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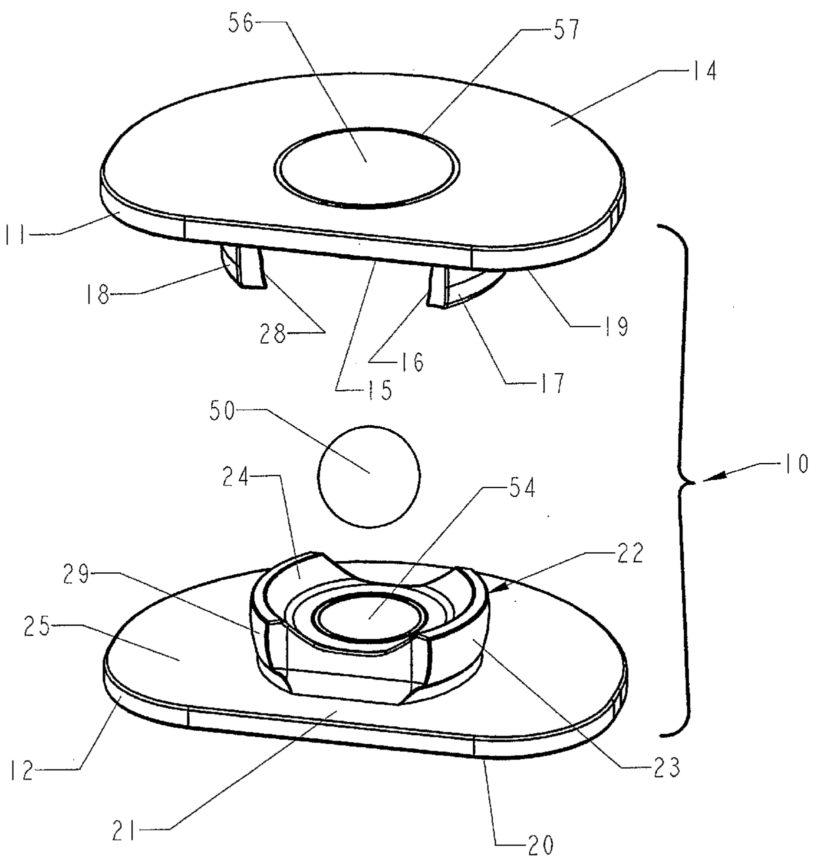
(54) Title: INTERIOR INSERT BALL AND DUAL SOCKET JOINT



(57) Abstract: A spinal implant is inserted between adjacent vertebrae to function as an disk prosthesis. The prosthesis has two plates fastened to adjacent vertebrae facing each other. The facing sides of the plates each have a depending skirt formed as concentric arcs of about (90) degrees. The skirts are either bowed or tapered in the axial direction. Depressions are centrally located between the arcs of the plates and a ball is universally movable in the depressions. A spring mechanism is centrally located in the plates to provide axial compression. One plate has a through bore and one plate has a receptacle, each, receiving a sleeve with a depression for holding the ball.

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INTERIOR INSERT BALL AND DUAL SOCKET JOINT

RELATED APPLICATIONS

This application claims priority from U. S. Provisional Application No. 60/655,662, filed Feb. 23, 2005.

This application is related to U. S. Patent Application 11/060,206 filed Feb. 15, 2005 which is a continuation-in-part of a U. S. Patent Application No. 11/025,656, entitled Ball-In-Cage Spinal Implant, filed Dec. 28, 2004 which is related to U. S. Application No. 10/793,433, filed March 3, 2004 which is a continuation-in-part of U. S. Application No. 10/792,399, filed March 2, 2004; the contents of which is incorporated herein by reference.

Field of the invention

This invention relates to orthopedic surgery and, in particular, spinal implants for replacement of ruptured or excised spinal disks.

BACKGROUND OF THE INVENTION

Several attempts have been made to design a spinal prosthesis for replacement of missing or excised disk material that replicates the functions of the missing tissue. U. S. Patent No. 4,759,769 to Hedman et al discloses an artificial disk device in which two plates are attached to the adjacent vertebrae by bone screws inserted through flanges on the plates. A spring biasing mechanism is captured between the plates to simulate the actions of the natural disk material. U. S. Patent No. 5,246,458 to Graham and U. S. Patent No. 6,228,118 to Gordon disclose other intervertebral implants with arcuate flanges used to connect the device to adjacent vertebra.

Graham also teaches a resilient structure.

The patents to Marnay, U. S. Patent No. 5,314,477, Buttner-Janz et al, U. S. Patent No. 5,401,269, Yuan et al, U. S. Patent No. 5,676,701, and Shelokov, U. S. Patent No. 6,039,763, all are directed to the design of the opposing faces of the adjacent plates of an implant to provide a limited universal joint to simulate the natural movement of the spine.

U. S. Patent No. 5,683,465 to Shinn et al teaches two plates with bow shaped skirts which are interlocked.

SUMMARY OF THE PRESENT INVENTION

The invention is directed to a spinal implant for insertion between adjacent vertebrae to function as an disk prosthesis. The prosthesis is formed from two plates fastened to adjacent vertebrae facing each other. The facing sides of the plates each have a depending skirt formed as concentric arcs of about 90 degrees. The skirts are either bowed or tapered in the axial direction. A depression is centrally located between the arcs of both plates. A spring mechanism is centrally located on one or both of the plates to provide axial compression. A sphere or ball is placed in the central depression of one of the plates. The plates are oriented to each other with the concentric arcs of each interrupted skirt at 90 degrees and the ball is engaged in the depression of the other plate. The plates are then rotated about 90 degrees and the opposed arcs of one plate interlock with the opposed arcs of the other plate to prevent separation in the axial direction.

Therefore, it is an objective of this invention to provide a spinal implant for axial support of the spinal column which replicates the dimensions and function of an intervertebral disk.

It is another objective of this invention to provide a kit including all the components for assembly and surgical placement of an artificial spinal disk.

It is a further objective of this invention to provide a method of assembly of the components of the kit which results in an axially interlocked spinal implant. Specifically, one plate forms a receptacle for a dynamic socket to be inserted and fixed in place internally.

It is yet another objective of this invention to provide a ball and socket joint between two plates attached to adjacent vertebrae permitting axial rotation, lateral bending, vertical tilting and axial compression.

It is a still further objective of this invention to provide shaped interrupted skirts on two plates which act as stop limits for tilting and bending.

It is another objective of this invention to provide an axially resilient ball and socket joint.

Other objectives and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings wherein are set forth, by way of illustration and example, certain embodiments of this invention. The drawings constitute a part of this specification and include exemplary embodiments of the present invention and illustrate various objects and features thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded perspective of the disassembled cage of this invention;

Fig. 2 is an exploded perspective of a disassembled plate of the spinal implant of Fig. 1;

Fig. 3 is an exploded cross section of the assembled implant of this invention;

Fig. 4 is an exploded cross section of another embodiment of the assembled implant of this invention;

Fig. 5 is a perspective of the embodiment shown in Fig. 6;

Fig. 6 is an exploded cross section of another embodiment of the assembled implant of this invention;

Fig. 7 is a perspective of the assembled implant of this
invention showing a bone attachment device; and

Fig. 8 is a perspective of the assembled implant of this invention showing another bone attachment device.

DETAILED DESCRIPTION OF THE INVENTION

The spinal implant 10, shown in Fig. 1, has three major components, an upper plate 11, a lower plate 12 and a universally rotatable sphere or ball 50. The upper plate 11 and the lower plate 12 form a cage when assembled with the ball 50 captured for universal movement within the interior of the cage. Of course, the position of the plates can be reversed, in use. Both upper plate 11 and lower plate 12 have a plan form substantially the size and shape of the end wall of the vertebra between which the implant will be placed to produce the maximum area of contact between the implant and the vertebra for stability and support. Obviously, different sized plates are necessary because of the difference in size of vertebra within regions of the spinal column and the different sizes or ages of patients.

The upper plate 11 has a planar surface 14 for contact with the end wall of a vertebra and an opposite disk surface 15. Depending from the disk surface is an interrupted skirt 16 with opposed arcs 17 and 18. The arcs are approximately 180 degrees apart at their centers and extend about 90 degrees. The diameter of the arcs is less than the periphery of the plate 11 leaving a horizontal flange 19. Centrally located within the semi-circular arcs is a through bore 13. A sleeve 51 is inserted in the through bore 13 and telescopes in the plate 11. The sleeve 51 has a spherical depression 52 facing plate 12.

The lower plate 12 has a planar surface 20 for contact with the end wall of a vertebra and an opposite disk surface 21. Upstanding from the disk surface is an interrupted skirt 22 with opposed arcs 23 and 24. The arcs are approximately 180 degrees apart at their centers and extend about 90 degrees. The diameter of the arcs is less than the periphery of the plate 12 leaving a horizontal flange 25. Centrally located within the semi-circular arcs is a receptacle 26. A sleeve 53 is inserted in the receptacle and reciprocates in the plate 12. The sleeve 53 has a depression 54 that is rounded and shaped to closely mirror the contours of the depression 52. The depressions 52 and 54, as well as the diameter of the ball 50, are of such dimensions as to support the weight of the spinal column.

As shown, though the relationship could be reversed, the opposed arcs 17 and 18 of the depending interrupted skirt 16 are concentric with the opposed arcs 23 and 24 of the upstanding interrupted skirt and of lesser diameter allowing rotation of the plates relative to each other with surface contact between the outer surface 28 of the upstanding arcs and the inner surface 29 of the depending arcs.

The spinal implant provides support and range of motion similar to the natural joint in that the plates 11 and 12 may rotate axially limited by natural anatomical structures, such as tendons, ligaments and muscles. To simulate the compression of the natural disk during normal activities, such as walking, a spring mechanism 60, 61 is placed in the vertical axis of the plates 11 and 12. The springs are resiliently compressionable.

The spring retainer 63 is in the opposite end of sleeve 51 from the depression 52. The annular spring retainer 63 is formed by the upstanding end wall of the sleeve and the dome shaped central portion. An O-ring spring 60 is disposed in the spring retainer 63. The spring 60 and the sleeve 51 are held in the plate 11 by dome cover plate 56.

In order to simplify the manufacturing process, the lower plate does not have a through bore. A receptacle is formed in the interior of the socket. The spring 61 is inserted and covered by the sleeve 53. A retainer ring is placed between the upper circumference of the sleeve and laser welded to the plate. Other permanent attachment methods may be used. The sleeve 53 is resiliently supported on the spring 61 in the form of a resilient O-ring. The spring is held in the cavity 26 by the retainer ring 55. The dome cover plate 56 and the retainer ring 55, each, has a laser weld 57, 58 or other bond to their respective plates. By absorbing some of the longitudinal loads, the prosthesis lessens the stresses on the adjacent natural disks. Further, during placement of the prosthesis, the springs may be compressed to lessen the overall height of the prosthesis.

To further imitate the function of a natural disk, the plates 11 and 12 may have a resilient material inserted therebetween, as shown in Fig.s 4, 5, and 6. The plates may be connected by a flexible or elastomeric membrane 70, as shown in Fig. 4. The membrane 70 can be discontinuous and act as a plurality of elastic bands about the periphery of the plates 11 and 12. Or the membrane 70 may be a continuous annular wall attached to the opposite flanges 19 and 25. A viscous polymeric compound 71 may occupy the space between the plates, such as a silicone. The membrane may be in the form of an outer skin integral with the polymeric compound. The viscosity of the material may vary from that of a gel to that of a resilient colloid. The polymeric compound may be molded or otherwise sealed between the plates 11 and 12. The continuous membrane discourages boney ingrowth which can limit spinal movement. As the spine is turned or tilted, the insert will be compressed on one side and extended on the other side producing a cushioning effect and a tendency to return to a state of equilibrium.

As shown in Fig. 6, an elastomeric plug 72 may be inserted between the plates and attached to one or both the plates 11 and 12. The plug 72 operates in the same manner as the polymeric compound discussed above.

The spine may bend laterally and tilt medially in flexion/extension in a range comparable to the normal range of motion. The inserts 71 and 72 may also having varying viscosities or moments of elasticity tailored to the area of the spine in which they are to be implanted.

The implant also provides limitation of these movements through interaction of the depending arcs and the upstanding arcs. As shown in Fig. 3, the components of the implant are connected together by orienting the interrupted skirts 16 and 22 at 90 degrees to each other. This action overlaps the interrupted skirts vertically. The plates are rotated through 90 degrees relative to each other. This rotation aligns the depending opposed arcs with the upstanding opposed arcs and interlocks the plates in a movable joint that cannot be separated axially. The inner surface 28 of the interrupted skirt 16 slidably contacts the outer surface 29 of the interrupted skirt 22. The contacting surfaces are spherical or bowed, from the plate at least to the height of the diameter of the ball 50, forming another ball and socket joint with the bottom edge of the depending arc 23 of a larger diameter than the top edge of the upstanding arc 17 by which the plates are interlocked. Of course, the remainder of the inner and outer surfaces of the interrupted skirts may be straight or tapered and spaced apart to allow for bending and tilting. In this instance, the cooperating interrupted skirts act as an bending stop when they come in contact with the opposite plate.

Fig. 4 also illustrates a modification of the dynamic spring action of the implant of Fig. 2. The depression 52 is formed on a slidable sleeve 51 in a bore 13 of the plate. The sleeve 51 is solidly mounted in the bore 13. The sleeve 51 may be formed integrally with the dome cover plate as a one piece component, in which case, the plug is then laser welded or otherwise bonded into the plate 11. As shown, the resilient O-ring 61 is disposed in the receptacle 26, as described above. This embodiment is less complex and less expensive to fabricate. Of course, the spring could be omitted from both plates, in which case the implant does not have the dynamic characteristics of the implant containing the O-ring.

In Fig. 7, a fastener is shown in the form of spikes 34 attached or formed on flanges 19 and 25 which are to be driven into the end walls of the adjacent vertebra. As shown in Fig. 8, each of flanges 19 and 25 of the spinal implant has a vertical extension with apertures 32, 33 which cooperate with bone screws to mount the spinal implant on the vertebra. As shown, the vertical extensions are disposed in line with each other. However, the vertical extensions can be on opposite lateral sides of the flanges 19 and 25 permitting fastening of each plate on the opposite side of adjacent vertebrae. Of course, the two fasteners may be used together, eg., the spikes may be on one plate and the vertical extensions on the other plate of the same spinal implant.

The components are made from materials that are suitable for implantation in the living body and have the requisite strength to perform the described functions without deformation, e.g., the opposed bearing surfaces of the depressions and ball may be made of metal or a ceramic and a metal, respectively, the ceramic material is implant grade alumina ceramic or a silicon nitride or carbide and the metal may be a nitrogen alloyed chromium stainless steel or cobalt chrome alloy, or titanium, and alloys of each, coated metals, ceramics, ceramic coatings, and polymer coatings.

The plates may be made entirely of cobalt chrome alloy or only the inserts. In the high wear areas, such as the depressions coatings or inserts may be used to prevent galling and permit repair. In this modular concept, the end plates may be titanium, titanium alloy, or stainless steel among other materails as discussed above.

The prosthetic ball 50 is preferably made from an implant grade alumina ceramic or a silicon nitride or silicon carbide material. The ball 50 may be formed entirely of the ceramic material or a ceramic coating on another matrix. The alumina ceramic or silicon nitride or silicon carbide material can be hot isostatic pressed (HIPing). The ball 50 is then polished to a mirror-like finish. The ceramic ball is completely corrosion resistant and is non-abrasive. The solid matrix eliminates the wear particles, such as liberated from metal, other coated metals and polyethylene implants. The ball 50 has excellent thermal conductivity thereby reducing patient discomfort associated with exposure to cold weather. Further, the alumina ceramic or silicon nitride implant will react well with x-ray and MRI (magnetic resonance imaging) diagnostic procedures.

The kit contains plates with protrusions and skirts of varying lengths to allow selection of components for an implant with the axial dimension substantially the same as the thickness of the disk the implant will replace. The kit may also contain upper and lower plate components of varying sizes. A prosthesis could be assembled from the kit with springs in the upper and lower plates.

A number of embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the invention is not to be limited by the specific illustrated embodiment but only by the scope of the appended claims.

CLAIMS

I (We) Claim:

1. 1. A spinal implant for placement between adjacent vertebrae to replace disk material comprising a first plate and a second plate adapted to interlock about a central axis, said first plate having a vertebrae engaging side and a disk side, a first depression in said central axis of said disk side of said plate, said second plate having a second vertebrae engaging side and a second disk side, a second depression in said central axis of said second disk side of said second plate, said first depression and said second depression facing each other and forming a spherical shaped cavity, and a ball universally mounted in said spherical shaped cavity, a resilient material contacting one of said first plate and said second plate whereby said first plate is adapted to contact a vertebrae and said second plate is adapted to contact an adjacent vertebrae with said spherical shaped cavity adapted to form bearing surfaces for said ball along said central axis and forming a dynamic universal joint.

2. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 1 wherein one of said first plate and said second plate has a central through bore, a sleeve movably disposed in said through bore, a cap sealing said through bore and fixed to said vertebrae side of said plate retaining said sleeve in said through bore.

3. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 2 wherein said sleeve has a depression formed in one end.

4. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 2 wherein said resilient material is disposed in said through bore.

5. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 4 wherein said sleeve has a depression formed in one end.

6. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 1 wherein one of said first plate and said second plate includes a unitary vertebrae engaging side surface, one of said first depression and said second depression includes a sleeve movably disposed in said depression, said resilient material disposed between said sleeve and said unitary vertebrae engaging side.

7. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 6 wherein said sleeve has a depression formed in one end.

8. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 2 wherein one of said first plate and said second plate includes a unitary vertebrae engaging side surface, one of said first depression and said second depression includes a sleeve movably disposed in said depression, said resilient material disposed between said sleeve and said unitary vertebrae engaging side.

9. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 2 wherein said first depression has a first interrupted skirt and said

second depression has a second interrupted skirt, said first and said second interrupted skirt being concentric and adapted to contact each other.

10. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 6 wherein said first depression has a first interrupted skirt and said second depression has a second interrupted skirt, said first and said second interrupted skirt being concentric and adapted to contact each other.

11. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 8 wherein said first depression has a first interrupted skirt thereabout and said second depression has a second interrupted skirt thereabout, said first and said second interrupted skirts being concentric and adapted to contact each other.

12. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 11 wherein said first interrupted skirt and said second interrupted skirt are adapted to interlock in a universal joint.

13. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 1 wherein said resilient material circumscribes said first depression and said second depression.

14. A spinal implant for placement between adjacent vertebrae to replace disk material of claim 13 wherein said resilient material approximates the consistency of the excised disk material.

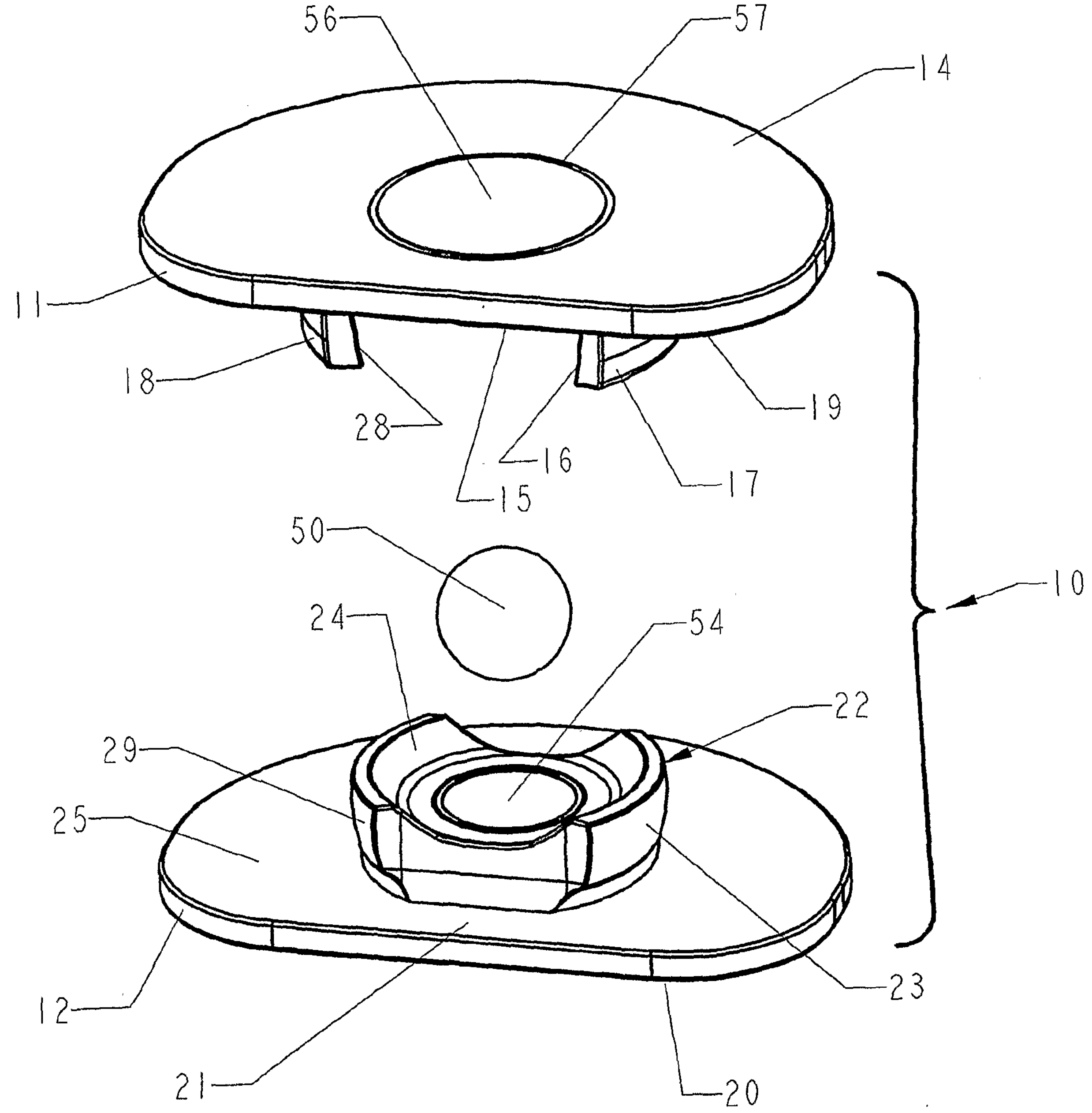

Fig. 1

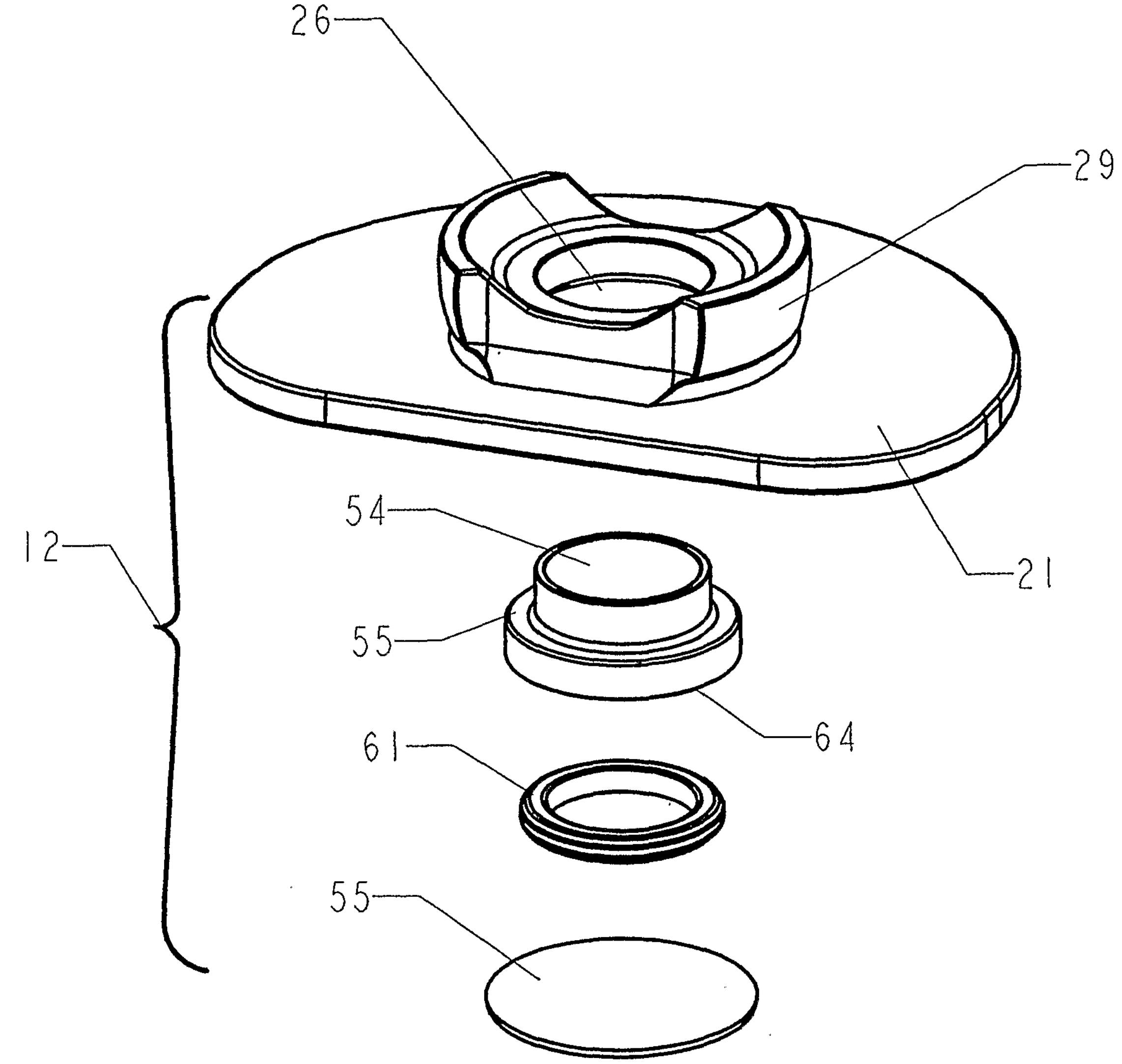

Fig. 2

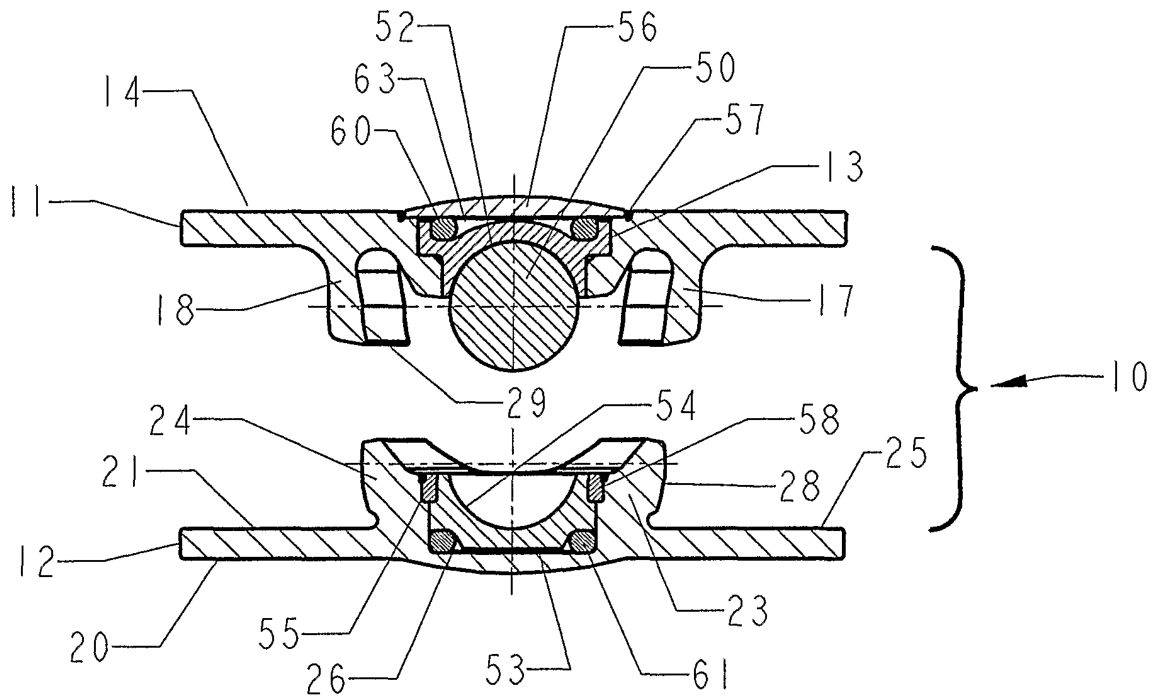
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Fig. 3

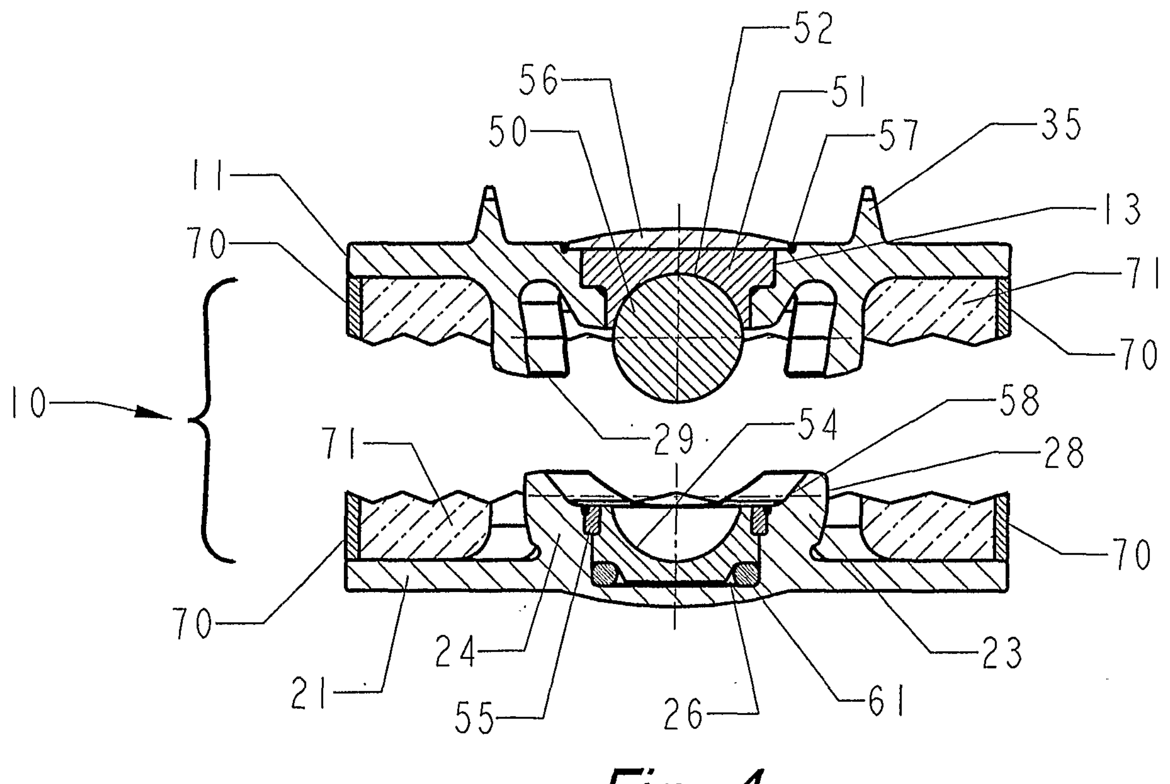
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Fig. 4

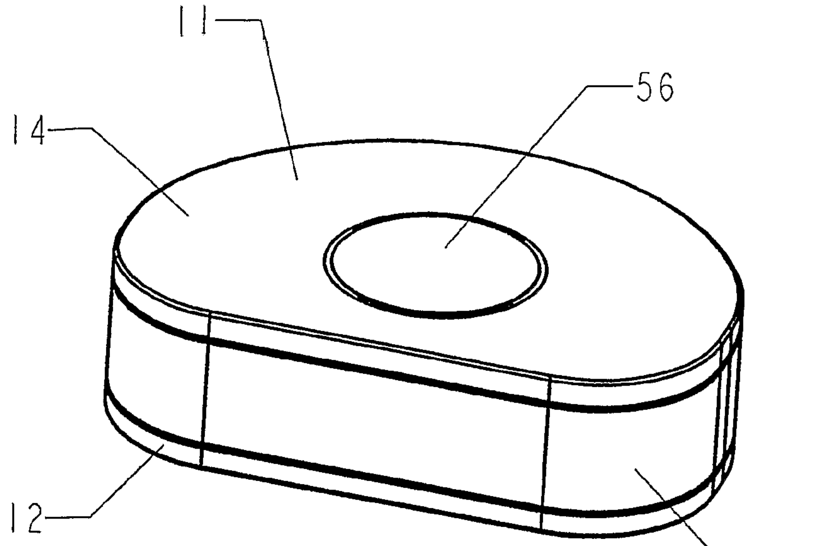

Fig. 5

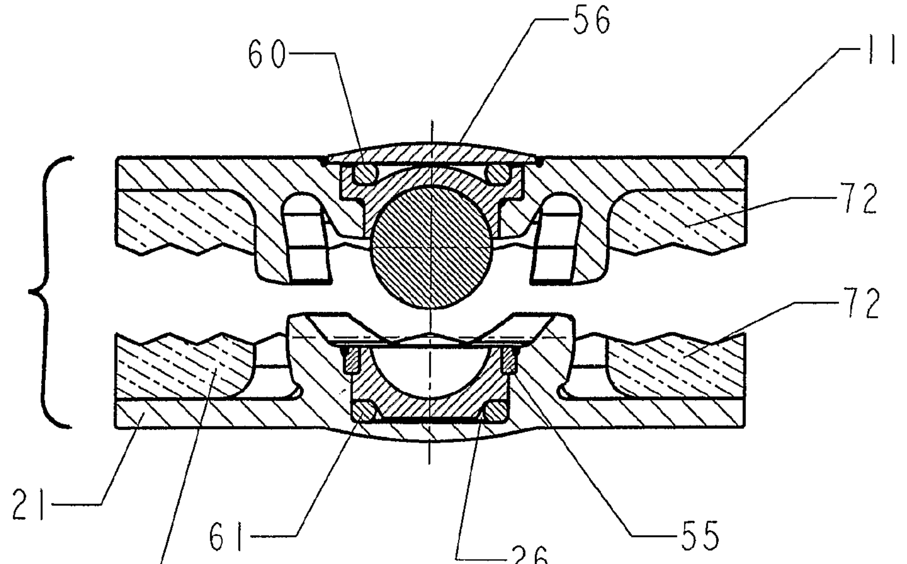

Fig. 6

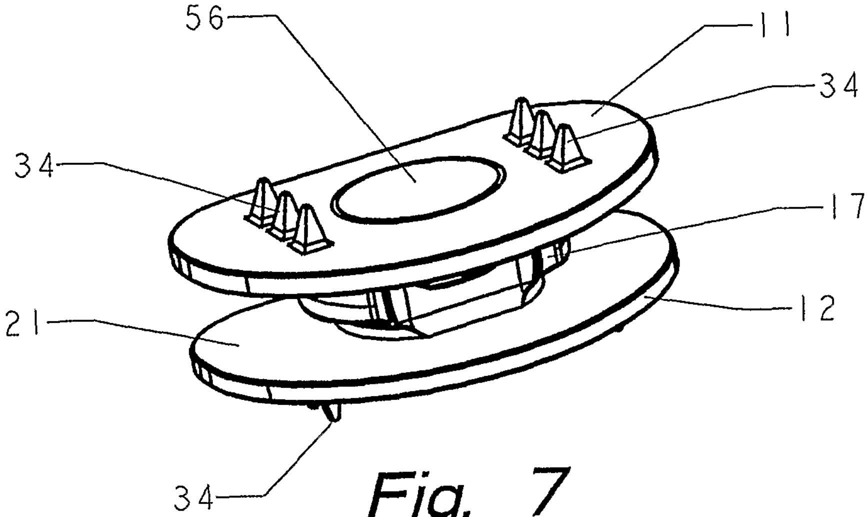

Fig. 7

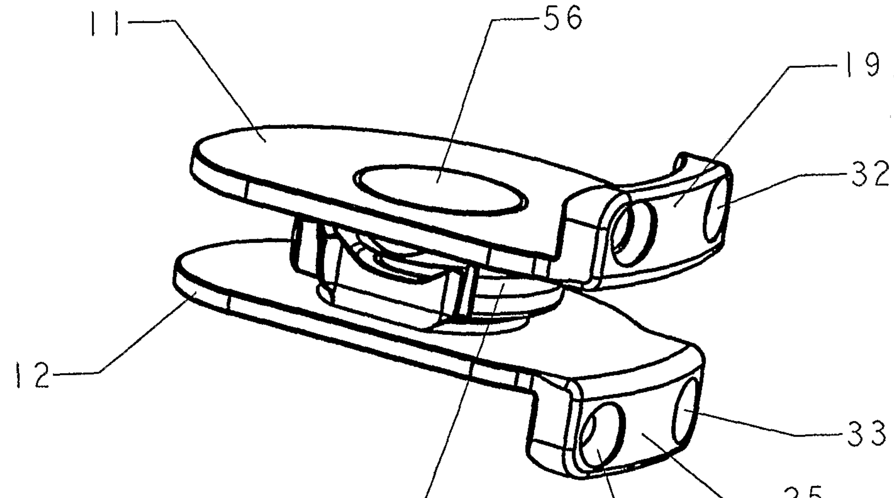

Fig. 8