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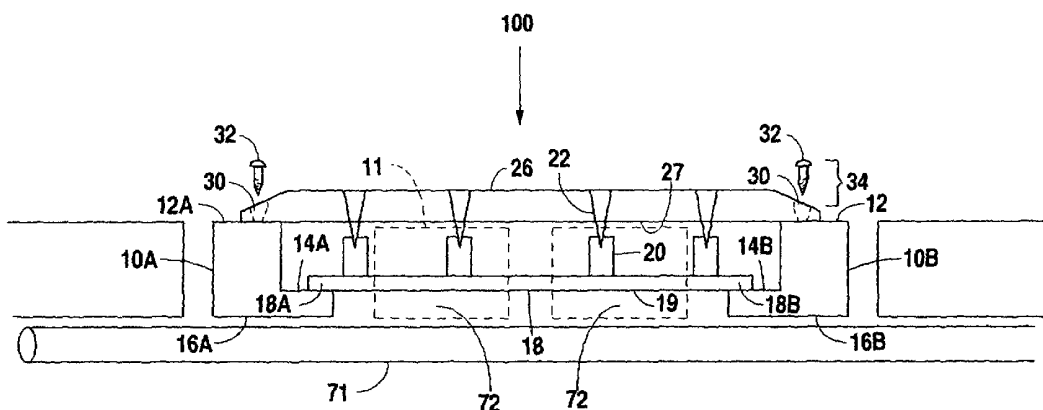
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(54) Title: PLATE SYSTEM FOR BRIDGING AND STABILIZING SPACED APART BONE SEGMENTS



(57) Abstract: A medical appliance (10) adapted to bridge and stabilize spaced apart bone segments (10A, 10B) having outside (12A, 12B), ledge (14A, 14B) and inside surfaces (16A, 16B). The appliance (10) has an elongate bottom plate (18), an elongate top plate (26), and a locking member (34). The bottom plate (18) is attachable to the ledge surfaces (14A, 14B) of the bone and has a bottom base plate (19), a plurality of screw barrels (20) extending from the bottom base plate (19) in a first direction for receiving barrel screws (20), and a plurality of openings (24) in the base plate (19) for rotatably retaining the screw barrels (20). The elongate top plate (26) has a top plate base (27), a plurality of slots (28) aligned to allow the barrel screws (20) to engage the top plate (26) of the bottom plate (18). The locking member (34) is disposed in a countersink (30) to engage the bone screws (32) such that axial and rotational movement of the bone screws (32) may be restricted. The screw barrels (20) are equipped with angle first end and riveted second end to restrain screw movement but allow the screws (32) to engage the barrels at various angles. A locking member (34) includes a locking ring (36) having a plurality of tapered ratchet teeth (38) on an interior surface.

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Title: PLATE SYSTEM FOR BRIDGING AND
STABILIZING SPACED APART BONE SEGMENTS

BACKGROUND OF THE INVENTION

1
2 The present invention relates to a medical appliance and more particularly to a
3 medical appliance and method for bridging and stabilizing spaced apart bone segments.

4 While the present invention is intended for use with vertebrae, it should be
5 understood that any spaced apart bone segment may utilize the present invention. The spine
6 is a flexible structure comprised of thirty-three vertebrae. The vertebrae are separated and
7 cushioned from each other by fibrous cartilage in structures called intervertebral disks. If the
8 spine is injured or becomes diseased, surgical intervention involving removal of one or more
9 of these disks and fusion of the adjacent vertebrae, may be indicated. Such disk injuries can
10 happen in the neck, in the thoracic region and in the lumbar region. The more frequent
11 injuries are in the lower lumbar and in the lower cervical regions.

12 Treatment of a herniated disk in the neck and in the lumbar region continues to be a
13 challenging field of medicine. The classical treatment for a ruptured disk continues to be
14 removal of the disk from between the vertebrae. By this process of removing the disk,
15 overall spinal instability is increased. This may aggravate the patient to some degree after
16 the operation. Another procedure previously employed is to replace the disk space with a
17 bone graft, bringing about fusion of the vertebrae above and below the disk, eliminating the
18 empty space between the vertebrae and improving stability.

19 Theoretically a discectomy with fusion is a satisfactory procedure, though not ideal
20 because the replaced bone does not have the principal functions of the cartilage tissue of the

1 disk. This fusion procedure is technically demanding and has medical complications because
2 of several physiological factors.

3 It must be remembered that the disk primarily serves as a mechanical cushion while
4 permitting limited mobility. For any replacement system for a disk to be truly effective, it
5 must allow for mobility within the natural limits of the original disk. In other words, the
6 replacement should match appropriate joint rheology (movement behavior). The natural disk
7 allows about 11 degrees of flexion-extension, limited lateral bending of 3 to 5 degrees, and
8 very restricted rotation of about 1 degree.

9 Various prosthetic devices and implants are disclosed in the art, but all are
10 characterized by compromises to the full functions of a natural disk discussed above.
11 Examples of the prior art include the following U.S. Patent Nos.: 5,893,890; 5,693,100;
12 5,658,336; 5,653,761; 5,653,762; 5,390,683; 5,171,278; and 5,123,926. The specification
13 and drawings of U.S. Patent Application No 09/627261 is herein incorporated by reference.
14 The present invention provides stabilization of spaced apart bone segments while still
15 allowing some flexion and rearward extension of the bones with some lateral displacement.
16 The present invention is particularly useful to stabilize adjacent vertebrae in the human spine.

18 SUMMARY OF THE INVENTION

19 Accordingly, the present invention provides a medical appliance and method for
20 bridging and stabilizing spaced apart bone segments. The present invention uses a rigid,
21 elongate bottom plate to span space between bone segments and to attach to a ledge surface

1 of each bone such that a plurality of screw barrels rotatably engaging a plurality of openings
2 in the bottom plate base may receive a plurality of barrel screws to couple the bottom plate
3 to a rigid, elongate top plate. The top plate is attachable to an outside surface of each bone
4 segment and has a top plate base having a plurality of slots for rotatably receiving screw
5 barrels. The slots are aligned to allow barrel screws to engage the screw barrels such that the
6 top and bottom plate may be coupled together.

7 The top plate is also equipped with a plurality of countersinks. The countersinks
8 receive bone screws such that the top plate may be attached to the outside surface of each
9 bone segment. The present invention also has a locking member disposed in the countersink
10 or attached to the bone screw for securing the bone screws to the medical appliance such that
11 axial and rotational movement of the bone screws is restricted.

12 The screw barrels of the present invention may be equipped with an angled first end
13 and a riveted second end such that movement of the screw barrels may be restricted in a first
14 and second direction while still allowing the screw barrels to rotate within the openings to
15 allow the barrel screws to engage the screw barrels at various angles. A locking ring having
16 a plurality of tapered ratchet teeth on an interior surface may be used to secure the bone
17 screws to the medical appliance. The teeth engage a serrated neck of each bone screw upon
18 insertion of each bone screw into a countersink, thus securing the bone screws.

19 The configuration of each locking ring and each countersink may vary depending on
20 the application of the medical appliance. They may have a substantially circular
21 configuration or a non-circular configuration that allow them to work in concert to provide

1 varying degrees of axial and rotational movement for the bone screws. In one embodiment
2 of the present invention, the locking ring may be attached to the bone screw to provide a pre-
3 assembled locking member.

4 Another embodiment of the present invention provides a pre-assembled locking
5 member having an arcuate lower surface such that the bone screw is capable of flexion. Still
6 another embodiment of the present invention provides for a locking member comprising a
7 bone screw having a grooved collar engageable with a threaded inner surface of the
8 countersink.

9 BRIEF DESCRIPTION OF THE DRAWINGS

10 Fig. 1 is a side elevation view of a portion of the human spinal column having a preferred
11 embodiment of the medical appliance of the present invention inserted therein.

12 Fig. 2 is an exploded perspective view of a portion of the human spinal column having a
13 preferred embodiment of the medical appliance of the present invention prior to attachment.

14 Fig. 2A is a side elevation view of a portion of the bottom plate of the present invention
15 illustrating a screw barrel having an angled first end and a riveted second end.

16 Fig. 3 is a side elevation view of an embodiment of the locking member of the present
17 invention using a substantially circular locking ring attached to a substantially circular
18 countersink.

19 Fig. 3A is a perspective view of the locking ring of Fig. 3 illustrating the ratchet teeth upon
20 an interior surface of the locking ring.

1 Fig. 4 is a side elevation view of an embodiment of the locking member of the present
2 invention using a non-circular locking ring and a non-circular countersink.

3 Fig. 4A is a perspective view of the locking ring of Fig. 4 illustrating the ratchet teeth upon
4 an interior surface of the locking ring.

5 Fig. 4B is a top plan view of a portion of a locking ring illustrating the tapered ratchet teeth.

6 Fig 5 is a side elevation view of an embodiment of the locking member of the present
7 invention using a non-circular locking ring preassembled to the bone screw.

8 Fig. 6 is a side elevation view of an embodiment of the locking member of the present
9 invention using a locking ring having an arcuate lower surface preassembled to the bone
10 screw.

11 Fig. 7 is a side elevation view of an embodiment of the locking member of the present
12 invention using a bone screw having a grooved collar for engaging a threaded inner surface
13 of the countersink.

14 15 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

16 The present invention is herein described as a medical appliance (100) adapted to
17 bridge and stabilize spaced apart bone segments (10A and 10B, respectively), as a locking
18 system for attaching a medical appliance to bone, and as a method for affixing a medical
19 appliance (100) to bridge and stabilize spaced apart bone. Referring to the Figures, the
20 spaced apart bone segments (10A and 10B, respectively) have outside surfaces (12A and
21 12B, respectively), ledge surfaces (14A and 14B, respectively), and inside surfaces (16A and

1 16B, respectively). Each ledge surface is a prepared surface used for the attachment of the
2 bottom plate (18) to the bone segments (10A and 10B, respectively) as described below.

3 One embodiment of the present invention is shown implanted into the human spinal
4 column in Fig. 1. The medical appliance of the present invention, indicated generally as
5 reference numeral (100), is implanted into space between bone segments (10A and 10B,
6 respectively) from which a portion of the vertebral body along with the intervertebral disk
7 (11) has been removed, i.e. by diskectomy with corpectomy. The medical appliance has a
8 bottom plate (18), a top plate (26), and a locking member (34).

9 Referring to Figs 1 and 2, the bottom plate (18) of the present invention is a rigid,
10 elongate plate for spanning space (72) between bone segments (10A and 10B, respectively)
11 and is attachable to the ledge surfaces (14A and 14B, respectively) of the bone segments.
12 The bottom plate (18) has a bottom plate base (19) having a plurality of openings (24) for
13 rotatably retaining a plurality of screw barrels (20). The screw barrels are substantially
14 cylindrical in shape and extend from the bottom plate base (19) in a first direction. In one
15 embodiment of the present invention, this first direction is away from the spinal cord (70)
16 of the patient (not shown) such that the screw barrels may receive a barrel screw (22), as
17 described below.

18 The medical appliance (100) of the present invention has a rigid, elongate top plate
19 (26) having a top plate base (27). The top plate base has a plurality of slots (28) for receiving
20 a plurality of barrel screws (22). The slots (28) are positioned and aligned upon the top plate
21 base (27) such that barrel screws may be placed through the slots of the top plate (26) so they

1 may extend in a second direction. In one embodiment of the present invention, this second
2 direction is in the direction of the spinal cord (70), as shown in Fig.1. This allows each
3 barrel screw to engage a threaded inner surface (20I) of each screw barrel (20) such that the
4 top plate (26) and the bottom plate (18) may be fastened together. This allows the top and
5 bottom plate to act in concert to bridge and stabilize the spaced apart bone segments (10A
6 and 10B, respectively).

7 Referring to Figs 1, 2 and 2A, the screw barrel (20) may have an angled first end
8 (20A) and a riveted second end (20B) in one embodiment of the present invention. The
9 angled first end prevents disengagement of the screw barrel (20) from the opening (24) in the
10 bottom base plate (19) by restricting movement of the screw barrel in a second direction
11 toward the spinal cord (70).

12 Alternatively, the riveted second end (20B) of the screw barrel (20) prevents the
13 disengagement of the screw barrel from the opening (24) by restricting movement in a first
14 direction away from the spinal cord (70). The angled first end (20A) of the screw barrels
15 also allows barrel screws (22) that are placed through the slots (28) of the top plate (26) to
16 engage the screw barrels (20) of the bottom plate (18) at various angles. This allows the
17 attachment of the medical appliance (100) to the bone segments (10A and 10B, respectively)
18 to be stable and flexible.

19 The top plate (26) has a plurality of countersinks (30) for receiving bone screws (32)
20 such that the top plate may be attached to the outside surfaces (12A and 12B, respectively)
21 of each bone segment (10A and 10B, respectively). In one embodiment, the countersinks

1 (30) are configured to receive bone screws (32) such that a bone screw inserted into a
2 countersink may engage the outside surface (16) of the bone segment (10A and 10B,
3 respectively), thus attaching the top plate (26) to the bone segment. The first and second ends
4 (26A and 26B, respectively) are tapered such no sharp edges may contact the body of the
5 patient (not shown).

6 The top (26) and bottom plates (18) of the present invention may be composed of any
7 strong, thin, non-porous material such as carbon fiber, modified carbon, titanium, surgically
8 compatible steel, physiologically inert and/or medically compatible polymers such as
9 urethane or DELRIN® polymers, or any other substantially rigid surgical implant or
10 biologically compatible material. On one embodiment, the top plate (26) is longer than the
11 bottom plate (18) such that the top plate attaches to the outside surfaces (12A and 12B,
12 respectively) of the bone segments and the bottom plate attaches to the ledge surface (14) of
13 the bone segments (10A and 10B, respectively). The present invention allows both the top
14 plate (26) and the bottom plate (18) to attach to each other and to the bone segments (10A
15 and 10B), respectively), thus providing additional stability to the medical appliance (100).

16 If intervertebral fusion is desired, cancellous bone chips (not shown) may be formed
17 into very fine particles such that they may be inserted and packed tightly into the space (72)
18 between the bone segments (10A and 10B, respectively). The cancellous bone chips may
19 then work in concert with the top (26) and bottom plate (18) of the medical appliance (100)
20 to provide stability to the bone segments (10A and 10B, respectively). The present invention
21 may also be used in concert with an artificial disk (not shown). This artificial disk may be

1 used to fill the space between the bone segments (10A and 10B, respectively) and may be
2 composed of any number of compressible physiologically inert and/or medically compatible
3 polymers. For example, the disk may be composed of urethane or DELRIN® polymer for
4 the purpose of providing shock absorption between the top plate (26) and the bottom plate
5 (18).

6 Referring to Figs 3, 3A, 4 and 4A, in one embodiment of the present invention, the
7 medical appliance (100) of the present invention has a locking member (34) disposed in each
8 countersink (30). Each locking member engages each bone screw (32) to the medical
9 appliance (100) such that axial and rotational movement of each bone screw is restricted.

10 In one embodiment of the present invention, the locking member (34) is a locking ring (36)
11 having a plurality of tapered, ratchet teeth (38). The ratchet teeth are located on an interior
12 surface (40) of the locking ring (36) such that when the locking ring is attached to a
13 countersink (30) of the top plate (26), the teeth are engageable with a serrated neck (33) of
14 the bone screw (32) when the bone screw (32) is inserted through the countersink (30). The
15 interplay between the teeth (38) and the serrated neck (33) allows the bone screw (32) to be
16 placed into the countersink and ratched into the bone segment (10A and 10B, respectively).

17 The bone screw is held in place by the teeth (38) once ratched into the bone segment. The
18 taper of the teeth (38) of the locking ring (36) may be adjusted to vary the amount of torque
19 required to remove the bone screw from the locking member (34).

20 Referring to Fig. 4B, each of the ratchet teeth (38) has a leading edge (80A) and a
21 trailing edge (80B). The taper of the leading edge (80A) controls the amount of torque

1 required to ratchet the bone screw (32) into the locking ring (36). For example, assuming the
2 insertion of the screw into the locking ring (36) is accomplished by clockwise rotation (94),
3 a leading edge taper angle (86) of about 90° with respect to the interior surface (40) of the
4 locking ring (36) will not allow the bone screw (32) to ratchet into the locking ring (36), as
5 illustrated in Fig 4B. A taper of about 90° will cause the serrations of the bone screw to
6 perpendicularly contact the ratchet teeth and block its clockwise rotation (94). However, an
7 increase in the angle (86) of the leading edge (80A) with respect to the interior surface (40)
8 to greater than 90° will allow the serrated neck (33) of the bone screw to ratchet (32) within
9 the locking ring (36), thus allowing sufficient clockwise rotation (94) of the bone screw to
10 allow its insertion into the locking ring. The greater the taper of the leading edge (80A)
11 above 90° , the less torque is required to insert the bone screw (32) into the locking ring (36)
12 due to decreased resistance between the ratchet teeth (38) and the serrations (33) of the bone
13 screw (32).

14 Alternatively, the taper of the trailing edge (80B) controls the amount of torque
15 required to ratchet the bone screw (32) out of the locking ring (36). Assuming the removal
16 of the bone screw from the locking ring (36) is accomplished by counter-clockwise rotation
17 (96), a trailing edge taper angle (88) of about 90° with respect to the interior surface (40) of
18 the locking ring (36) will not allow the bone screw to ratchet out of the locking ring (36) in
19 a counter-clockwise direction (96), as illustrated in Fig 4B. A taper of about 90° will cause
20 the serrations (33) on the bone screw (32) to perpendicularly contact the ratchet teeth (38) and
21 block its counter-clockwise rotation (96). However, an increase in the angle (88) of the

1 trailing edge (80B) with respect to the interior surface (40) to greater than 90° will allow the
2 serrated neck (33) of the bone screw (32) to ratchet within the locking ring, thus allowing
3 sufficient counter-clockwise rotation (96) of the bone screw (32) to allow its withdrawal
4 from the locking ring (36). The greater the taper of the trailing edge (80B) above 90° , the
5 less torque is required to remove the bone screw (32) from the locking ring (36) due to
6 decreased resistance between the ratchet teeth (38) and the serrations (33) of the bone screw
7 (32). The taper angles of the leading and trailing edges (86 and 88, respectively) may be
8 manipulated to provide varying degrees of stability for the bone screws (32).

9 Both the locking ring (36) and the countersink (30) may have a substantially circular
10 configuration or a non-circular configuration as illustrated in Figs 3-6. Referring to Figs 4,
11 4A and 5, one embodiment of the present invention uses a non-circular locking ring (36)
12 having a plurality of tapered, ratchet teeth (38) upon an interior surface (40) is used in
13 conjunction with a non-circular countersink (30). The locking ring (36) may be attached
14 directly to the bone screw (32) such that the teeth are engageable with a serrated neck (33)
15 of the bone screw (32) upon insertion of the bone screw (32) through the countersink (30).

16 The locking ring rotates when the bone screw rotates due to the engagement of the
17 teeth of the locking ring and the serrated neck of the bone screw (32). This non-circular
18 configuration allows limited rotational movement of the bone screw without causing the
19 bone screw to disengage from the bone segment (10A and 10B, respectively). The locking
20 ring (36) is sized slightly smaller than the countersink (30) such that the locking ring may
21 rotate along with the bone screw until it abuts side wall (90) of the countersink. Referring

1 to Fig. 6, another embodiment of the present invention uses a locking ring having an arcuate
2 lower surface (52) that allows limited flexion of the bone segment (10A and 10B,
3 respectively) about the appliance once the bone screw (32) has been inserted through the
4 countersink (30).

5 Referring to Fig. 7, another embodiment of the present invention uses a bone screw
6 (32) having a grooved collar (42) for engaging a threaded inner surface (44) of the
7 countersink (30) as a locking member (34). Engagement of the threaded inner surface and
8 the collar allows for attachment of the bone screw to the countersink (30) of the medical
9 appliance (100) but also provides for limited movement of the bone segment (10A, 10B) in
10 relation to the appliance (100). An hour glass shaped orifice (60) located between the collar
11 and the bone screw (32) allows limited bone segment (10A, 10B) movement while the
12 engagement of the collar (42) and the threaded surface (44) allows rotational movement even
13 though the collar remains engaged with the threaded surface of the countersink (30). The
14 number of threads present upon the threaded inner surface (44) may be varied to provide for
15 additional stability or range of motion. To illustrate, an increase in the number of threads
16 contained by the threaded inner surface (44) will increase the stability of the locking member
17 by allowing only limited rotation. Alternatively, a decrease in the number of threads will
18 increase the range of rotation available to the collar (42) within the threaded inner surface
19 allowing rotation of the collar (42) within the threaded inner surface (44).

20 Referring to the Figures, the present invention may also be described as a locking
21 system used to attach a medical appliance (100) to bone. The locking system of the present

1 invention has a plurality of countersinks (30) located within the base of the appliance (110).
2 Each countersink (30) has an opening (46) for receiving a bone screw (32). The bone screw
3 having a first threaded end (48), an opposite second end (50), and a serrated neck (33). The
4 locking system also has a locking member (34) for engaging the bone screw (32) to the
5 medical appliance (100) at its serrated neck (33) such that axial and rotational movement of
6 the bone screw is restricted.

7 The bone screw (32) of the locking system may have a substantially spherical head
8 end (50) or any other configuration that allows the screw to be secured to the countersink
9 (30) of the medical appliance (100). Referring to Figures 3, 3A, 4, and 4A, in one
10 embodiment of the present invention, the locking system of the present invention has a
11 locking member (34) disposed in each countersink (30). Each locking member engages each
12 bone screw (32) to the medical appliance (100) such that axial and rotational movement of
13 each bone screw is restricted.

14 In one embodiment of the present invention, the locking member (34) of the locking
15 system is a locking ring (36) having a plurality of tapered, ratchet teeth (38) working in
16 conjunction with a serrated neck (33) of a bone screw (32). The ratchet teeth are located on
17 an interior surface (40) of the locking ring (36) such that when the locking ring is attached
18 to a countersink (30) of the top plate (26), the teeth are engageable with a serrated neck (33)
19 of the bone screw (32) when the bone screw (32) is inserted through the countersink (30).
20 The interplay between the teeth (38) and the serrated neck (33) allows the bone screw (32)
21 to be placed into the countersink and ratcheted into the bone segment (10A and 10B,

1 respectively). The bone screw is held in place by the ratchet teeth (38) once ratched into the
2 bone segment. The taper of the teeth (38) of the locking member (34) may be adjusted to
3 vary the amount of torque required to remove the bone screw from the locking member (34).

4 Referring to Fig. 4B, each of the ratchet teeth (38) has a leading edge (80A) and a
5 trailing edge (80B). The taper of the leading edge (80A) controls the amount of torque
6 required to ratchet the bone screw (32) into the locking ring (36). For example, assuming the
7 insertion of the screw into the locking ring (36) is accomplished by clockwise rotation (94),
8 a leading edge taper angle (86) of about 90° with respect to the interior surface (40) of the
9 locking ring (36) will not allow the bone screw (32) to ratchet into the locking ring (36), as
10 illustrated in Fig 4B. A taper of about 90° will cause the serrations of the bone screw to
11 perpendicularly contact the ratchet teeth and block its clockwise rotation (94). However, an
12 increase in the angle (86) of the leading edge (80A) with respect to the interior surface (40)
13 to greater than 90° will allow the serrated neck (33) of the bone screw to ratchet (32) within
14 the locking ring (36), thus allowing sufficient clockwise rotation (94) of the bone screw to
15 allow its insertion into the locking ring. The greater the taper of the leading edge (80A)
16 above 90° , the less torque is required to insert the bone screw (32) into the locking ring (36)
17 due to decreased resistance between the ratchet teeth (38) and the serrations (33) of the bone
18 screw (32).

19 Alternatively, the taper of the trailing edge (80B) controls the amount of torque
20 required to ratchet the bone screw (32) out of the locking ring (36). Assuming the removal
21 of the bone screw from the locking ring (36) is accomplished by counter-clockwise rotation

1 (96), a trailing edge taper angle (88) of about 90° with respect to the interior surface (40) of
2 the locking ring (36) will not allow the bone screw to ratchet out of the locking ring (36) in
3 a counter-clockwise direction (96), as illustrated in Fig 4B. A taper of about 90° will cause
4 the serrations (33) on the bone screw (32) to perpendicularly contact the ratchet teeth (38) and
5 block its counter-clockwise rotation (96). However, an increase in the angle (88) of the
6 trailing edge (80B) with respect to the interior surface (40) to greater than 90° will allow the
7 serrated neck (33) of the bone screw (32) to ratchet within the locking ring, thus allowing
8 sufficient counter-clockwise rotation (96) of the bone screw (32) to allow its withdrawal
9 from the locking ring (36). The greater the taper of the trailing edge (80B) above 90° , the
10 less torque is required to remove the bone screw (32) from the locking ring (36) due to
11 decreased resistance between the ratchet teeth (38) and the serrations (33) of the bone screw
12 (32). The taper angles of the leading and trailing edges (86 and 88, respectively) may be
13 manipulated to provide varying degrees of stability for the bone screws (32).

14 Both the locking ring (36) and the countersink (30) of the locking system may have
15 a substantially circular configuration or a non-circular configuration as illustrated in Figs 3-6.
16 In one embodiment of the present invention, a non-circular locking ring (36) having a
17 plurality of tapered, ratchet teeth (38) upon an interior surface (40) is used in conjunction with
18 a non-circular countersink (30). The locking ring (36) is attached to the bone screw (32)
19 such that the teeth are engageable with a serrated neck (33) of the bone screw (32) upon
20 insertion of the bone screw (32) through the countersink (30). The locking ring rotates when
21 the bone screw rotates due to the engagement of the ratchet teeth of the locking ring and the

1 serrated neck of the bone screw (32). This non circular configuration allows limited
2 rotational movement of the bone screw without causing the bone screw to disengage from
3 the bone segment (10A and 10B, respectively). The locking ring (36) is sized slightly
4 smaller than the countersink (30) such that the locking ring may rotate along with the bone
5 screw until it abuts the countersink, thus allowing limited rotation. Referring to Fig. 6,
6 another embodiment of the locking system of the present invention has a locking ring having
7 an arcuate lower surface (52) that allows limited flexion of the bone screw (32) once it has
8 been inserted through the countersink (30).

9 Referring to Figure 7, another embodiment of the locking system of the present
10 invention uses a bone screw (32) having a grooved collar (42) for engaging a threaded inner
11 surface (44) of the countersink (30). Engagement of the threaded inner surface and the collar
12 allows for attachment of the bone screw to the countersink (30) of the medical appliance
13 (100) but also provides for limited movement of the collar (42) with respect to the
14 countersink (30). An orifice (60) located between the collar and the bone screw (32) allows
15 limited axial and flexion movement while the engagement of the collar (42) and the threaded
16 surface (44) allows rotational movement of the screw collar even though the collar remains
17 engaged with the threaded surface of the countersink (30). The number of threads present
18 upon the threaded inner surface (44) may be varied to provide for additional stability or range
19 of motion. To illustrate, an increase in the number of threads contained by the threaded inner
20 surface (44) will increase the stability of the locking member by allowing only limited
21 rotation. Alternatively, a decrease in the number of threads will increase the range of rotation

1 available to the collar (42) within the threaded inner surface allowing rotation of the collar
2 (42) within the threaded inner surface (44).

3 It is understood that each embodiment of the locking system described above may be
4 used in combination with the apparatus described above or to affix any other medical
5 appliance (100) to bone. The locking system described above may also be used to secure
6 both the top plate (26) to the outside surfaces (12A and 12B, respectively) of the bone
7 segments (10A and 10B, respectively) and the bottom plate (18) to the ledge surfaces (14A
8 and 14B, respectively) of the bone segments.

9 The medical appliance (100) may be affixed to spaced apart bone segments (10A and
10 10B, respectively) by following a few simple steps. First, a first and second ledge surface
11 (14A and 14B, respectively) is prepared on the spaced apart bones (10A and 10B,
12 respectively). This may be accomplished by using any acceptable medical technique. A first
13 and second end (18A and 18B, respectively) of the bottom plate (18) are then attached to the
14 first and second ledge surfaces (14A and 14B, respectively) of the spaced apart bone
15 segments (10A and 10B, respectively). A first end (26A) of the top plate (26) is attached to
16 a first bone segment (10A) upon its outside surface (12A) and the second end (26B) of the
17 top plate (26) is attached to a second bone segment (10B) at its outside surface (12B) using
18 bone screws (32).

19 The screw barrels (20) of the bottom plate (18) are then aligned with the slots (28)
20 of the top plate (26). The top plate may then be attached to the bottom plate (18) such that
21 the barrel screws (22) extend through the slots (28) and engage the threaded inner surface

1 (20I) of the screw barrels (20). The bone screws (32) are then locked to the medical
2 appliance such that the teeth (38) of the locking ring (36) engage the serrated neck (33) of
3 the bone screws (32).

4 The bone screws may be locked to the bone segments (10A and 10B, respectively)
5 using several different locking members (34). A locking member (34) having a locking ring
6 (36) attached to the bone screw (32) may be used to lock the bone screws to the appliance
7 (100) such that ratchet teeth (38) of the locking ring (36) engage a serrated neck (33) of each
8 bone screw (32). A locking ring (36) with an arcuate lower surface that is pre-attached to the
9 bone screw (32) may be used to lock the bone screws to the appliance (100) such that the
10 ratchet teeth (38) of the locking ring (36) engage a serrated neck (33) of the bone screws (32).
11 A locking member (34) having a grooved collar (42) may be used to lock the bone screws
12 (32) to the countersink (30) such that the collar engages a threaded inner surface (34) of the
13 countersink.

14 Although the invention has been described with reference to specific embodiments,
15 this description is not meant to be construed in a limited sense. Various modifications of the
16 disclosed embodiments, as well as alternative embodiments of the inventions will become
17 apparent to persons skilled in the art upon the reference to the description of the invention.
18 It is, therefore, contemplated that the appended claims will cover such modifications that fall
19 within the scope of the invention.
20

PATENT CLAIMS

I Claim:

1. A medical appliance adapted to bridge and stabilize spaced apart bone segments, said bone segments having an outside surface, a ledge surface, and an inside surface, said appliance comprising;
- a rigid, elongate bottom plate for spanning space between said bone segments, said bottom plate attachable to said ledge surface of said bone, said bottom plate further comprising;
 - a bottom plate base;
 - a plurality of screw barrels for receiving a plurality of barrel screws, said screw barrels extending from said bottom plate base in a first direction;
 - a plurality of openings in said bottom base plate for rotatably retaining said screw barrels;
 - a rigid, elongate top plate further comprising;
 - a top plate base;
 - a plurality of slots in said top plate base for receiving said plurality of barrel screws, said slots aligned to allow said barrel screws to engage said screw barrels of said bottom plate;
 - a plurality of countersinks for receiving bone screws; and a locking member disposed in said countersink for engaging said bone screws to said

1 medical appliance such that axial and rotational movement of said
2 bone screws is restricted.

3 2. The appliance of claim 1, wherein said top plate is longer than said bottom plate.

4 3. The appliance of claim 1, wherein said screw barrel further comprises an angled first
5 end and a second riveted end.

6 4. The appliance of claim 1, wherein said locking member further comprises a locking
7 ring having a plurality of tapered ratchet teeth on an interior surface, said locking ring
8 attached to said top plate countersink, said teeth engagable with a serrated neck of said bone
9 screw upon insertion through said countersink.

10 5. The appliance of claim 4, wherein said taper of said teeth may be adjusted to vary the
11 amount of torque required to remove said bone screw from said locking member.

12 6. The appliance of claim 4, wherein said locking ring has a substantially circular
13 configuration.

14 7. The appliance of claim 4, wherein said countersink has a substantially circular
15 configuration.

16 8. The appliance of claim 1, wherein said locking member further comprises a non-
17 circular locking ring having a plurality of tapered ratchet teeth upon an interior surface, said
18 locking ring attached to said bone screw such that said teeth may engage a serrated neck of
19 said bone screw upon insertion of said bone screw through a non-circular countersink.

20 9. The appliance of claim 8, wherein said locking ring comprises an arcuate lower
21 surface.

1 10. The appliance of claim 1, wherein said locking member comprises a bone screw
2 having a grooved collar for engaging a threaded inner surface of said countersink.

3 11. A locking system for attaching a medical appliance to bone comprising:

4 a countersink in said appliance, said countersink having an opening for
5 receiving a bone screw having a threaded first end, an opposite
6 second head end, and a serrated neck; and

7 a locking member for engaging said bone screw to said medical appliance at
8 said serrated neck such that axial and rotational movement of said
9 bone screw is restricted;

10 12. The locking system of claim 11, wherein said head end is substantially spherical.

11 13. The appliance of claim 11, wherein said locking member further comprises a locking
12 ring having a plurality of tapered ratchet teeth on an interior surface, said locking ring
13 attached to said top plate countersink said teeth engagable with a serrated neck of said bone
14 screw upon insertion through said countersink.

15 14. The appliance of claim 13, wherein said taper of said teeth may be adjusted to vary
16 the amount of torque required to remove said bone screw from said locking member.

17 15. The appliance of claim 13, wherein said locking ring comprises a substantially
18 circular configuration.

19 16. The appliance of claim 13, wherein said countersink comprises a substantially
20 circular configuration.

1 17. The appliance of claim 11, wherein said locking member further comprises a non-
2 circular locking ring having a plurality of tapered ratchet teeth upon an interior surface, said
3 locking ring attached to said bone screw such that said teeth engages a serrated neck of said
4 bone screw upon insertion of said bone screw through a non-circular countersink.

5 18. The appliance of claim 17, wherein said locking ring comprises an arcuate lower
6 surface.

7 19. The appliance of claim 11, wherein said locking member comprises a bone screw
8 having a grooved collar for engaging a threaded inner surface of said countersink.

9 20. A method for affixing a medical appliance to bridge and stabilize spaced apart bone
10 comprising the steps of:

11 preparing a first and second ledge surface on said spaced apart bones;

12 providing a bottom plate comprising;

13 a bottom plate base;

14 a plurality of screw barrels for receiving a plurality of barrel screws, said

15 screw barrels extending from said bottom plate base in a first

16 direction;

17 a plurality of openings in said base plate for rotatably retaining said screw

18 barrels;

19 attaching a first end and a second end of said bottom plate to said first and

20 said second ledge surfaces;

21 providing a top plate comprising;

1 a top plate base;
2 a plurality of slots in said top plate base for receiving said plurality of barrel
3 screws, said slots aligned to allow said barrel screws to engage said
4 screw barrels of said bottom plate;
5 a plurality of countersinks for receiving bone screws;
6 attaching a first and second end of said top plate to a first and second bone;
7 aligning said screw barrels of said bottom plate with said slots of said top
8 plate; and
9 attaching said top plate and said bottom plate such that said screws engage
10 said screw barrels.

- 11 21. The method of claim 20, further comprising the steps of:
12 providing a locking member disposed in said countersink for engaging said bone
13 screws to said medical appliance such that axial and rotational movement of
14 said bone screws is restricted; and
15 locking said bone screws to said appliance such that teeth of said locking member
16 engage a serrated neck of said bone screws.
- 17 22. The method of claim 20, further comprising the steps of:
18 providing a locking member comprising a locking ring attached to said bone screw
19 for engaging said bone screw to said medical appliance such that axial and
20 rotational movement of said bone screw is restricted;

1 locking said bone screws to said appliance such that teeth of said locking ring
2 engages a serrated neck of said bone screws.

3 23. The method of claim 20, further comprising the steps of:

4 providing a locking member comprising a locking ring having a lower arcuate
5 surface, said locking ring attached to said bone screw for engaging said bone
6 screw to said medical appliance such that axial and rotational movement of
7 said bone screw is restricted;

8 locking said bone screws to said appliance such that teeth of said locking ring
9 engages a serrated neck of said bone screws.

10 24. The method of claim 20, further comprising the steps of:

11 providing a locking member comprising a bone screw having a grooved collar for
12 engaging a threaded inner surface of said countersink;

13 locking said bone screws to said appliance such that said collar engages a threaded
14 inner surface of said countersink.

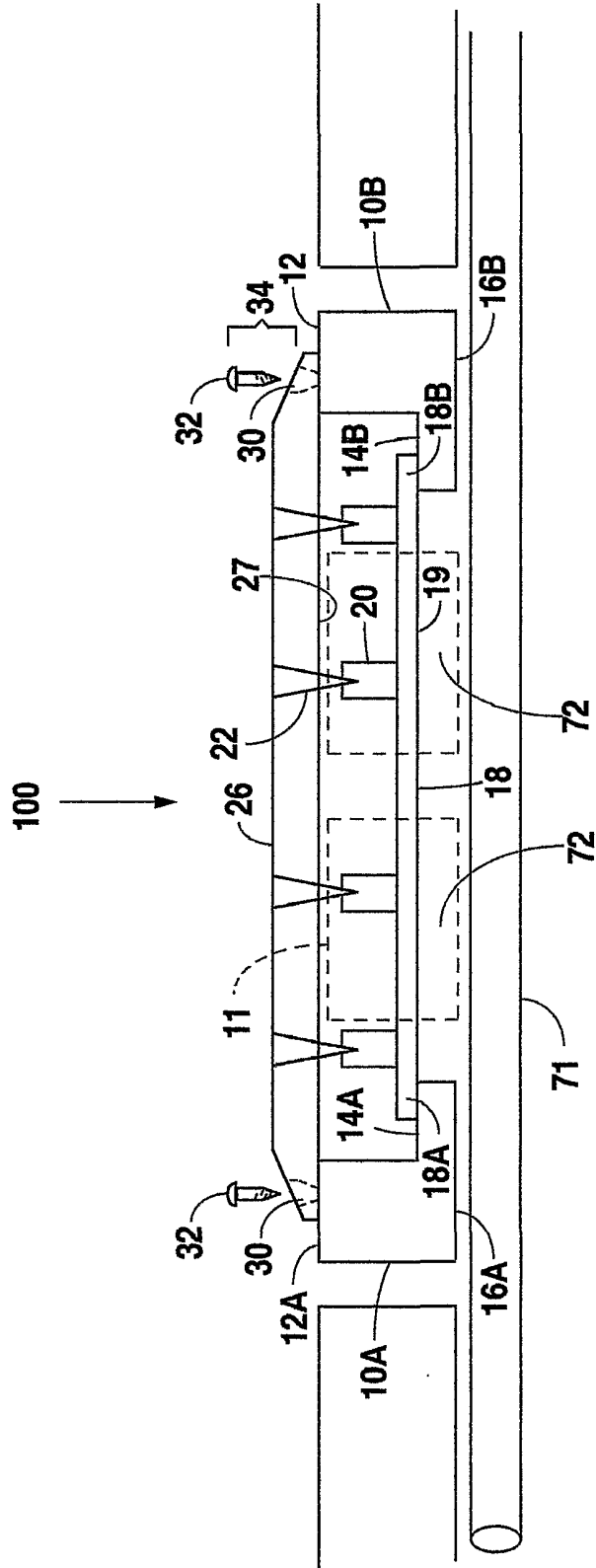
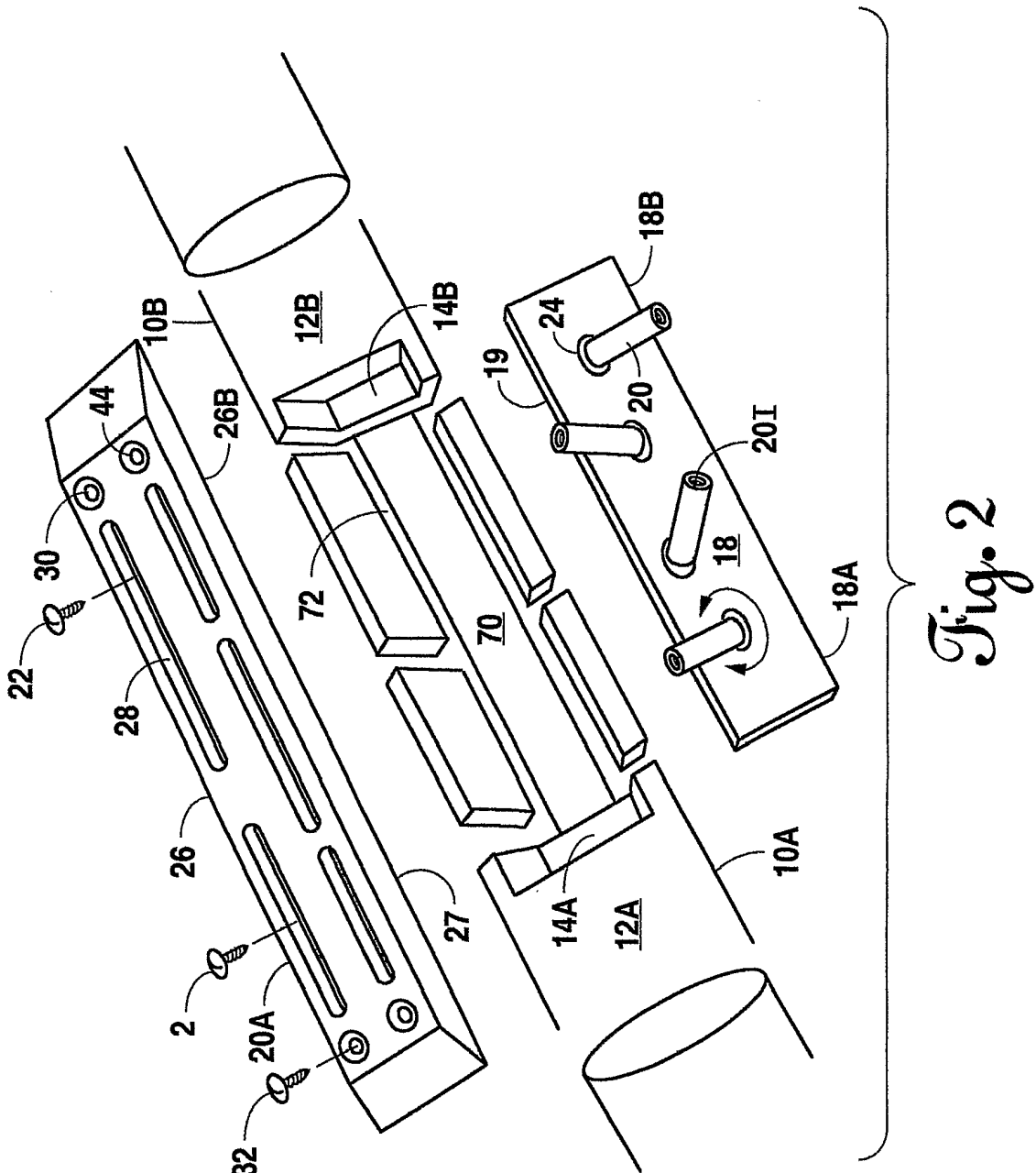


Fig. 1



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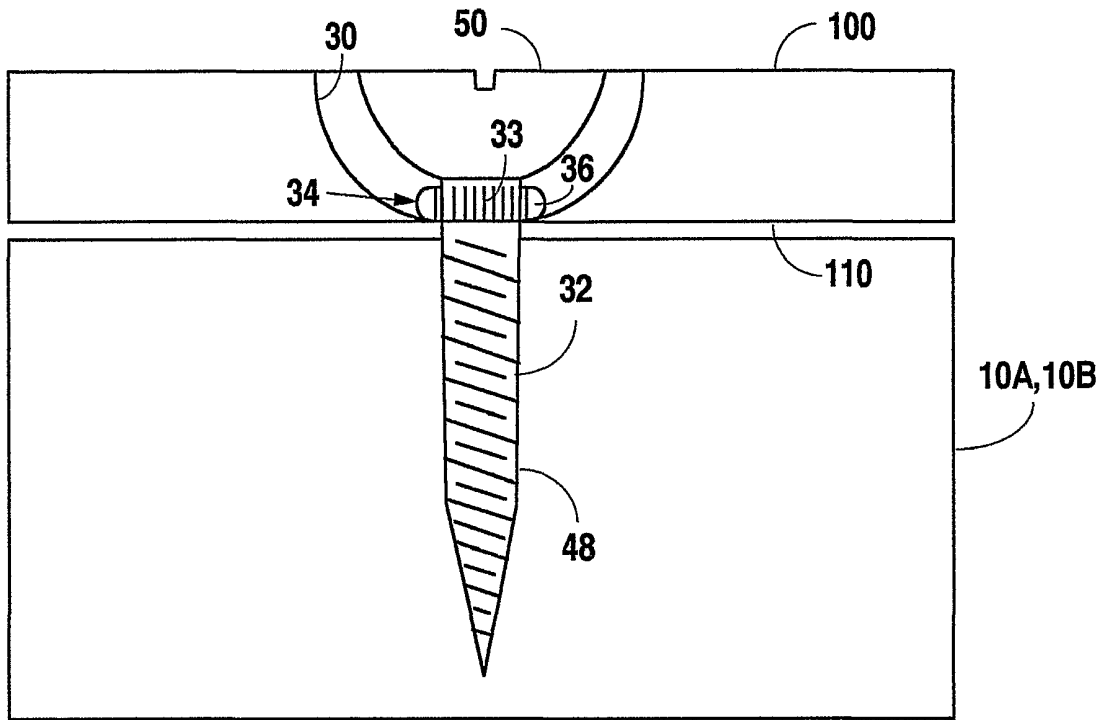


Fig. 3

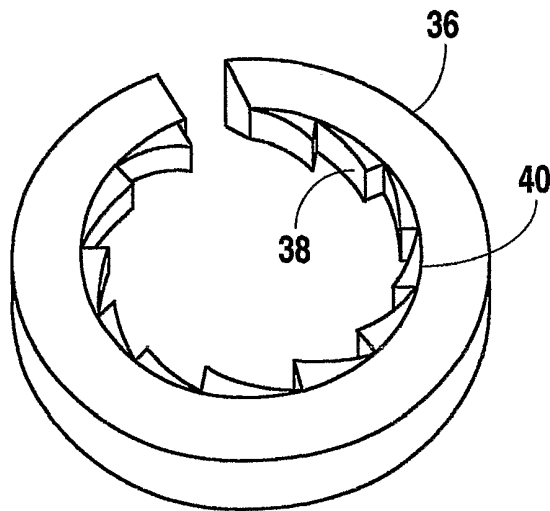


Fig. 3A

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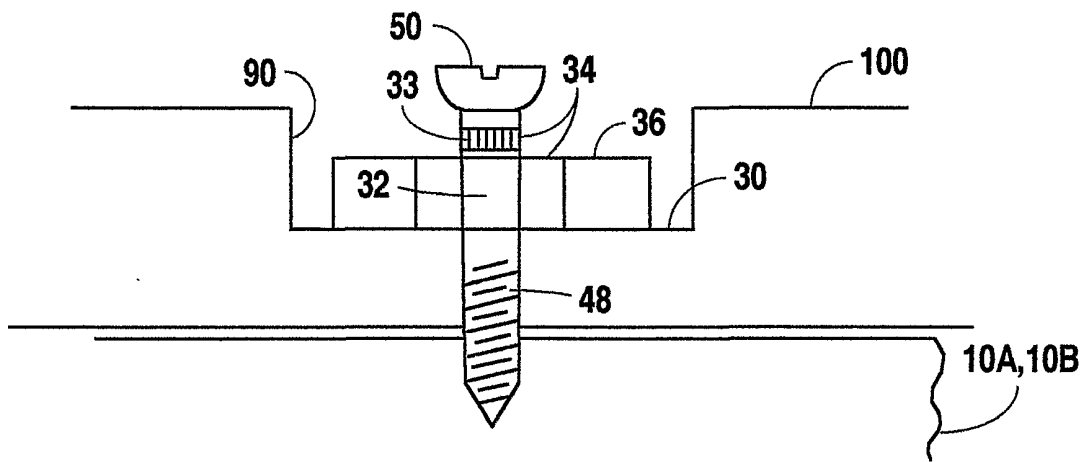


Fig. 4

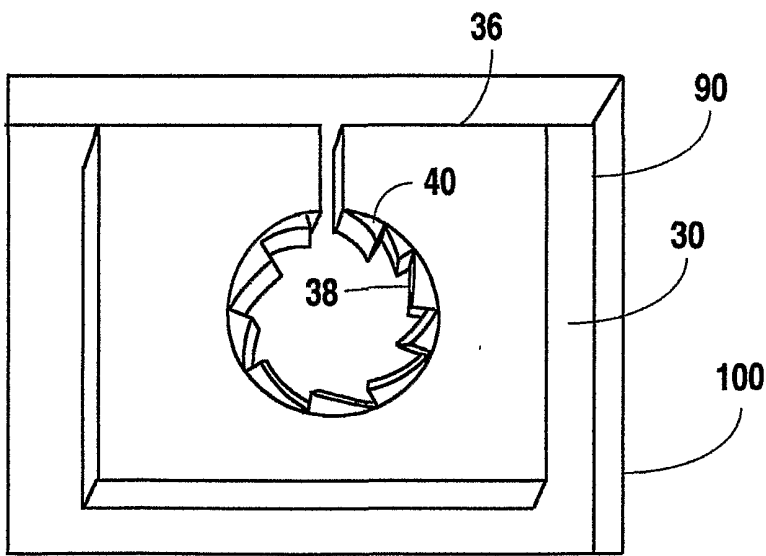


Fig. 4A

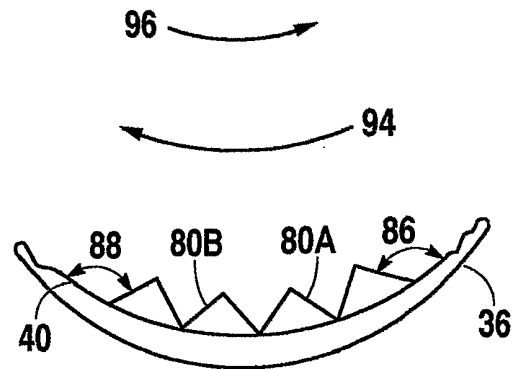


Fig. 4B

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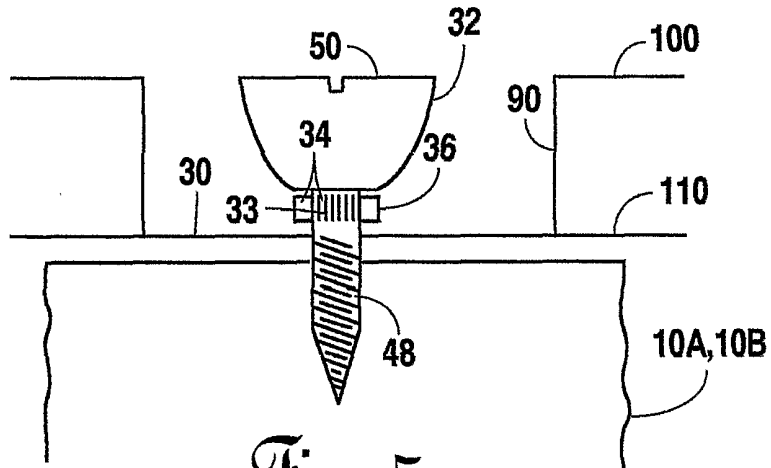


Fig. 5

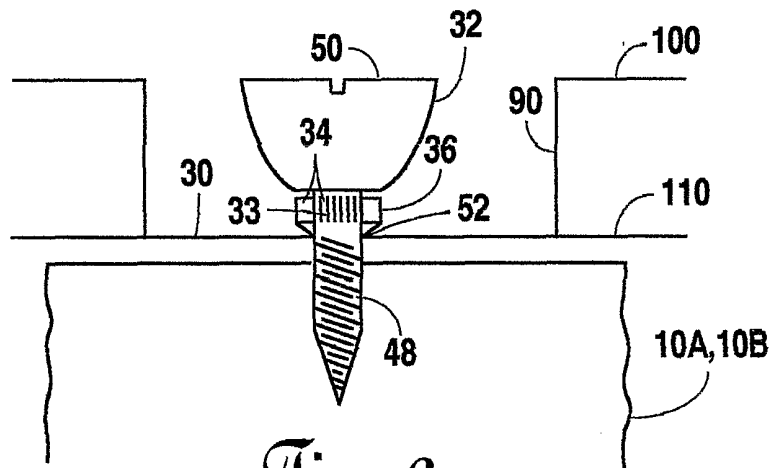


Fig. 6

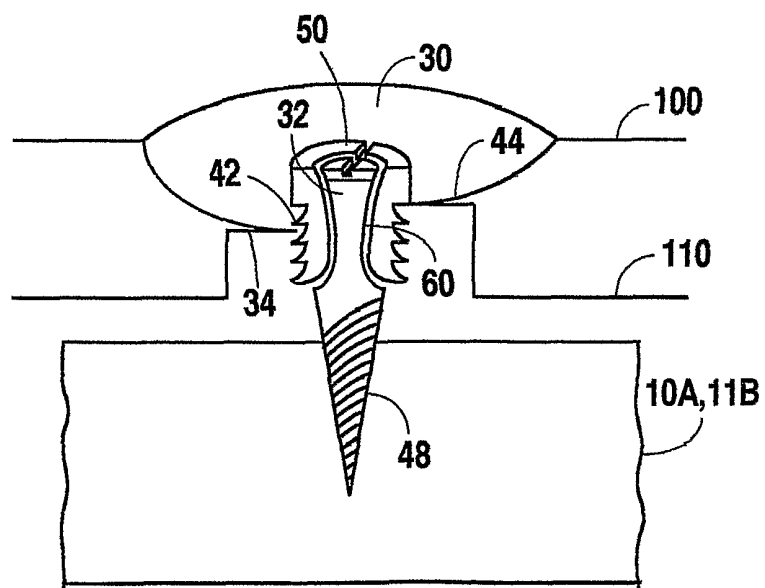


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/29915

A. CLASSIFICATION OF SUBJECT MATTER		
IPC(7) : A61B 17/56 US CL : 606/71 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) U.S. : 606/71,60,61,69,70,72,73,104		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,030,389 A (Wagner et al) 29 February 2000, see entire document.	1-24
A, P	US 6,193,721 B1 (Michelson) 27 February 2001, see entire document.	1-24
A	US 4,892,545 A (Day et al.) 09 January 1990, see entire document.	1-24
A	US 5,458,641 A (Ramirez Jimenez) 17 October 1995, see entire document.	1-24
A	US 5,810,816 A (Roussouly et al.) 22 September 1998, see entire document.	1-24
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"G"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search 18 DECEMBER 2001	Date of mailing of the international search report 25 JAN 2002	
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer PEDRO PHILOGENE <i>Diane Smith f</i> Telephone No. (703) 308-2252	