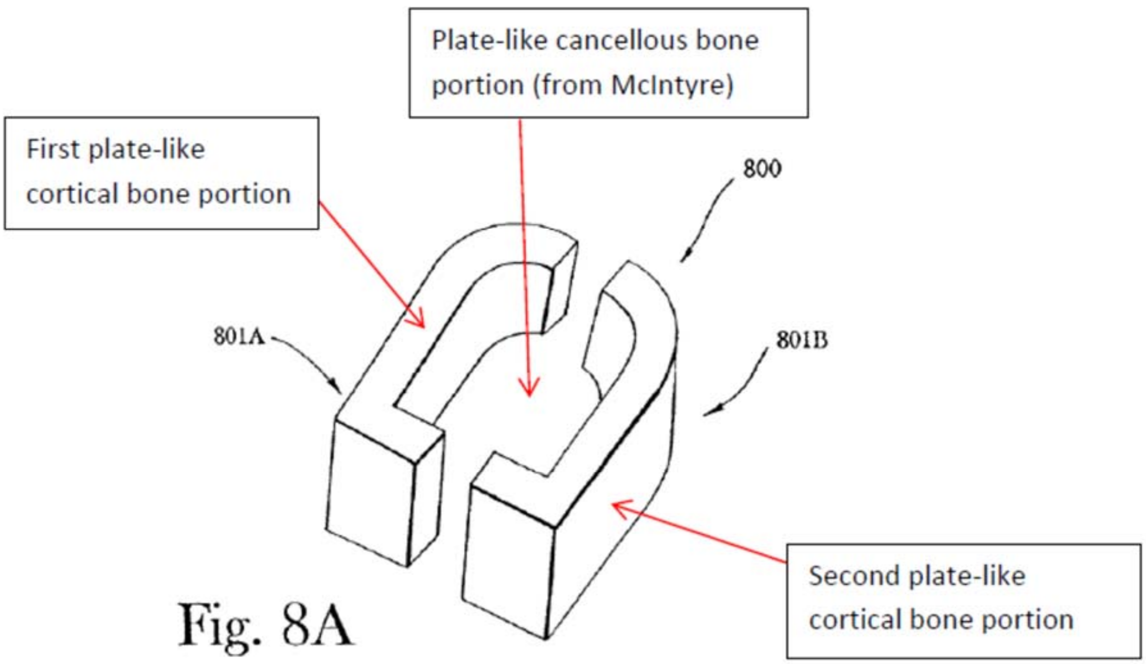
One of ordinary skill in the art would have looked to McIntyre because it (1) is directed to similar spinal fusion bone grafts as those taught by Grooms and (2) discloses the advantages of using a cancellous plug as an osteogenic material in such grafts. Ex. 1015, ¶¶157, 158. It would have been obvious to a person of ordinary skill in the art to have incorporated the cancellous plug of McIntyre as the osteogenic material in the central canal of the Grooms graft, *i.e.*, to have inserted it between the first and second cortical bone portions in Grooms. *See* Ex. 1015, ¶158. Such a person would have been motivated to do so by McIntyre's teaching, and the common knowledge in the art, that cancellous bone is a highly osteogenic substance. *Id.*, ¶¶157, 272.[4] Moreover, such a person would have had a reasonable expectation of success in doing so, as it would require no more than what was already taught by McIntyre, the insertion of a cancellous plug into the central cavity of a cortical bone graft. *Id.*, ¶¶157, 158.

A person of ordinary skill in the art would have considered the cancellous plug of McIntyre, as sized to fit into the central canal of a graft such as disclosed

---

[4] Cancellous bone is also an example of allograft bone, which is one of the materials disclosed by Grooms for filling the central canal. Ex. 1005 at 3:28-31.

by Grooms, to be "plate-like" (i.e., a generally flat portion). *See* Ex. 1015, ¶¶159, 33-39. Accordingly, the composite graft resulting from the combination of Grooms and McIntyre would have comprised a first plate-like cortical bone portion, a second plate-like cortical bone portion, and a plate-like cancellous bone portion disposed between the first and second cortical bone portions, as shown by annotated Figure 8A.



See Ex. 1015, ¶¶ 155, 159.

Element 3 (contact with host bone)

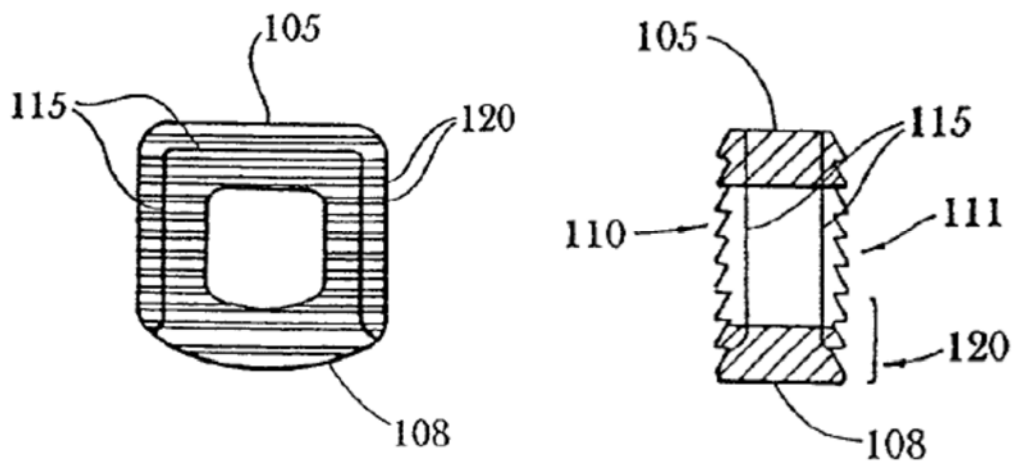
As described in §VII.A, (*Element 3*), Grooms teaches that Figure 1A is a top view of the graft. Accordingly, a person of ordinary skill in the art would have understood Grooms to disclose that the first and second cortical bone portions and the cancellous bone portion disposed within the central cavity are configured to contact a portion of the host bone, namely the adjacent vertebrae located above and below the graft. *See* Ex. 1015, ¶¶75, 112.

Element 4 (bone pins)

Grooms teaches that the two halves of the graft shown by Fig. 8A may be held together by forming holes in each half and forcing pins, such as pins made from cortical bone, through those holes in a fashion like that described by Grooms for a stacked implant. *See* §VI.A. While Figure 8A does not show the holes, Grooms clearly discloses that the holes of the stacked implant extend all the way through the cortical bone portions. Ex. 1003, ¶48; Ex. 1004, 16:29-17:21; *id.*, Figs. 7A-B. One of ordinary skill in the art would therefore have understood that the holes in the embodiment shown in Figure 8A may also extend through the graft and would have found it obvious to have used such through-holes. *See* Ex. 1015, ¶154. Accordingly, such a person would have been motivated by Grooms to construct a graft having one or more through-holes configured to accommodate one or more pins and including one or more cortical bone pins connecting portions of the graft, and would have had a reasonable expectation of success in view of that disclosure. *Id.*, ¶¶154, 160.

Element 5 (textured surfaces)

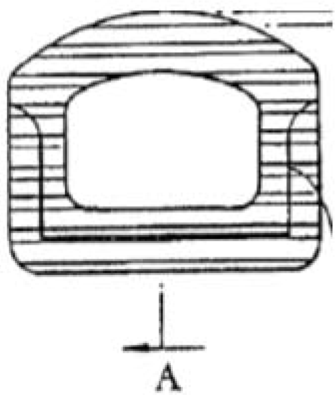
Grooms discloses a graft having top and bottom surfaces inscribed with a plurality of continuous, linear protrusions comprising teeth to retain the graft within the spine. *See* §VI.A; Ex. 1003, Figs. 1C-1D, reproduced below.



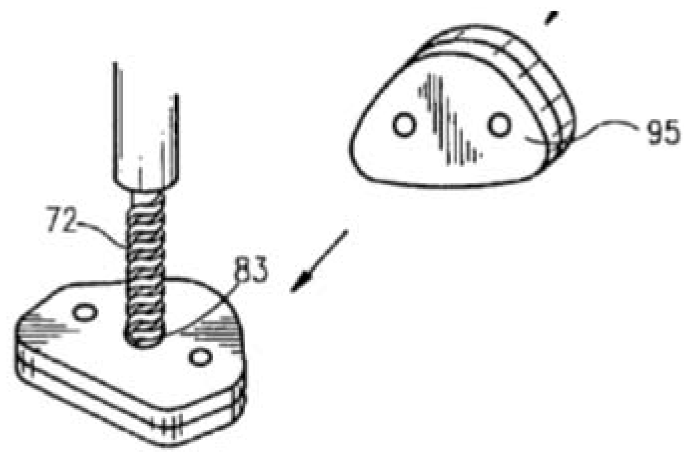
Grafts having similar protrusions are shown in Figures 6A-6I. *See id.*, Figures 6A-6I. Those teeth are and would have been recognized by one of ordinary skill in the art to be closely spaced. *See* Ex. 1015, ¶163. Grooms discloses a graft having a plurality of closely spaced continuous protrusions in a linear arrangement. *Id.*

Element 6 (shape of graft)

Grooms discloses a "D-shaped" graft, which a person of ordinary skill would consider to be in the shape of a flattened curved block. *See* Ex. 1015, ¶¶161-162. Embodiments of the "D-shaped" graft of Grooms are, in fact, almost identical in shape to the embodiment described in the 532 patent as a "flattened curved block." *Compare* Exs. 1003, 1004, Fig. 6A *with* Ex. 1001, Fig. 15, 17:65-67 (identifying the "flattened curved block"):



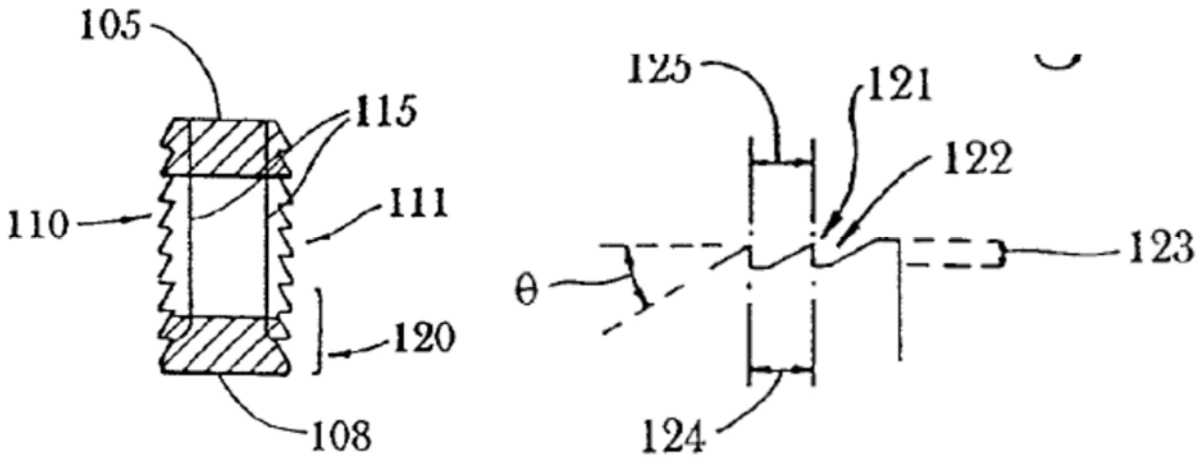
Grooms Fig. 6A



532 Patent Fig 15

B. Claims 6-8

Claim 6 recites that the continuous protrusions in the graft of claim 4 comprise a cross-section having one or more shapes selected from the group consisting of irregular, triangular, square, rectangular, and curved. The continuous linear protrusions disclosed by Grooms have a triangular cross-section. *See* Ex. 1003, ¶34; Ex. 1004, 9:25-27; *see also id.*, Figures 1D-E, reproduced below, *see* Ex. 1015, ¶170.



Claim 7 recites that the continuous protrusions in the graft of claim 4 are sized to be in a range of: (1) greater than or equal to 1.5 mm in length, (2) 0.5 to about 10.0 mm in width, and (3) 0.1 to about 5.0 mm in depth.

Grooms teaches that the teeth may have a *depth* of 0.381 mm (0.015"), which falls squarely within the "0.1 to about 5.0 mm" recited in claim 7. Ex. 1003, ¶44; Ex. 1004, 15:1-3, Ex. 1015, ¶173.

Moreover, because the teeth span the width of the Grooms graft, *see* Exs. 1003, 1004, Figure 1C, they have a length equivalent to the width of the graft, which Grooms discloses may be between about 11 and 14 mm. Ex. 1003, ¶56; Ex. 1004, 18:17-18. Thus, the teeth of Grooms have a *length* that satisfies the "greater than or equal to 1.5 mm" recited in claim 7. *See* Ex. 1015, ¶174.

Finally, while Grooms does not explicitly disclose the width of each protrusion, the range recited in claim 7 is incredibly broad. Using the length of the graft, which Grooms discloses is between about 11 and 14 mm (Ex. 1003, ¶56;

Ex. 1004, 18:17-18), the maximum recited width of 10.0 mm would accommodate only a single protrusion while the minimum width of 0.5 would accommodate up to twenty-eight protrusions. *See* Ex. 1015, ¶174 (Grooms discloses protrusions having a width in the range recited by claim 7). It therefore would have been a matter of selection of a known option for a person of ordinary skill to have provided protrusions having a *width* within the range recited in claim 7. *Id.*, ¶169; *see also* Ex. 1003, ¶34; Ex. 1004, 10:4-6.

Claim 8 recites that the protrusions of claim 7 are spaced from about 0.0 to about 3.0 mm apart.

Again, this range is incredibly broad. Using the length of the graft, which Grooms discloses is between about 11 and 14 mm (Ex. 1003, ¶56; Ex. 1004, 18:17-18), the maximum spacing of 3.0 mm would accommodate only 3-4 protrusions, which is significantly fewer than is shown in the illustrated grafts of Grooms. Grooms discloses that teeth are separated. *See* Ex. 1015, ¶177. Thus, it would have been a matter of simple selection for a person of ordinary skill to have selecting the specific spacing of the protrusions of Grooms within the range recited in claim 8 to achieve the advantages taught by Grooms. *Id.*, ¶169; *see also* Ex. 1003, ¶34; Ex. 1004, 10:4-6.

C. Claims 9-10

Claim 9 recites that pin(s) in the graft of claim 4 comprise one or more biocompatible materials selected from the group consisting of cortical bone, stainless steel, titanium, cobalt-chromium-molybdenum alloy, and plastic. Claim 10 recites that the plastic is selected from the group consisting of nylon, polycarbonate, polypropylene, polyacetal, polyethylene, polysulfone, bioabsorbable polymer, and a combination thereof.

Grooms teaches that the pins may be made of cortical bone, resorbable but strong biocompatible synthetic material, or metal. Ex. 1003, ¶¶48-49; Ex. 1004, 17:10-18:6. It therefore would have been obvious to a person of ordinary skill in the art to utilize cortical bone or bioabsorbable polymer as the material for the pins in the graft of Grooms. *See* Ex. 1015, ¶¶180, 181, 183.

D. Claim 11

Claim 11 recites that the graft of claim 4 is a polyhedron.

The 532 patent defines polyhedron to be a solid formed by plane faces, preferably six. Ex. 1001, 14:65 – 67. Grooms implants are not in the shape of a polyhedron because they have one curved rather than plane face. Ex. 1003, ¶10. Ex. 1004, 2: 22-23, Fig. 1A. McIntyre discloses a graft that is generally a cube formed by six plane faces. Ex. 1005, 3:5-7. The shape of a particular graft is defined by the needs of a patient and surgeon. Ex. 1016, ¶¶41-46. It would have been obvious to a person of ordinary skill in the art to have prepared the grafts of Grooms in the shape disclosed by McIntyre for implantation as described by McIntyre. *See* Ex. 1015, ¶¶187-188.

IX. Ground 3: Claims 12 and 20 are anticipated by or obvious over Paul

A. Claim 12

As explained in detail below, Paul discloses or renders obvious a graft having each of the four elements of claim 12 (*see* §V.A).

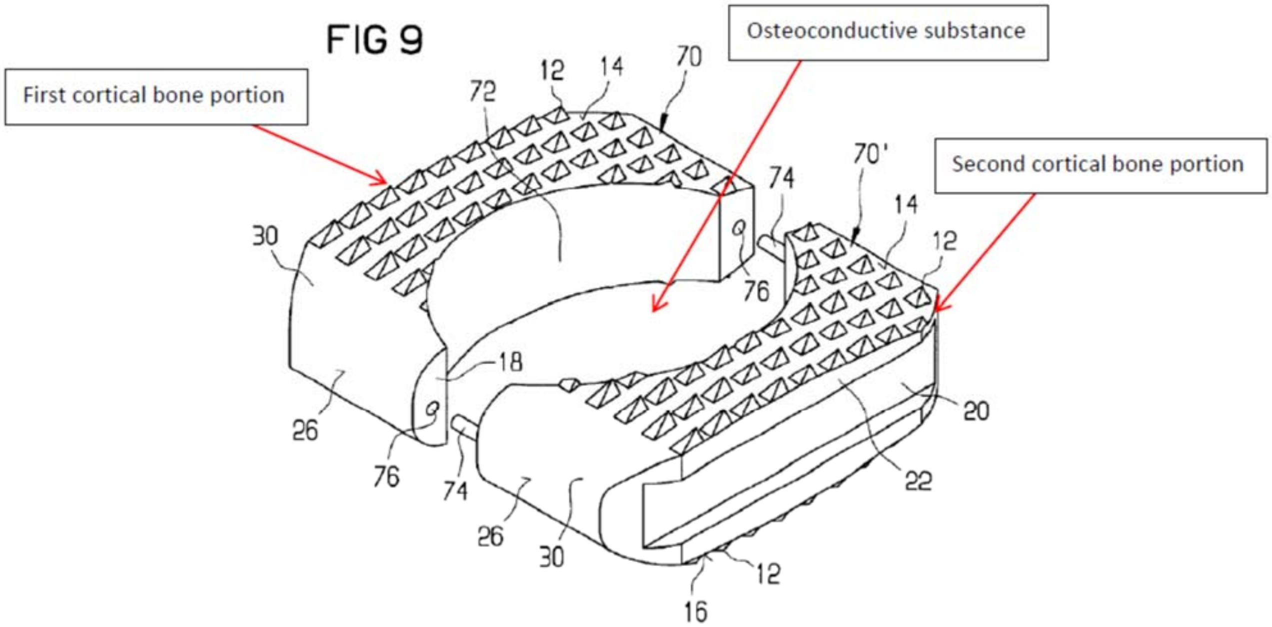
Element 1 (load-bearing spinal bone graft)

Paul discloses cortical bone implants, *i.e.*, grafts, for use in posterior lumbar interbody fusion ("PLIF") procedures, in which an implant is inserted between two adjacent vertebral bodies in the anterior spine. *See* §VI.B. In view of Paul's description of those implants and the loads supported by PLIF implants, a person of ordinary skill in the art in January 1999 and earlier would have understood that the bone used in the Paul graft is not demineralized, and, for the same reasons, it would have been obvious to that person to form the grafts disclosed by Paul from non-demineralized bone. *See* Ex. 1015, ¶¶96-99. Accordingly, Paul discloses or renders obvious to one of ordinary skill in the art in January 1999 and earlier, a load-bearing bone graft configured for implantation into the anterior spinal column of a host, as recited in claim 12. *Id.*, ¶190.

Element 2 (cortical-osteoconductive-cortical composite)

Paul discloses graft implants made from multiple distinct portions of bone including the embodiment shown in Figure 9 that is made from first and second bone portions that one of ordinary skill would have understood to be cortical bone. *See* §VI.B. Paul also discloses that the graft implant shown by Figure 9 has a space filled with an osteoconductive material to promote the formation of new bone. Ex. 1006, 5:8-23; Ex. 1007, 6:33-7:13.

Therefore, a person of ordinary skill in the art would have understood that Paul discloses a composite graft comprising a first cortical bone portion, a second cortical bone portion, and one or more osteoconductive substances disposed between the first and second cortical bone portions, as shown in annotated Figure 9 below.



Ex. 1015, ¶¶191, 192.

Element 3 (textured surfaces, contact with host bone)

A plurality of teeth are formed on the vertebra-engaging surfaces of the Paul graft to provide a mechanical interlock between the graft and the end plates of the vertebrae between which the graft is implanted. Ex. 1006, 3:27-38; Ex. 1007, 4:7-20; *see also* Figure 9. A person of ordinary skill in the art in January 1999 and earlier would have understood from Paul that both the first and second cortical bone portions are configured to contact a portion of the host bone of the adjacent vertebrae. *See* Ex. 1015, ¶¶105, 191. Because the surfaces of the first and second cortical bone portions that contact a portion of the host bone include a plurality of teeth, those surfaces are "textured" as recited in the claim. *See* Ex. 1015, ¶¶105, 107, 191.

One of ordinary skill in the art in January 1999 and earlier would have understood that the one or more osteoconductive substances in the space formed by the cortical bone portions necessarily contacts adjacent vertebrae to effectively promote bone formation by the adjacent vertebral bone. *See* Ex. 1015, ¶106.

Element 4 (mechanical connector)

Paul teaches that locking pins, preferably made of allograft bone, may be used to maintain the spatial relationship between the first and second portions of the graft. Ex. 1006, 5:20-23, 4:58-63; Ex. 1007, 7:10-13, 6:27-32. Thus, Paul discloses one or more "non-adhesive mechanical connectors for holding together" a composite bone graft. *See* Ex. 1015, ¶190.

B. Claim 20

Claim 20 recites that the mechanical connector in the graft of claim 12 comprises one or more biocompatible materials selected from the group consisting of cortical bone, stainless steel, titanium, cobalt-chromium-molybdenum alloy, and plastic. Paul teaches that the pins may be made of any biocompatible material, and preferably of allogenic bone. Ex. 1006, 4:58-63; Ex. 1007, 6:27-32. A person of ordinary skill would have understood that the allogenic bone referred to by Paul is cortical bone. *See* Ex. 1015, ¶196, 197.

X. Ground 4: Claims 13-19 are obvious over Paul in view of Coates

As described in §IX.A, (*Element 2*), Paul discloses a graft having a space filled with a material to promote bone growth, but it does not specify the particular materials.

Like Paul, Coates describes a spinal fusion bone graft having a central chamber packed with one or more materials that promote bone growth. Coates provides a list of suitable materials. Because Coates is in the same area of endeavor as Paul, one of ordinary skill would therefore have looked to Coates for guidance in selecting materials to include in the space of the Paul graft. As explained below, such a person would have found it obvious to have filled the space of the Paul graft with one or more of the materials disclosed by Coates in order to achieve the goal of promoting bone growth as stated by both Paul and Coates.

A. Claim 13

Claim 13 recites that the osteoconductive substance of claim 12 is selected from the group consisting of hydroxyapatite, collagen, polymeric matrix materials, bioglass, bioceramics, resorbable biomaterials, bioabsorbable polymers, plastic matrix, stainless steel, titanium and cobalt-chromium-molybdenum alloy matrix.

Paul discloses that the space is filled with an osteoconductive material to help promote the formation of new bone, but does not specifically disclose any of the materials recited in claim 13. Ex. 1006, 5:17-20, 4:21-25.

Like Paul, Coates discloses spinal fusion bone grafts that stimulate bone growth and provide strength to support the vertebral column until the adjacent vertebrae are fused. Ex. 1008, Abstract, 3:40-51; 5:37-65. The grafts of Coates similarly include a central chamber packed with an osteogenic composition to facilitate and promote bone growth. *Id.*, 5:66-6:17, 6:38-41. One of ordinary skill in the art in January 1999 and earlier would have understood the osteogenic composition disclosed by Coates to have the same purpose as the osteoconductive materials disclosed by Paul. Ex. 1015, ¶201.

Coates discloses a number of osteogenic materials that may be packed into the central chamber, including, for example, *bioceramics*. *Id.*, 6:34-38. Coates also describes packing the central chamber with bone morphogenic protein (BMP) and a carrier such as *collagen*, *polymeric matrix materials,* including those made of resorbable polymers, and *hydroxyapatite*. Ex. 1008, 6:59-7:43. In a preferred embodiment, Coates describes the packing of the central chamber with a collagen sponge soaked with bone morphogenic protein. *Id.*, 8:33-42, Figure 4.

One of ordinary skill would have found it advantageous to fill the space of the Paul graft with one of the osteogenic materials taught by Coates, including, for example, bioceramics, collagen, hydroxyapatite, or polymeric matrix materials — each recited in claim 13 — in order to achieve Paul's stated goal of promoting bone growth. *See* Ex. 1015, ¶¶202, 203.

B. Claims 14-15

Claim 14 recites that the graft of claim 13 further comprises one or more osteoinductive substances. Claim 15 recites that at least one of those osteoinductive substances is selected from the group consisting of autograft bone, allograft bone, cortical bone, demineralized cortical bone, cancellous bone, demineralized cancellous bone, and collagen.

Coates identifies autograft bone and allograft bone among the osteogenic materials suitable for packing into the central chamber of a graft. Ex. 1008, 6:35-39, *see* Ex. 1015, ¶210. In addition to any of the materials recited above with respect to claim 13, therefore, it would have been obvious to one of ordinary skill to have filled the space of the Paul graft with autograft bone or allograft bone, both of which are recited in claim 15, in order to achieve Paul's stated goal of promoting bone growth. *See* Ex. 1015, ¶211-213.

C. Claims 16-19

Claims 16 and 17 recite that the graft of claims 13 and 14 further comprises one or more pharmaceutically active agents. Claim 18 recites that the pharmaceutically active agent is a growth factor and claim 19 recites that the growth factor is either bone morphogenic protein or transforming growth factor.

One of ordinary skill in the art would have been led to consult Coates for the reasons stated above for materials to be packed in the space formed by the Paul implant. *See* Ex. 1015, ¶203. Coates lists bone morphogenic protein ("BMP") among the osteogenic materials for packing into a central chamber of a graft. Ex. 1008, 6:59-7:17. Coates also describes a preferred embodiment in which the central chamber is packed with a collagen sponge soaked with BMP. *Id.*, 8:33-42, Figure 4. It would have been obvious to a person of ordinary skill in the art to provide BMP in the filled space of the Paul graft, by BMP-carrying collagen sponge or otherwise, as described by Coates, in order to achieve Paul's stated goal of promoting bone growth. *See* Ex. 1015, ¶¶64, 202, 221-223. Doing so would satisfy the limitation recited by claim 19, and thereby limitations recited by each of claims 13-18. *Id.*, ¶224.

XI. Ground 5: Claims 4, 6-9, and 11 are obvious over Paul in view of McIntyre and Coates

A. Claim 4

As shown below, Paul discloses most of the six elements of claim 4 (*see* §V.A). Although Paul discloses that the space of the graft is filled with a material that promotes bone growth, it does not specifically disclose that the space is filled with a plate-like cancellous bone portion, as recited in element 2. McIntyre, however, discloses spinal fusion bone grafts in which a cancellous bone plug is fitted into a central cavity of a cortical shell. As explained below, it would have been obvious to one of ordinary skill to have fit the cancellous bone plug of McIntyre into the space of the Paul graft, as cancellous bone was known (and disclosed by McIntyre) to be a highly suitable material for promoting bone growth.

Although Paul discloses that the vertebral-engaging surfaces of the graft include linearly-arranged teeth, those teeth may not be considered "continuous" as recited in element 5. Coates, however, discloses spinal fusion bone grafts comprising continuous linear teeth (*i.e.,* protrusions) that engage adjacent vertebrae. As explained below, it would have been obvious to one of ordinary skill in the art in January 1999 and earlier to have replaced the *discrete* teeth of Paul with the *continuous* linear protrusions disclosed by Coates in order to achieve the advantage of better preventing migration and/or expulsion of the graft.

Element 1 (spinal bone graft)

Paul discloses cortical bone implants, *i.e.,* grafts, for use in posterior lumbar interbody fusion ("PLIF") procedures, in which an implant is inserted between two adjacent vertebral bodies in the anterior spine. *See* §VI.B. Thus, a person of ordinary skill would have understood that Paul discloses a bone graft configured for implantation into the anterior spinal column. *See* Ex. 1015, ¶226.

Element 2 (cortical-cancellous-cortical composite)

As described in §IX.A, (*Element 2*), Paul discloses to a person of ordinary skill that the graft shown in Figure 9 is made from first and second cortical bone portions. Paul also discloses to such a person that each of the first and second portions of certain configurations disclosed by Paul are plate-like. *Id.*, ¶¶232-234 (providing dimensional analysis of disclosed implant shapes).

Paul also teaches that the graft has a space filled with osteoconductive material to promote the formation of new bone (Ex. 1006, 5:8-23; Ex. 1006, 6:33-7:13), but does not specifically disclose a "plate-like cancellous bone portion."

McIntyre discloses bone grafts for use in PLIF procedures. Ex. 1005, 2:14-16. The McIntyre grafts comprise a cortical shell having a central cavity into which a cancellous plug is fitted. Ex. 1005, Abstract, Figures 3-4 (annotated reproductions below):

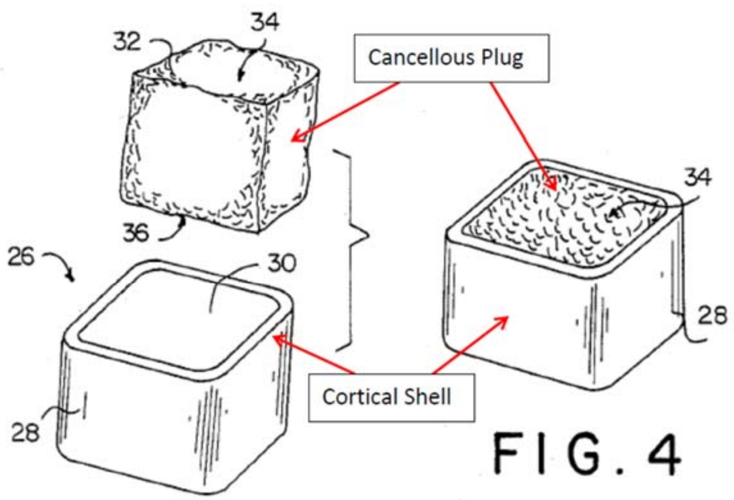


FIG. 3

FIG. 4

Ex. 1015, ¶¶57-58.

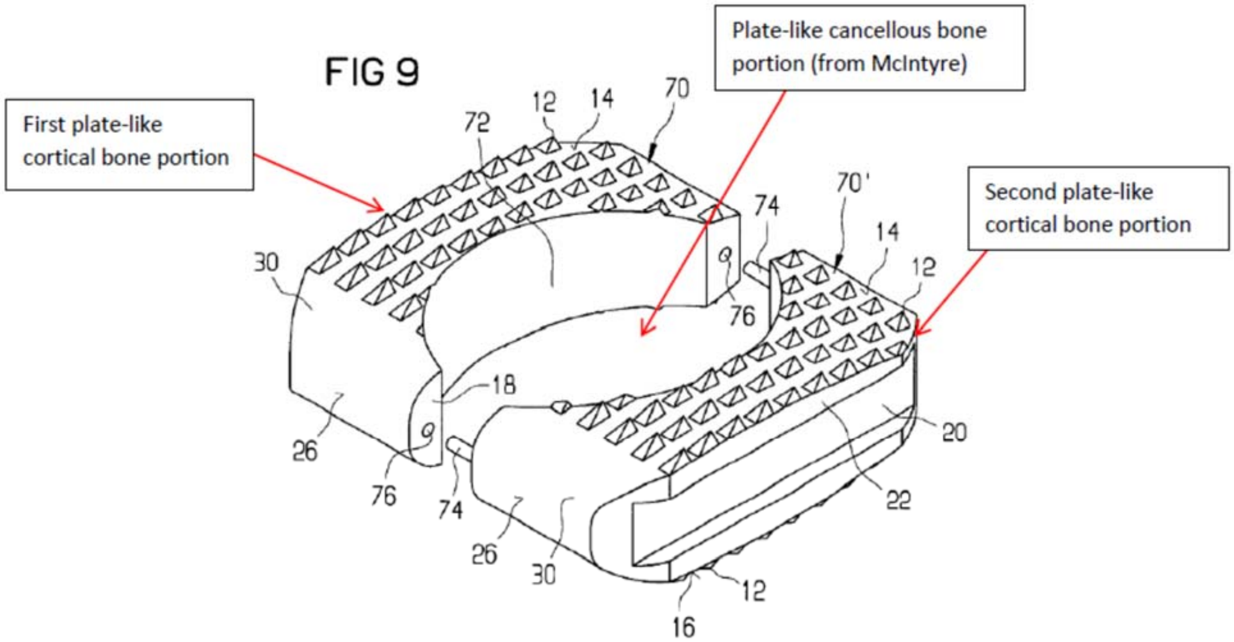
McIntyre describes the cancellous plug as promoting bone growth, calling it "the most suitable matrix for rapid bone regeneration and repair." Ex. 1005, 1:43-50. That cancellous plug is described as provided to "maximize the chances of a successful transplant." *Id.*, 1:43-64, 3:32-36.

Accordingly, a person of ordinary skill in the art looking for a suitable material to fill the space of Paul would have been led to the cancellous plug of McIntyre because (1) McIntyre is directed to spinal fusion bone grafts similar to those taught by Paul and (2) McIntyre discloses the advantages of using a cancellous bone plug to promote bone growth in such grafts. Ex. 1015, ¶¶56, 231. It would therefore have been obvious to a person of ordinary skill to have fit the cancellous plug of McIntyre into the space of the Paul graft. *See* Ex. 1015, ¶231.

Such a person would have been motivated to do so by McIntyre's teaching, and the common knowledge in the art, that cancellous bone is highly effective at promoting bone growth. *Id.*, ¶230. Moreover, such a person would have had a reasonable expectation of success , as it would require no more than practicing what was already taught by McIntyre; namely, inserting a cancellous plug into the central cavity of a graft made from cortical bone. *Id.*, ¶231.

A person of ordinary skill would have considered the cancellous plug of McIntyre, as sized to fit into the space of the Paul graft, for at least some configurations disclosed by Paul to be plate-like. Ex. 1015, ¶¶232, 233 (providing dimensional analysis of disclosed implant shapes).

Accordingly, the composite graft resulting from the combination of Paul and McIntyre would comprise a first plate-like cortical bone portion, a second plate-like cortical bone portion, and a plate-like cancellous bone portion disposed between the first and second cortical bone portions, as shown by annotated Figure 9, below.



Ex. 1015, ¶¶233, 234.

Element 3 (contact with host bone)

A plurality of teeth are formed on the vertebra-engaging surfaces of the Paul graft to provide a mechanical interlock between the graft and the end plates of the vertebrae between which the graft is implanted. Ex. 1006, 3:27-38; Ex. 1007, 4:7-20; *see also* Figure 9. Accordingly, a person of ordinary skill would have understood that the first and second cortical bone portions and the cancellous bone portion are configured to contact a portion of the host bone; namely, the adjacent vertebrae located above and below the graft. *See* Ex. 1015, ¶¶58, 228, 230.

Element 4 (bone pins)

Paul teaches that locking pins, preferably made of allograft bone, may be used to maintain the spatial relationship between the first and second portions of the graft. Ex. 1006, 5:20-23, 4:58-63; Ex. 1007, 7:10-13, 6:27-32. A person of ordinary skill in the art would have understood that the allogenic bone referred to by Paul is cortical bone. *See* Ex. 1015, ¶¶102, 104.

Paul discloses that holes are created in each of the first and second bone portions and a pin is inserted into those holes. Figure 9 does not show the depth of the holes. Another embodiment of a composite graft disclosed by Paul has pins inserted into holes that extend completely through the composite. Exs. 1006, 1007, Figure 7; *see also* Ex. 1006, 4:58-63; Ex. 1007, 6:27-32. One of ordinary skill would therefore have understood that the holes in the embodiment shown in Figure 9 may also extend through the graft and would have found it obvious to have used such through-holes. *See* Ex. 1015, ¶227. Accordingly, Paul discloses or suggests to a person of ordinary skill a graft having one or more through-holes configured to accommodate one or more pins and one or more cortical bone pins connecting portions of the graft. *Id.*

Element 5 (textured surfaces)

The Paul graft contains a plurality of teeth on its top and bottom surfaces. Ex. 1006, 3:27-46; Ex. 1007, 4:7-26; *see also* Figure 9. These teeth penetrate the adjacent vertebrae and prevent post-operative expulsion of the graft. *Id.* Although these teeth are arranged linearly, each tooth is a discrete structure. Accordingly, the teeth of Paul may not be considered *continuous* protrusions.

Coates discloses a spinal fusion bone graft having upper and lower vertebral engaging surfaces having a series of alternating grooves and continuous protrusions in a linear arrangement. Ex. 1008, Abstract; Figures 15-18:

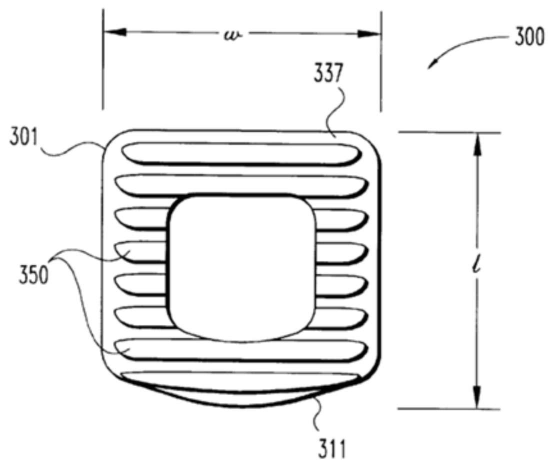


Fig. 15

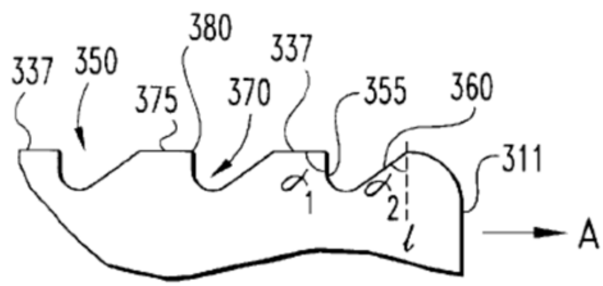


Fig. 18

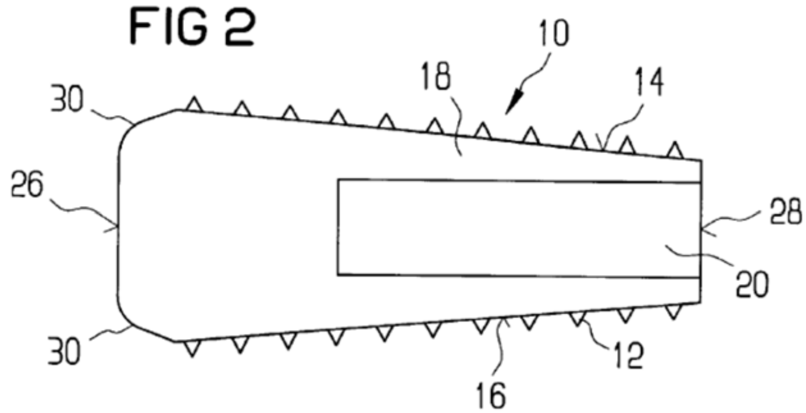
Coates discloses that the series of grooves and protrusions prevent anterior migration of the graft. Ex. 1008, 3:46-67. If a force urges the graft in the anterior direction, the edge of the protrusion will dig into the adjacent vertebrae and prevent movement. *Id.*, 11:18-22.

It would have been obvious to a person of ordinary skill to have replaced the teeth of Paul with the continuous linear protrusions of Coates, as both are taught to prevent post-operative migration/expulsion of the graft. *See* Ex. 1015, ¶243. Such a person would have been motivated to do so because one would have expected the continuous linear protrusions of Coates to be (1) easier to form and (2) less likely to break than the teeth disclosed by Paul. *Id.*, ¶¶65, 66, 243. Moreover, such a person would have had a reasonable expectation of success because the continuous protrusions of Coates and the teeth of Paul would be expected to function in the same manner to prevent undesired graft movement, which can result in expulsion of the graft. *Id.*, ¶¶241, 243.

Element 6 (shape of graft)

Paul discloses wedge-shaped grafts, (Ex. 1006, 4:6-15; Ex. 1007, 5:12-21), specifically a trapezoidal wedge graft having rounded edges comparable to the chamfered edges described in the 532 patent. Exs. 1006, 1007, Figure 2, reproduced below; *see also* Ex. 1001, 30:50-51, 23:52-24:22 (describing a trapezoidal wedge having chamfered edges).

FIG 2



Accordingly, a person of ordinary skill would have understood that the Paul graft is shaped like a trapezoidal wedge or would, at the very least, have found it obvious to have provided the Paul graft with such a shape, as such shapes were known to accommodate anatomic curvature of the spine. *See* Ex. 1015, ¶¶236-238, Ex. 1016, ¶¶41, 43, 45.

B. Claim 6

Claim 6 recites that the continuous protrusions comprise a cross-section having one or more shapes selected from the group consisting of irregular, triangular, square, rectangular, and curved.

Coates discloses protrusions with a cross-section having curved and/or irregular shapes. Specifically, Figures 18 and 19 of Coates shows protrusions having front faces with a curved cross-sectional shape and having overall cross-sectional shapes that can best be described as irregular. Ex. 1008, Figures 18-19:

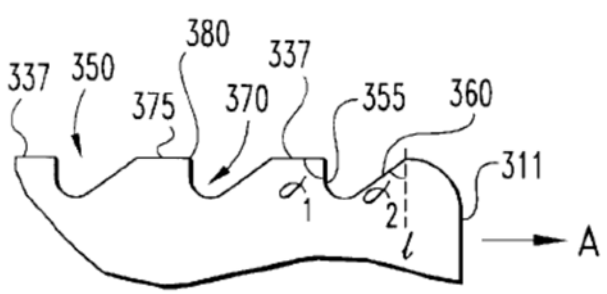


Fig. 18

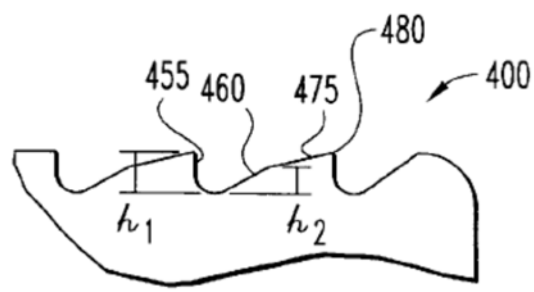


Fig. 19

Coates states that each protrusion includes a first face defining an angle no more than about 90º relative to the surface of the graft and a second, opposing and sloped face. Ex. 1008, 10:43-58.[5] Those protrusions have a cross section that is triangular as would be recognized by one of ordinary skill in the art in January 1999 and earlier. *See* Ex. 1015, ¶248

C. Claims 7-8

Claim 7 recites that the continuous protrusions are sized to be in a range of: (1) greater than or equal to 1.5 mm in length, (2) 0.5 to about 10.0 mm in width, and (3) 0.1 to about 5.0 mm in depth. Claim 8 recites that the protrusions of claim 7 are spaced from about 0.0 to about 3.0 mm apart.

Neither Paul nor Coates discloses the dimensions of the teeth/protrusions or the spacing between adjacent teeth/protrusions. However, given the dimensions of the graft itself, which is taught by Paul to have a width between 6-15 mm and a length between 15-30 mm (*see* Ex. 1006, 3:60-65; Ex. 1007, 5:3-8), and by Coates to have a length and width of 11mm to 14 mm (Ex. 1008, 11:64-66), one of ordinary skill in the art would have understood Coates to disclose protrusions

---

[5] Coates describes the flattened upper surface in Figure 18 as preferable, but not necessary. Ex. 1008, 10:66-67. The graft of Figure 19 has a sloped surface that renders the cross-section almost triangular. Ex. 1008, Fig. 19.

having dimensions within the broad ranges recited by claim 7. *See* Ex. 1015, ¶258. It would have been obvious to have provided the protrusions with dimensions that fall within the very broad ranges recited in claim 7 and to have spaced the protrusions between 0.0 and 3.0 mm apart, as recited in claim 8, as doing so would have been nothing more than routine optimization. *See* Ex. 1015, ¶¶251-258, 260-261.

D. Claim 9

Claim 9 recites that the one or more pins comprises one or more biocompatible materials selected from the group consisting of cortical bone, stainless steel, titanium, cobalt-chromium-molybdenum alloy, and plastic.

Paul teaches that the pins may be made of any biocompatible material, and preferably allogenic bone. Ex. 1006, 4:58-63; Ex. 1007, 6:27-32. A person of ordinary skill would have understood that the allogenic bone referred to by Paul is cortical bone. *See* Ex. 1015, ¶¶102, 104, 261.

E. Claim 11

Claim 11 recites that the graft of claim 4 is a polyhedron. The shape of the Paul implant is similar to a polyhedron. *See* Ex. 1015, ¶¶267. The graft disclosed by McIntyre is a polyhedron. *See* Ex. 1015, ¶186. A person of ordinary skill in the art would have found it obvious to have provided the Paul graft with the shape disclosed by McIntyre for the reasons disclosed by McIntyre. *See* Ex. 1015, ¶268.

XII. Ground 6: Claims 12 and 20 are anticipated by Wolter

A. Claim 12

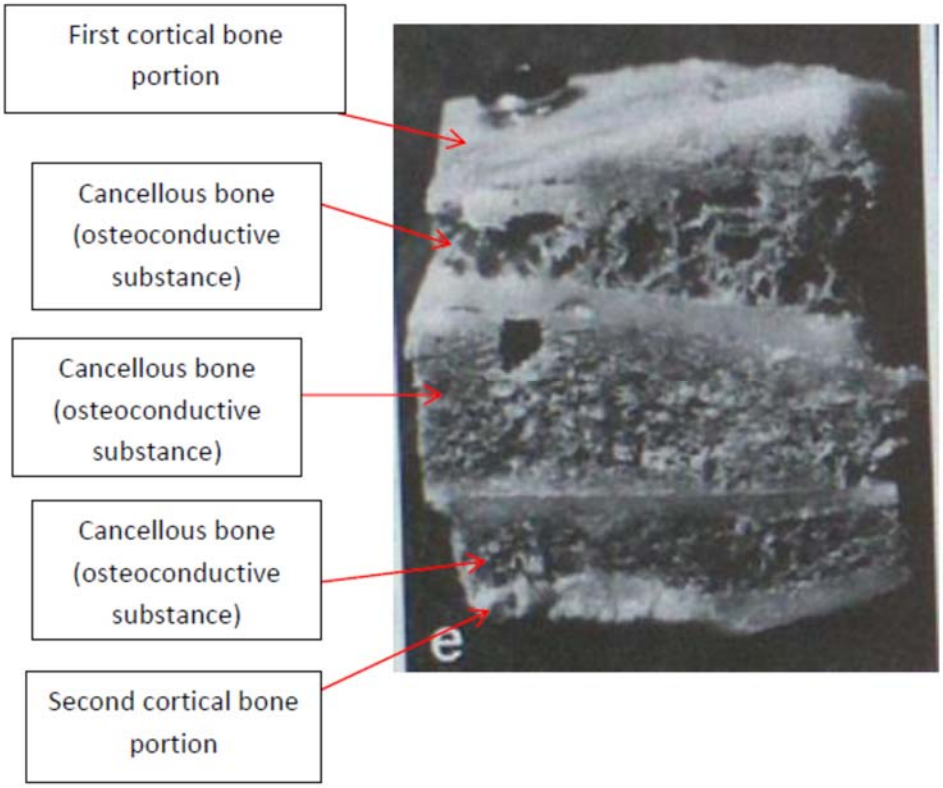
As explained in detail below, Wolter discloses a graft having each of the four elements of claim 12 (*see* §V.A).

Element 1 (load-bearing spinal bone graft)

Wolter discloses a graft for implantation into the anterior spinal column of a host that withstands a physical load. *See* Ex. 1015, ¶¶50, 270; *see also* Ex. 1010, 5 (describing the composite block as having "a high load resistance"). Because the Wolter graft was made from autograft bone and prepared during the same surgery in which it is implanted, a person of ordinary skill would also have understood that the graft is non-demineralized. Ex. 1015, ¶43. Such a person would therefore have understood that Wolter discloses a load-bearing bone graft configured for implantation into the anterior spinal column. *Id.*, ¶¶50, 270.

Element 2 (cortical-osteoconductive-cortical composite)

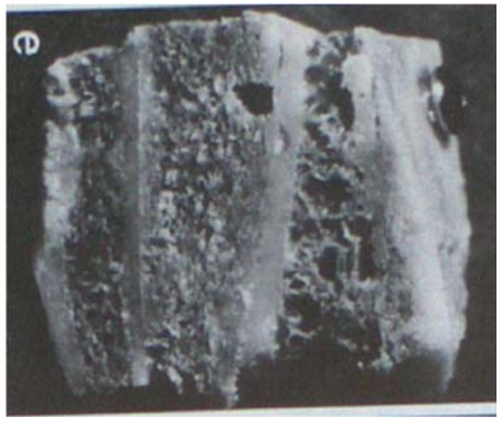
The Wolter graft is a composite comprising a first cortical bone portion, a second cortical bone portion, and one or more osteoconductive substances (cancellous bone) disposed between the first and second cortical bone portions. *See* Ex. 1010, Fig. 1e, reproduced below with annotations:



Ex. 1015, ¶46.

Element 3 (textured surfaces, contact with host bone)

The Wolter graft is configured such that the first and second cortical bone portions and the cancellous bone portions contact a portion of the host bone. Ex. 1015, ¶272. Specifically, Wolter discloses that the block is oriented so that the direction of the cortical bone parts lies in the same direction as the primary stress (Ex. 1010, 6), *i.e.*, vertically as shown below, meaning that the upper and lower surfaces of the graft contain alternating layers of exposed cortical and cancellous bone. Ex. 1015, ¶50.



The vertebral-engaging surfaces of the Wolter graft are textured, including the surfaces of the first and second cortical bone portions that contact a portion of the host bone. Specifically, the surfaces of the Wolter graft are textured by the surgical saw used to form the graft. *See* Ex. 1015, ¶49. The texture created by that saw is within the meaning of the term "textured" used in the 532 patent. *See* Ex. 1015, ¶¶ 274, 49.

Element 4 (mechanical connector)

Wolter discloses that the graft assembly is secured by one or two screws (Ex. 1010, 5, Figure 1e), i.e., by one or more non-adhesive mechanical connectors. Ex. 1015, ¶270.

B. Claim 20

Claim 20 recites that the mechanical connector comprises one or more biocompatible materials selected from the group consisting of cortical bone, stainless steel, titanium, cobalt-chromium-molybdenum alloy, and plastic. A person of ordinary skill would have understood Wolter's disclosure to encompass stainless steel bone screws, because that material was commonly used for implantable medical screws such as bone screws. *See* Ex. 1015, ¶280. Indeed, such a person would have understood that the screw actually shown in Figure 1e is formed of stainless steel. *Id.*, ¶¶281-283.

XIII. Ground 7: Claims 12 and 20 are obvious over Wolter in view of any of (a) Grooms, (b) Paul, or (c) Coates

As described in §XII, Wolter discloses every element of claims 12-20. However, to the extent that the surfaces of the first and second cortical bone portions of Wolter are not considered textured, it would have been obvious to one of ordinary skill in the art to have provided the vertebral-engaging surfaces of the Wolter graft with protrusions, such as those taught by Grooms (*see* Exs. 1003, 1004, Figures 1C-E), Paul (*see* Exs. 1006, 1007, Figure 9), or Coates (*see* Ex. 1008, Figures 15-19) in order to prevent graft migration and/or expulsion, as was well known in the art. Ex. 1015, ¶¶285-288; *see also* §XIV.A, *infra* (explaining a motivation to provide surfaces on the Wolter graft as disclosed by Grooms, Paul, and Coates to resist movement as disclosed by those references).

XIV. Ground 8: Claims 4 and 6-11 are obvious over Wolter in view of Grooms

A. Claim 4

As shown below, the graft recited in claim 4 is the graft disclosed by Wolter modified in two respects that were commonplace at the time of the alleged invention. First, the Wolter graft is held together by a metal screw rather than a bone pin, and second, Wolter does not clearly disclose continuous linear protrusions.

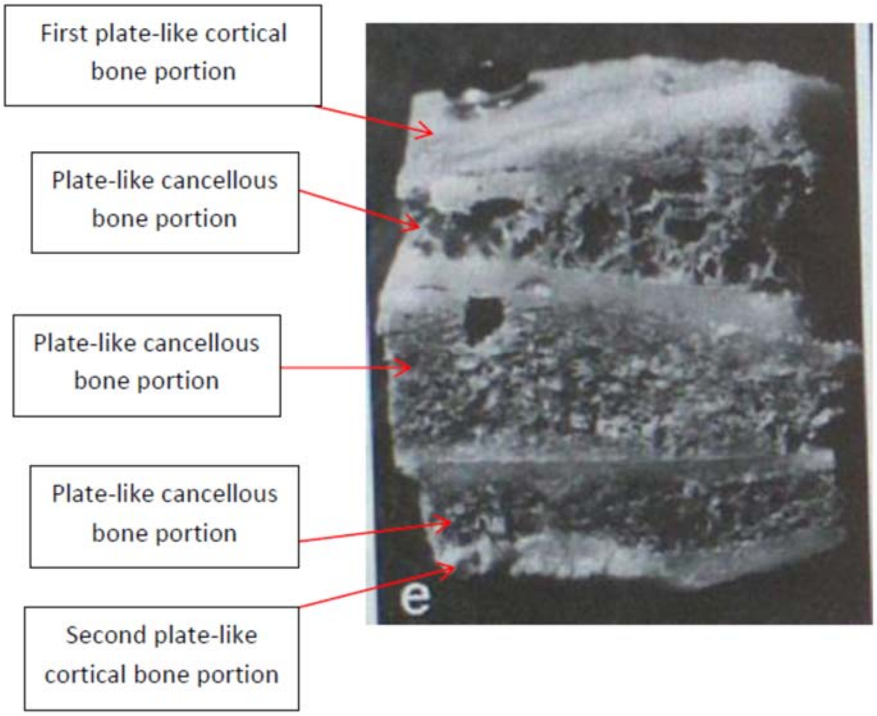
It would have been obvious to one of ordinary skill in the art in January 1999 and earlier to provide a pin made from bone as taught by Grooms in place of the screw disclosed by Wolter. Ex. 1015, ¶¶297-300. It would also have been obvious to one of ordinary skill in the art in January 1999 and earlier to provide the upper and lower surfaces of the Wolter graft with continuous linear protrusions as taught by Grooms to prevent post-operative expulsion of the graft. *Id.*, ¶301. As set out below, the graft resulting from those two known modifications satisfies every element of claim 4.

Element 1 (spinal bone graft)

Wolter discloses a bone graft configured for implantation into the anterior spinal column of a host. *See* Ex. 1015, ¶¶50, 293.

Element 2 (cortical-cancellous-cortical composite)

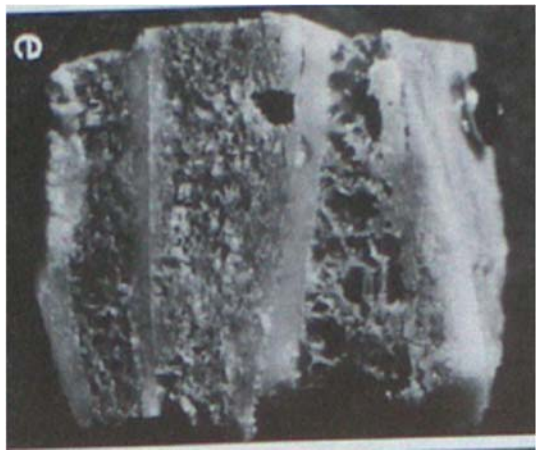
The Wolter graft is a composite comprising a first plate-like cortical bone portion, a second plate-like cortical bone portion, and a plate-like cancellous bone portion disposed between the first and second cortical bone portions. *See* Ex. 1010, Figure 1e, reproduced below with annotations:



Ex. 1015, ¶293.

Element 3 (contact with host bone)

The Wolter graft is configured such that the first and second cortical bone portions and the cancellous bone portions each contact a portion of the host bone. Ex. 1015, ¶¶50, 51. Specifically, the Wolter block is oriented so that the direction of the cortical bone parts lies in the same direction as the primary stress (Ex. 1010, 6), *i.e.*, vertically as shown below, meaning that the upper and lower surfaces of the graft contain alternating layers of exposed cortical and cancellous bone. *Id.*



Element 4 (bone pins)

Wolter discloses one or more metal screws to secure portions of the assembled graft. Grooms teaches that distinct portions of a composite graft may be connected by forming a hole in each portion and forcing a pin into the aligned through-hole. Ex. 1003, ¶48; Ex. 1004, 16:29-17:21; *see also* Figures 7A-B. Grooms also teaches that the pins may be made of cortical bone. *Id.*, Ex. 1015, ¶¶77-79.

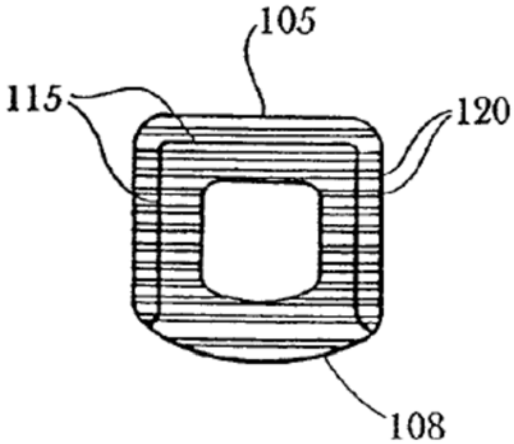
It would have been obvious to a person of ordinary skill in the art to have replaced the metal screw(s) of Wolter with the cortical bone pin(s) of Grooms. *See* Ex. 1015, ¶¶297-300. Such a person would have been motivated to replace the metal screws used by Wolter with cortical bone pins, such as disclosed by Grooms, in order to eliminate a foreign object from being permanently present in the patient's spine and avoid problems that may arise from screw loosening. *Id.*, ¶300. Moreover, one of ordinary skill in the art would have had a reasonable expectation of successfully making such a substitution because Grooms discloses that cortical bone pins are suitable to secure portions of a load-bearing spinal bone graft together. *Id.*, ¶¶299, 300.

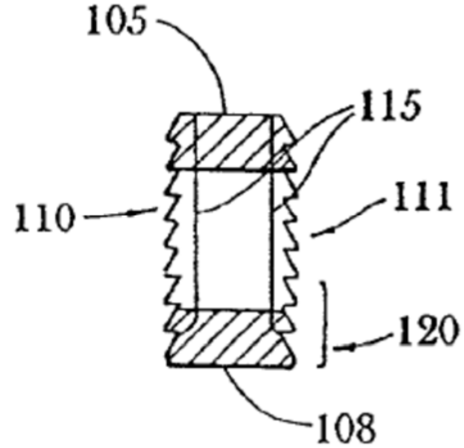
The graft of Wolter, modified to include a cortical bone pin in place of a metal screw, would comprise one or more through-holes configured to accommodate one or more pins and one or more cortical bone pins connecting portions of the graft. *Id.*, ¶299.

Element 5 (textured surfaces)

Wolter does not disclose a graft having a textured surface comprising a plurality of closely spaced continuous protrusions in a linear arrangement. Providing a spinal graft as taught by Wolter, but with texturing on its vertebral-engaging surfaces to retain the graft within the spine was well known in the art. *See* Ex. 1015, ¶¶301, 429.

As set out above in §VII.A, Grooms discloses a graft having top and bottom surfaces inscribed with a plurality of closely spaced, continuous linear protrusions.





It would have been obvious to a person of ordinary skill to have prepared the upper and lower vertebral engaging surfaces of the Wolter graft to include a plurality of closely spaced continuous protrusions in a linear arrangement, as taught by Grooms. Ex. 1015, ¶300. Such a person would have been motivated to do so in order to reduce the chances of graft migration and/or expulsion of the graft. *Id.* Moreover, such a person would have had a reasonable expectation of successfully forming the continuous protrusions on the surfaces of the Wolter graft as Grooms describes procedures for forming the continuous protrusions. Ex. 1003, ¶44; Ex. 1004, 14:25-15:6. Providing such texturing to the surfaces of bone grafts was well understood. *Id.*, ¶288.

Element 6 (shape of graft)

The Wolter graft has a general shape of a parallel or square block, each of which is a parallelepiped and a polyhedron. *See* Ex. 1010, Figure 1e, reproduced below:

Ex. 1015, ¶296. It would have been obvious to a person of ordinary skill in the art in January 1999 and earlier, and well within that person's skill, to form the graft disclosed by Wolter in the recited specific configuration. *Id.*, *See* Ex. 1004.

B. Claims 6-8

As set out above, claim 4 would have been obvious to one of ordinary skill in the art in January 1999 and earlier over Wolter in view of the disclosures of Grooms that a composite spinal implant may be assembled pieces of bone through which a through hole is formed, in which through hole a cortical bone pin may be provided to secure the bone pieces to form a unitary implant, and the disclosure by

Grooms that teeth may be formed in the surface of the implant. Claims 6 and 7 depend from claim 4 and claim 8 depends from claim 7.

As set out in §VIII.B, the teeth disclosed by Grooms are within the scope of claims 6, 7, and 8 of the 532 patent. Because it would have been obvious to one of ordinary skill in the art in January 1999 and earlier to form the teeth disclosed by Grooms on the surface of a graft disclosed by Wolter, one of ordinary skill in the art in January 1999 and earlier would have found it obvious to form the graft of claims 6, 7, and 8. *See* Ex. 1015, ¶¶303-305.

C. Claims 9-10

Claim 9 recites that the pin(s) in the graft comprises one or more biocompatible materials selected from the group consisting of cortical bone, stainless steel, titanium, cobalt-chromium-molybdenum alloy, and plastic. Claim 10 recites that the pin(s) is/are plastic selected from the group consisting of nylon, polycarbonate, polypropylene, polyacetal, polyethylene, polysulfone, bioabsorbable polymer, and a combination thereof.

Grooms teaches that the pins may be made of cortical bone, resorbable but strong biocompatible synthetic material, or metal. Ex. 1003, ¶48; Ex. 1004, 17:10-12. It therefore would have been obvious to a person of ordinary skill in the art to have used pins made of cortical bone or bioabsorbable polymer (both of which would have the well-known advantage of eliminating a foreign object from being permanently present in the patient's spine) as a replacement for the metal screws of Wolter. *See* Ex. 1015, ¶¶300, 306-310.

D. Claim 11

Claim 11 recites that the graft of claim 4 is a polyhedron. As described in §XIV.A, (*Element 6*), a person of ordinary skill in the art would either have understood the Wolter graft to be shaped like a parallel or square block, both of which are polyhedrons, or would have at least found it obvious to have provided the Wolter graft with such a shape to accommodate the host's physiology. *See* Ex. 1015, ¶313.

XV. Ground 9: Claims 4, 6-9, and 11 are obvious over Wolter in view of Paul and Coates

A. Claim 4

As shown by §XIV.A, Wolter discloses most of the six elements of claim 4 (*see also* §V.A). The graft disclosed by Wolter differs from claim 4 in two ways: the Wolter graft is held together by a metal screw rather than a bone pin; and the Wolter graft does not expressly disclose continuous linear protrusions.

The Wolter graft (from 1987) is an autograft bone implant, meaning that the bone material used in the graft is harvested from the patient and the graft is prepared during the spinal surgery. By the late 1990s, however, it was well accepted that the preparation of spinal implants from allograft bone, *i.e.,* bone harvested from donations, was preferred to the use of autograft bone. *See* Ex.

1015, ¶318. It would therefore have been obvious to a person of ordinary skill in the art to have prepared the graft disclosed (and shown to be effective) by Wolter from allograft bone. *See id.*, ¶318. A person would have found it obvious to do so using techniques which were common to the preparation of implants from allograft bone (*e.g.,* where more advanced machining was typically used). *See Id.*, ¶315.

It would have been obvious to one of ordinary skill in the art in January 1999 and earlier to replace the screw that holds the Wolter graft together with a pin made from bone, as taught, for example, by Paul. Ex. 1015, ¶¶319-320. It would also have been obvious to one of ordinary skill in the art in January 1999 and earlier to provide the upper and lower surfaces of the Wolter graft with continuous linear protrusions, such as those taught by Coates, in order to better prevent post-operative migration and/or expulsion of the graft. *Id.*, ¶¶312-324. As set out below, the graft resulting from these known modifications satisfies every element of claim 4.

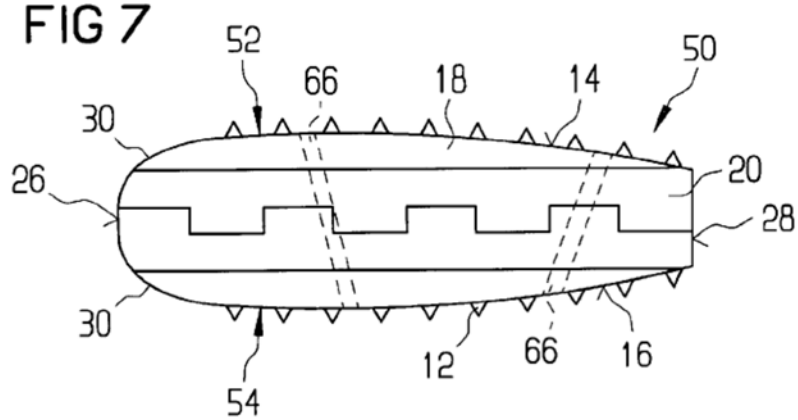
Element 1 (spinal bone graft), Element 2 (cortical-cancellous-cortical composite), Element 3 (contact with host bone), and Element 6 (shape of graft)

As shown by §XIV.A, Wolter discloses elements 1, 2, 3, and 6 of claim 4 (*see also* §V.A).

Element 4 (bone pins)

Wolter discloses using one or more metal screws to connect portions of the graft. Paul, on the other hand, discloses passing pins made of bone (understood to be cortical bone) into aligned through-holes in assembled bone portions to secure the assembled portions together. Ex. 1006, 2:30-38, 4:58-63; Ex. 1007, 3:7-14, 6:27-32*; see also* Ex. 1015, ¶102. An example of such a graft is shown in Figure 7 of Paul, reproduced below (showing holes for pins via dotted line).

FIG 7



It would have been obvious to a person of ordinary skill in the art to have replaced the metal screws of Wolter with the cortical bone pins of Paul. *See* Ex. 1015, ¶¶319, 321. Such a person would have been motivated to replace the metal screws used by Wolter with cortical bone pins as disclosed by Paul, in order to eliminate a foreign object from being permanently present in the patient's spine. *Id.*, ¶320. Moreover, one of ordinary skill in the art would have had a reasonable expectation of successfully making such a substitution because Paul discloses that cortical bone pins are effective to secure portions of a load-bearing spinal bone graft together. *Id.*, ¶319.

The graft of Wolter, modified as disclosed by Paul to accept a cortical bone pin in place of a metal screw disclosed by Wolter, would comprise one or more through-holes configured to accommodate one or more pins and one or more cortical bone pins connecting portions of the graft. *Id.*, ¶¶319-321.

Element 5 (textured surfaces)

Wolter does not disclose a graft having a textured surface comprising a plurality of closely spaced continuous protrusions in a linear arrangement. It was well known in the art at the relevant time, however, to provide a spinal graft of the sort taught by Wolter with texturing on its vertebral-engaging surfaces to retain the graft within the spine. *See* Ex. 1015, ¶322.

Coates, for instance, discloses a graft having upper and lower vertebral engaging surfaces, each of which contains a series of alternating grooves and continuous linear protrusions. Ex. 1008, Abstract, Figures 15-18.

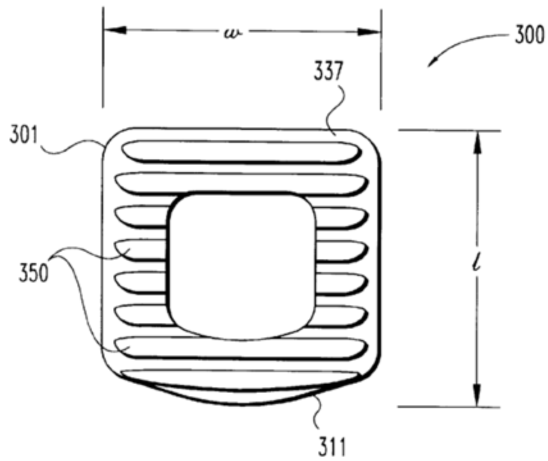


Fig. 15

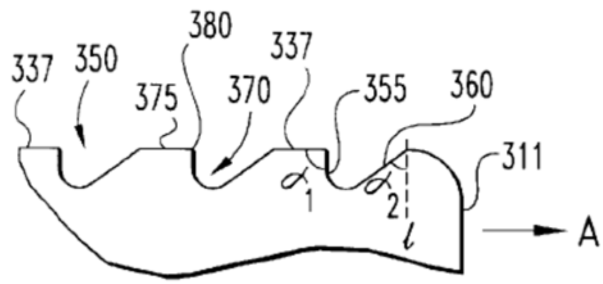


Fig. 18

According to Coates, the grooves and protrusions prevent anterior migration of the graft. *Id.*, 3:46-67. Specifically, if a force urges the graft in the anterior direction, the edges of the protrusions will dig into the adjacent vertebrae and prevent movement. *Id.*, 11:18-22.

It would have been obvious to a person of ordinary skill in the art to have prepared the upper and lower vertebral-engaging surfaces of the Wolter graft to include a plurality of closely spaced continuous protrusions in a linear arrangement, as taught by Coates. *See* Ex. 1015, ¶323. Such a person would have been motivated to do so in order to reduce the chances of graft migration and/or expulsion of the graft. *Id.*, ¶322.

Moreover, such a person would have had a reasonable expectation of successfully forming the continuous protrusions on the surfaces of the Wolter graft because the provision of such texturing to the surfaces of bone grafts was well understood. *Id*. For instance, Coates teaches that the series of alternating grooves and continuous linear protrusions can be made using conventional machining methods using a standard milling machine adapted to shape bone. Ex. 1008, 11:52-55.

B. Claim 6

Claim 6 recites that the continuous protrusions comprise a cross-section having one or more irregular, triangular, square, rectangular, and curved shapes. As set out in §XI.B, Coates discloses continuous protrusions having an irregular cross-section and a triangular cross section. It would have been obvious to one of ordinary skill in the art in January 1999 and earlier to provide those protrusions disclosed by Coates on the vertebral-engaging surfaces of the Wolter graft as set out above in §XV.A with respect to claim 4.

C. Claims 7-8

Claim 7 recites that the continuous protrusions in the graft are sized to be in a range of: (1) greater than or equal to 1.5 mm in length, (2) 0.5 to about 10.0 mm in width, and (3) 0.1 to about 5.0 mm in depth. Claim 8 recites that the protrusions of claim 7 are spaced from about 0.0 to about 3.0 mm apart.

Coates does not disclose the specific dimensions of the protrusions or the spacing between adjacent protrusions. As set out above in §XI.C, however, it would have been obvious to have provided the protrusions with dimensions that fall within the very broad ranges recited in claim 7 and to have spaced the protrusions between 0.0 and 3.0 mm apart, as recited in claim 8, as doing so would have been nothing more than routine optimization. *See* Ex. 1015, ¶¶252-258. It would have been obvious to one of ordinary skill in the art in January 1999 and earlier to provide those protrusions disclosed by Coates on the vertebral-engaging surfaces of the Wolter graft as set out in §XV.A concerning claim 4.

D. Claim 9

Claim 9 recites that the one or more pins are formed of one or more biocompatible materials selected from the group consisting of cortical bone, stainless steel, titanium, cobalt-chromium-molybdenum alloy, and plastic. Paul teaches that the pins used in the Paul graft may be made of any biocompatible material, and preferably allogenic bone (understood by one of ordinary skill to be cortical bone). Ex. 1006, 4:58-63; Ex. 1007, 6:27-32; *see also* Ex. 1015, ¶¶102, 104.

E. Claim 11

Claim 11 recites that the graft of claim 4 is a polyhedron. As described in §XV.A (*Element 6*), a person of ordinary skill either would have understood from Wolter that the graft is shaped like a parallel or square block, both of which are polyhedrons, or would have found it obvious to provide the Wolter graft with such a shape. *See* Ex. 1015, ¶337.

XVI. Conclusion

Petitioner has established a reasonable likelihood of prevailing as to each of claims 4 and 6-21 of the 532 patent, and therefore respectfully requests that the Board institute *inter partes* review of those claims.

Respectfully submitted,

McANDREWS, HELD & MALLOY, LTD.

Dated: February 19, 2019 By: /Herbert D. Hart III/
Herbert D. Hart III
Reg. No. 30,063
Lead Counsel for Petitioner
RTI Surgical, Inc.

CERTIFICATE OF WORD COUNT

I certify, under 37 CFR § 42.24, that this **PETITION FOR INTER PARTES REVIEW** contains fewer than 13,922 words, as determined by Microsoft Word.

Dated: February 19, 2019

By: /Herbert D. Hart III/
Herbert D. Hart III *for Petitioner RTI Surgical, Inc.*

CERTIFICATE OF SERVICE

Under 37 C.F.R. §§ 42.6(e)(4) and 42.105, the undersigned certifies on this date, a true and correct copy of this Petition for *Inter Partes* Review and all supporting exhibits were served by Federal Express to the Patent Owner at the following correspondence address of record for U.S. Patent No. 8,182,532:

Morgan, Lewis & Bockius LLP
1111 Pennsylvania Avenue, N.W.
Washington, D.C. 20004

and via email to the below:

Crowell & Moring, LLP
11th Floor
1001 Pennsylvania Ave NW
Washington, DC 20004−2595
LifeNet-RTI@crowell.com

RatnerPrestia
Suite 1200
1090 Vermont Avenue, N.W.
Washington, DC 20005
LNHvRTI@ratnerprestia.com

Dated: February 19, 2019

By: /Herbert D. Hart III/
Herbert D. Hart III
Reg. No. 30,063
Lead Counsel for Petitioner
RTI Surgical, Inc.