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(21) International Application Number: PCT/US99/12609 (22) International Filing Date: 4 June 1999 (04.06.99) (30) Priority Data: 60/088,863 9 June 1998 (09.06.98) US 60/120,663 19 February 1999 (19.02.99) US Not furnished 4 June 1999 (04.06.99) US (71) Applicant: NUVASIVE, INC. [US/US]; 10065 Old Grove Road, San Diego, CA 92037 (US). (72) Inventor: MARINO, James, F.; 2620 St. Tropez Place, La Jolla, CA 92037 (US). (74) Agents: HECKADON, David, R. et al.; Townsend and Townsend and Crew LLP, 8th floor, Two Embarcadero Center, San Francisco, CA 94111 (US).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: IMAGE INTENSIFIER RETICLE SYSTEM 		
(57) Abstract A method of aligning a C-arm (26) of an image intensifier for rotation in a selected plane, the C-arm having a transmitter (22) mounted at one end and a receiver (24) mounted at an opposite end, comprising: identifying the selected plane by viewing the location of bony structure (12) with the image intensifier; and aligning indicia disposed on a radio-opaque reticle (25) covering at least a portion of the receiver with the selected plane, the indicia being aligned with the plane of rotation of the C-arm, thereby aligning the plane of the C-arm with the selected plane.		

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IMAGE INTENSIFIER RETICLE SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

The present application is a regular application
5 claiming benefit under 35 USC §119(e) from U.S. Provisional
Patent Application Serial No. 60/120,663 filed February 19,
1999; the complete disclosure of which is hereby
incorporated herein by reference in its entirety for all
purposes.

10

TECHNICAL FIELD

The present invention relates to C-arm surgical
image intensifiers.

SUMMARY OF THE INVENTION

The present invention provides a reticle for
15 attachment to an image intensifier and a method of use which
allows a standard C-arm image intensifier to be easily
aligned to rotate in a selected plane about any desired
point in a human body. The present invention can be used to
align an image intensifier to rotate in any plane through
20 the human body, wherein the plane is preferably defined by
viewing bones or other radio-opaque structures in the body
with the image intensifier system. Although the present
invention can be aligned to rotate the C-arm in any desired
plane passing through a human body, the present invention is
25 ideally suited to align a conventional C-arm image
intensifier to rotate in a plane passing between two
adjacent vertebrae in a patient's spine. It is to be
understood, however, that the present invention is not so
limited to alignment of C-arm image intensifiers only with
30 respect to intervertebral planes.

After aligning the orientation of the image intensifier with the selected intervertebral plane, the image intensifier can be rotated about a selected point to provide both lateral and anterior-posterior views through the patient while remaining in the selected intervertebral plane.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a rear elevation view of a prone lying patient with an image intensifier taking a lateral view through the patient.

Fig. 2 is a view corresponding to Fig. 1, but with the image intensifier taking an anterior-posterior view through the patient.

Fig. 3 is a side elevation view corresponding to Fig. 1.

Fig. 4 is a view of an image taken by the image intensifier with the image intensifier being positioned as shown in Figs. 1 and 3.

Fig. 5 is a sectional side elevation view taken along line 5-5 in Fig. 2.

Fig. 6 is a view of an image taken by the image intensifier with the image intensifier being positioned as shown in Figs. 2 and 5.

Fig. 7 is an end view of a reticle of the present invention as attached over the receiving end of the image intensifier.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

Referring first to Fig. 1, a patient 10 having a spine 12, head 13 and feet 14 is positioned in a prone lying manner on a radiotransparent table 15. A conventional image intensifier 20 having an emitter 22 and a receiver 24 which

are together held on opposite sides of the patient by a standard C-arm 26 is positioned as shown in Fig. 1 to generate a lateral radioimage view through the patient. As is shown in Fig. 2, C-arm 26 can also be rotated so as to
5 provide an anterior-posterior image through the patient.

C-arm image intensifier 20 may comprise any standard image intensifier, preferably having the property that rotation 24 of C-arm 26 in the plane of the C-arm, (such as from the orientation in Fig. 1 to that of Fig. 2),
10 causes the image intensifier to rotate about a fixed point in space equidistant between emitter 22 and a receiver 24.

In a preferred aspect of the present invention, C-arm 26 is aligned to rotate in a preferred plane about a desired point in space positioned equidistant between
15 emitter 22 and a receiver 24.

In an exemplary aspect of the invention, the desired point in space is disposed within the patient's intervertebral space and the desired plane is an intervertebral plane which passes between adjacent
20 vertebrae, as follows.

When taking either lateral or an anterior-posterior images of adjacent vertebrae in the patient's spine, as seen in Figs. 1 and 2, respectively, it is preferred to take such images along a plane which passes
25 between the adjacent vertebrae. However, each pair of adjacent vertebrae in the patient's spine will have a different intervertebral plane due to the natural lordosis in the patient's spine. For example, as is seen in Fig. 5, spine 12 comprises adjacent vertebrae 17 and 19. Each pair
30 of adjacent vertebrae in the spine will each have a unique intervertebral plane passing therethrough. For example, intervertebral plane 30 will pass between vertebrae 17 and 19, as shown. Accordingly, considerable adjustment of the

image intensifier orientation is required to align it with the selected intervertebral plane. These alignment problems are further complicated when attempting to rotate the image intensifier from a lateral position to an anterior-posterior position.

In a preferred aspect, the present invention may be used to align C-arm 26 image intensifier 20 with intervertebral plane 30 such that as the image intensifier is moved from the position shown in Fig. 1 to the position shown in Fig. 2, C-arm 26 of image intensifier 20 remains at all times disposed in the intervertebral plane 30, as follows.

As can be seen in Figs. 3 and 5, the positioning of the image intensifier 20 to align C-arm 26 with a selected intervertebral plane 30 will require C-arm 26 to be rotated by angle A_1 to a vertical plane 32. The point 34 about which image intensifier 20 is pivoted should preferably be between adjacent vertebrae 17 and 19, (as determined by viewing the lateral image through the patient as shown in Fig. 4 as will be explained). Image intensifier 20 is preferably initially positioned about the patient such that point 34 will be disposed equidistant between emitter 22 and a receiver 24. Accordingly, rotation of C-arm 26 in plane 30 will be about point 34 with point 34 remaining equidistant between emitter 22 and a receiver 24. The correct angling of C-arm 26 about point 34 is accomplished as follows.

As is seen in Fig. 4, when the image intensifier is positioned as shown in Figs. 1 and 3, images of adjacent vertebrae 17 and 19 will be seen. Receiver 24 is covered with reticle 25 which has radiopaque indicia, for example, crosshairs 40 and 42 as shown in Fig. 7. Being radiopaque,

crosshairs 40 and 42 will also appear on the image viewed by the system operator.

Adjusting the vertical and horizontal position of C-arm 26 of image intensifier 20 will enable the image of the intersection point of crosshairs 40 and 42 to be positioned between adjacent vertebrae 17 and 19 collinear with point 34 when the C-arm is positioned to take a lateral view as illustrated in Figs. 1 and 4.

Similarly, adjusting the vertical and horizontal position of C-arm 26 of image intensifier 20 will enable the image of the intersection point of crosshairs 40 and 42 to be positioned between adjacent vertebrae 17 and 19 collinear with point 34 as shown when the C-arm is positioned to take an anterior-posterior view as illustrated in Figs. 2 and 6. In order to align C-arm 26 in the anterior-posterior view of Figs. 2 and 6, C-arm 26 can be rotated by oblique angle A2.

When crosshairs 40 are aligned in the intervertebral plane in both lateral and anterior-posterior images, rotation of C-arm 26 in its plane of rotation (ie: the plane defined by crosshair 40 on reticle 25, about point 34), will align the C-arm for rotation in a plane which is co-planar to the patient's intervertebral plane. Specifically, when reticle 25 is initially attached to receiver 24, crosshairs 40 are pre-aligned to be coplanar with the plane of rotation of C-arm 26 as is shown in Fig. 7.

After aligning radiopaque crosshairs 40 with intervertebral plane 32, the image intensifier can then be rotated to any position in plane 30 about point 34, (which is also viewable as the intersection point of crosshairs 40 and 42), including an anterior-posterior orientation as is shown in Figs. 3 and 5, thus aligning C-arm 26 of image intensifier 20 with the intervertebral plane 30.

Once positioned as is shown in Figs. 1 and 3, image intensifier 20 can then be easily rotated into the position shown in Figs. 2 and 5 with C-arm 26 remaining in plane 30 to take an anterior-posterior image.

5 It is to be understood that alignment of image intensifier 20 with plane 32 can also be accomplished first with the image intensifier positioned to take an anterior-posterior view. For example, Fig. 6 shows an illustration of the image intensifier view through adjacent vertebrae 17
10 and 19 taken along intervertebral plane 30 when the image intensifier is positioned in the orientation shown in Figs. 2 and 5. Subsequently, image intensifier 20 can be easily rotated to take a lateral view while C-arm 26 remains in the selected intervertebral plane 30. Alignment of the image
15 intensifier with the selected intervertebral plane can also be accomplished at positions between lateral and anterior-posterior orientations.

While the above is a complete description of the preferred embodiments of the invention, various
20 alternatives, modifications, and equivalents may be used. Therefore, the above description should not be taken as limiting the scope of the invention which is defined by the appended claims.

WHAT IS CLAIMED IS:

- 1 1. A method of aligning a C-arm of an image
2 intensifier for rotation in a selected plane, the C-arm
3 having a transmitter mounted at one end and a receiver
4 mounted at an opposite end, comprising:
5 identifying the selected plane by viewing the
6 location of bony structures with the image intensifier; and
7 aligning indicia disposed on a radio-opaque
8 reticle covering at least a portion of the receiver with the
9 selected plane, the indicia being aligned with the plane of
10 rotation of the C-arm, thereby aligning the plane of the C-
11 arm with the selected plane.
- 1 2. The method of claim 1, further comprising:
2 rotating the C-arm in the selected plane.
- 1 3. The method of claim 1, further comprising:
2 rotating the C-arm about a selected point in the
3 selected plane.
- 1 4. The method of claim 3, wherein the C-arm is
2 positioned such that the selected point is positioned
3 equidistantly between the receiver and the emitter disposed
4 at opposite ends of the C-arm.
- 1 5. The method of claim 3, wherein the indicia
2 comprise first indicia disposed in the plane of rotation of
3 the C-arm and second indicia disposed perpendicular to the
4 plane of rotation of the C-arm.
- 1 6. The method of claim 5, further comprising:
2 centering the selected point between the first and
3 second indicia.

1 7. The method of any of claims 1 to 6, wherein,
2 the selected plane is an intervertebral plane.

1 8. A reticle for aligning a C-arm of an image
2 intensifier for rotation in a selected plane, the C-arm
3 having a transmitter mounted at one end and a receiver
4 mounted at an opposite end, comprising:
5 first indicia disposed in the plane or rotation of
6 the C-arm and second indicia disposed perpendicular to the
7 plane of rotation of the C-arm.

1 9. A crosshair reticle for attachment to an
2 image intensifier receiver for aligning the image
3 intensifier with an intervertebral plane passing between
4 adjacent vertebrae.

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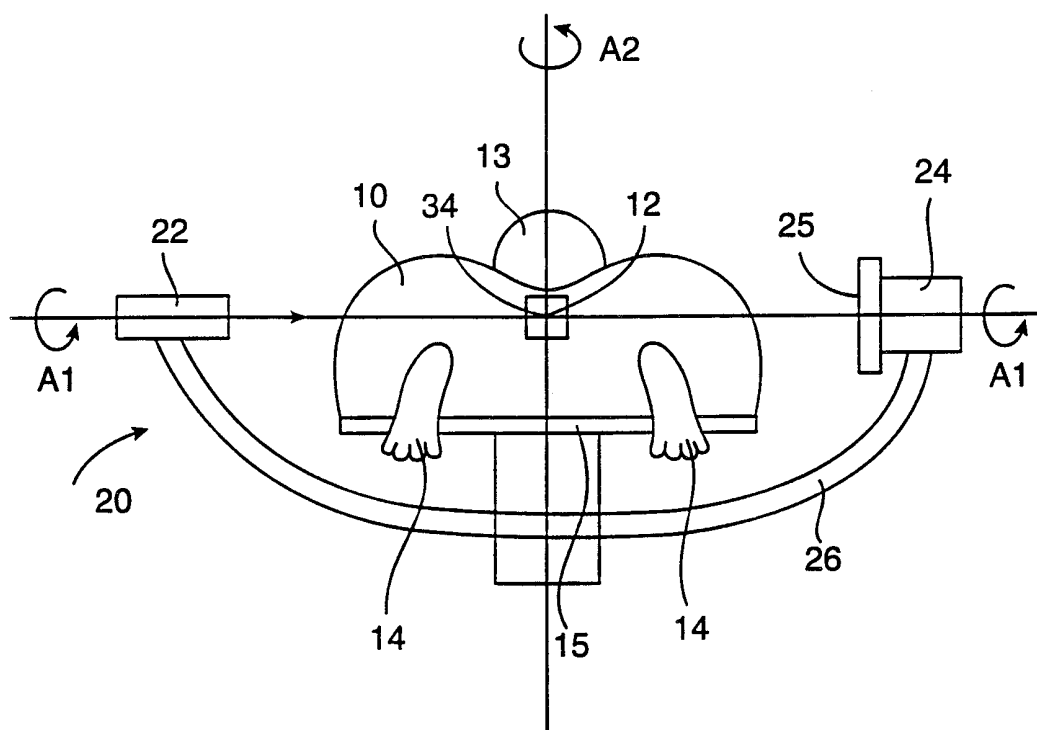


FIG. 1

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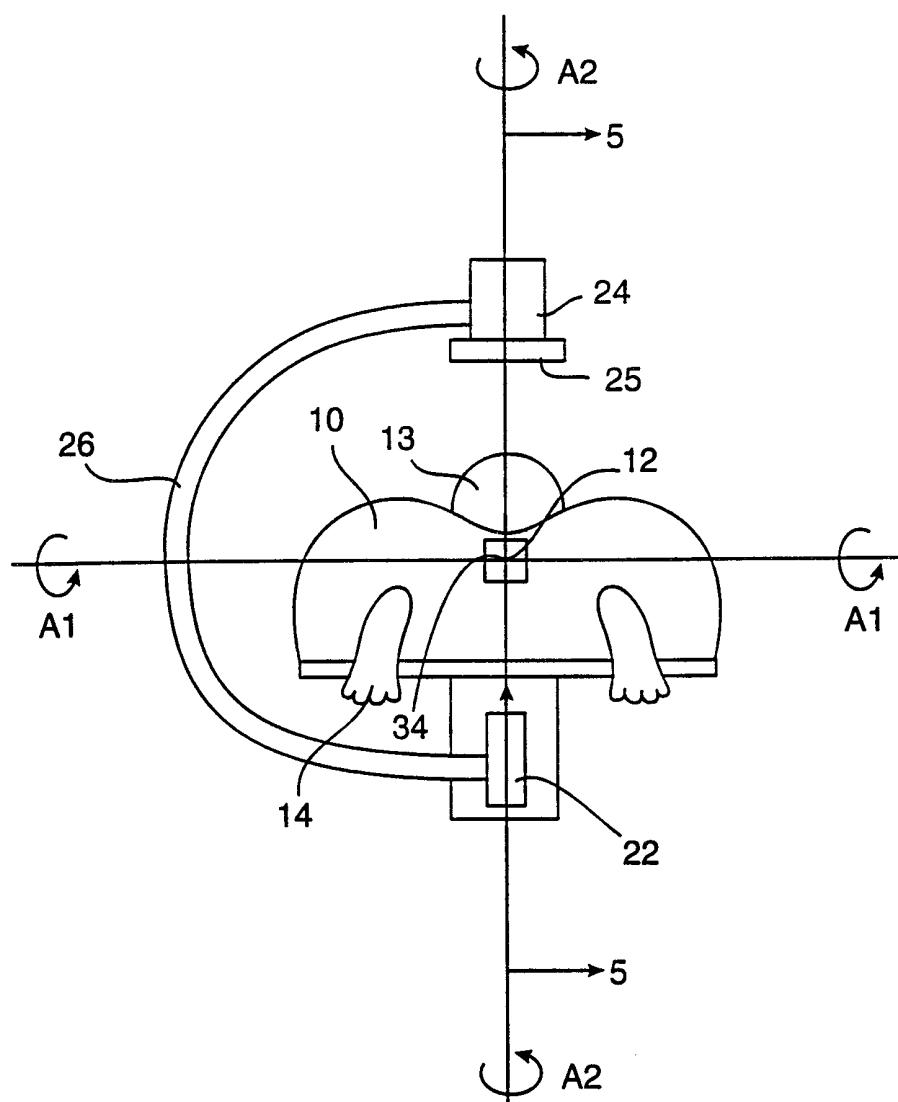


FIG. 2

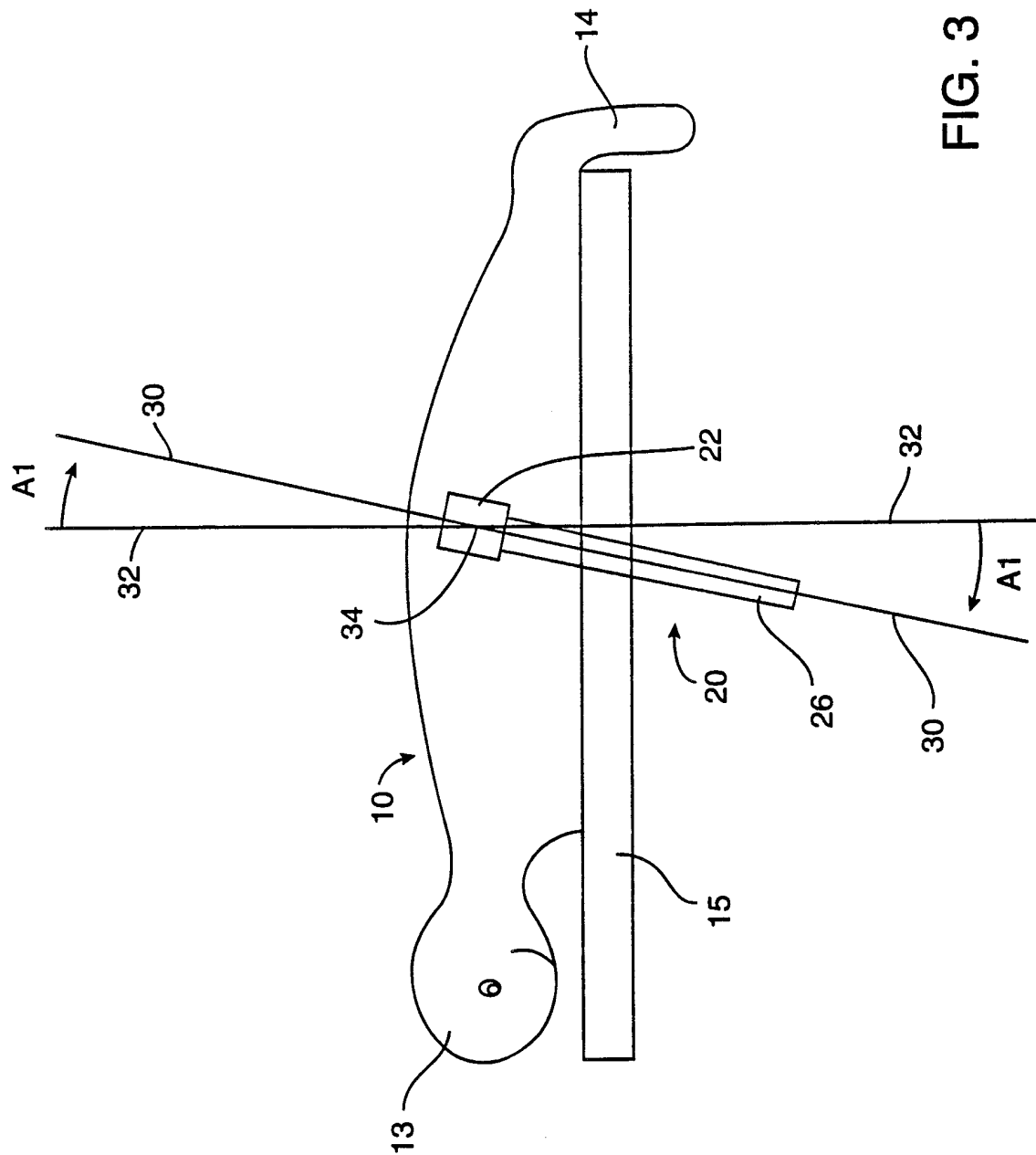
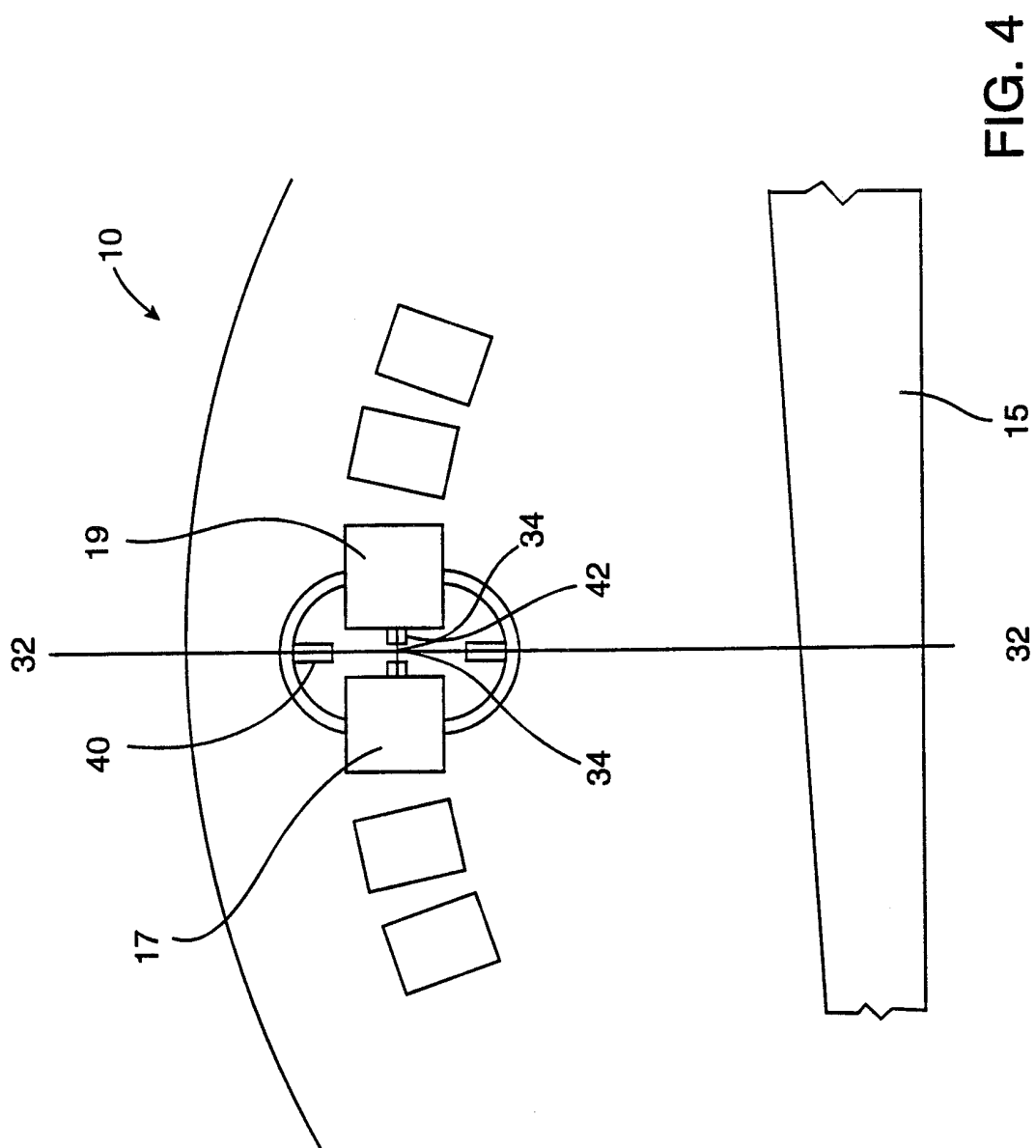


FIG. 3

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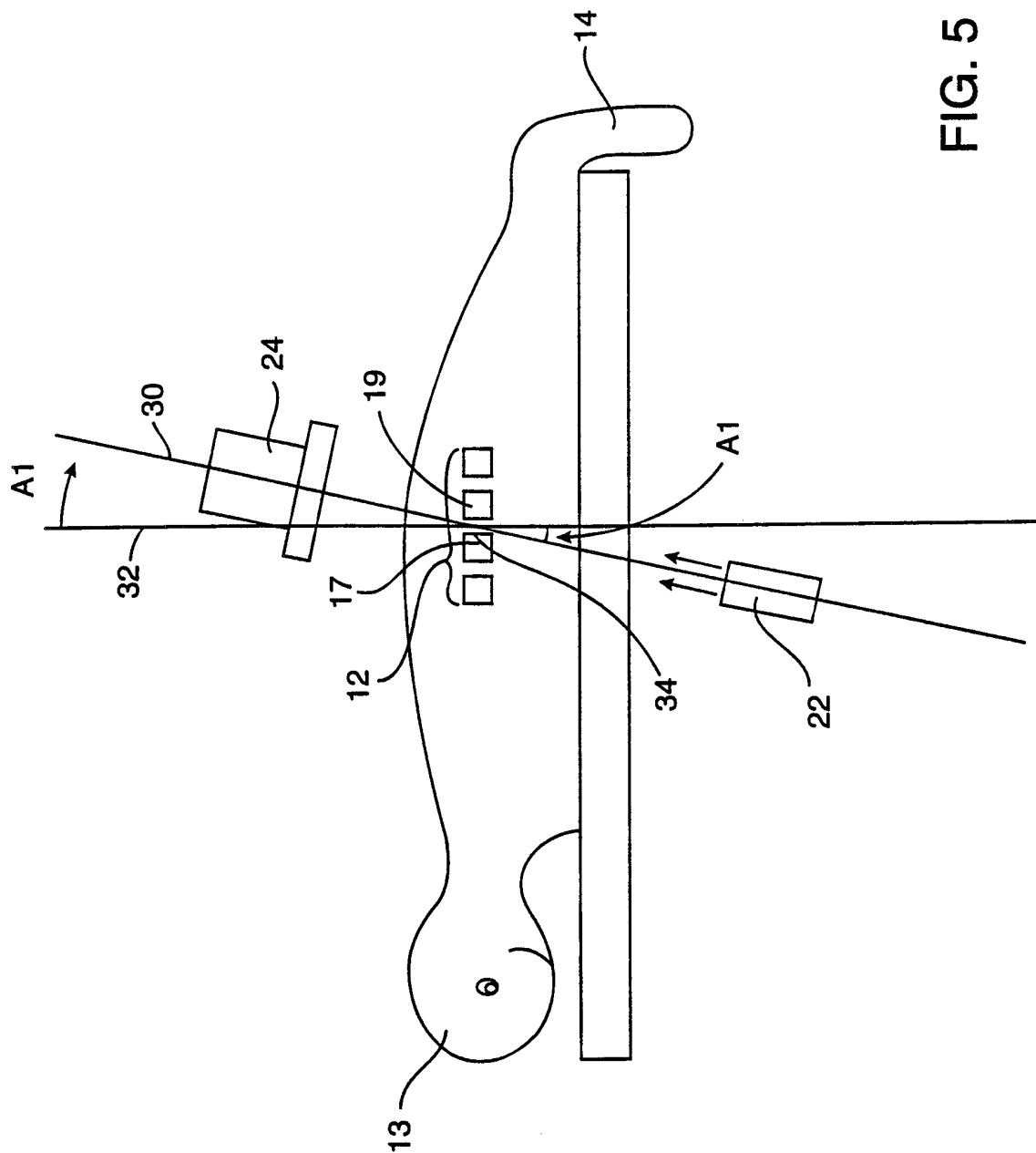


FIG. 5

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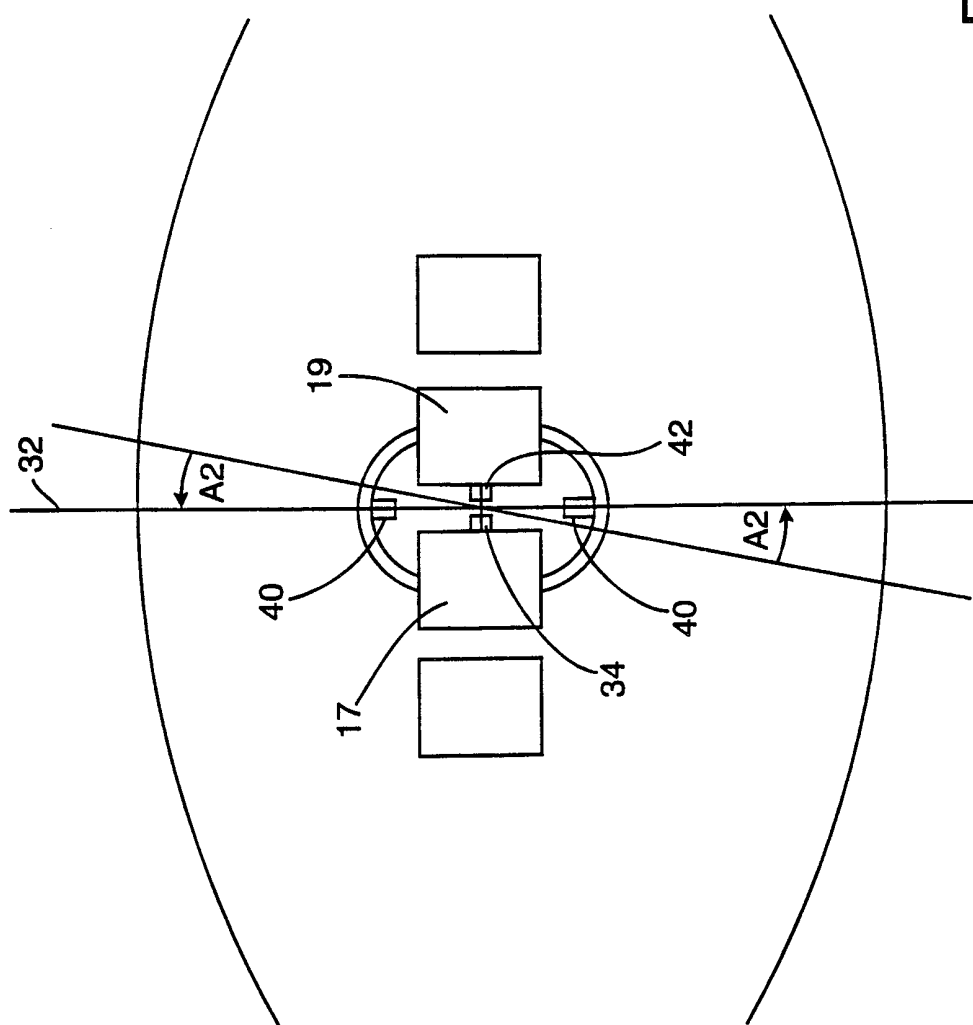


FIG. 6

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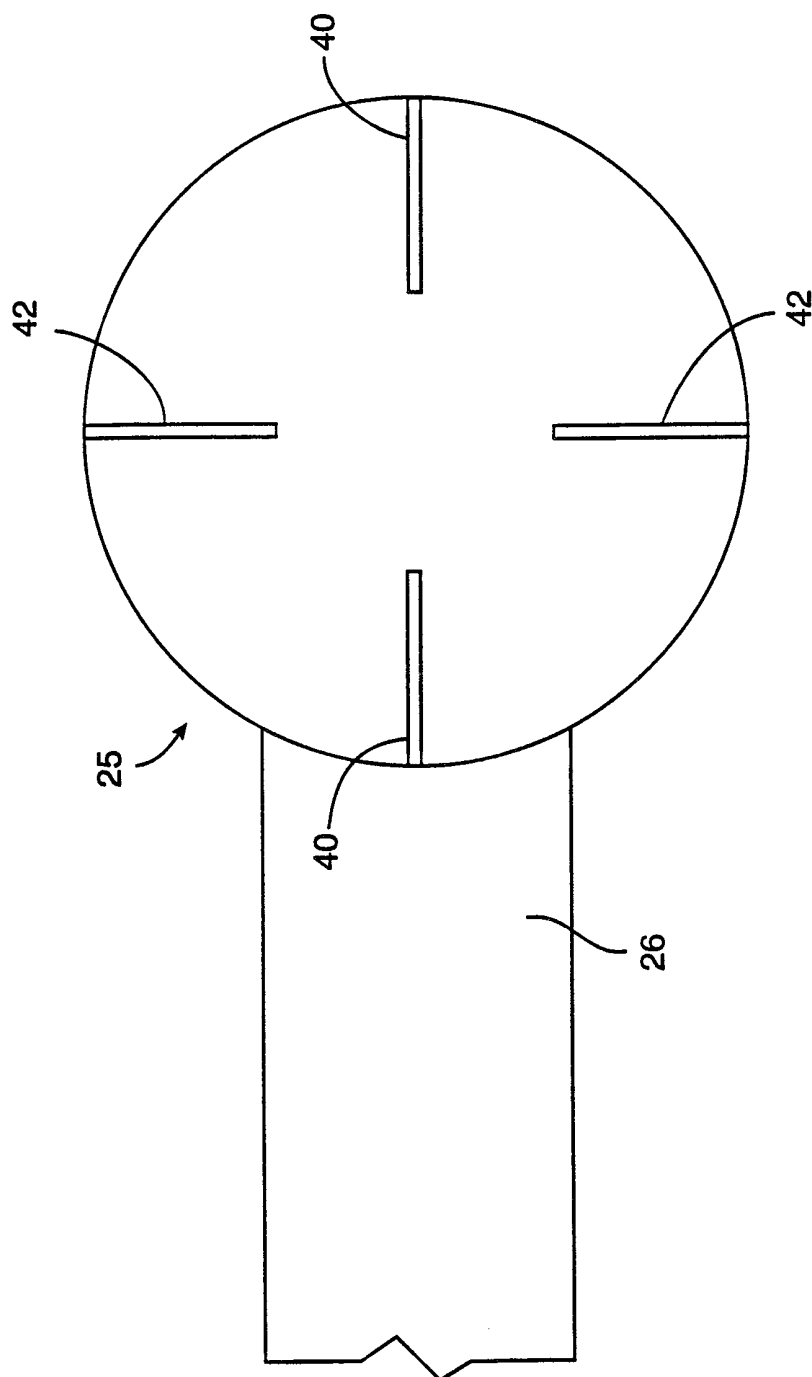


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/12609

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : A61B 6/08

US CL : 378/162,205

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. : 378/162,163,164,205

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,722,336 A (KIM et al.) 02 February 1988 (02.02.1988), figures 1, 15-18, element 90.	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

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