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(54) ULTRASONIC PUNCTURE NEEDLE

ULTRASCHALL-DURCHSTECHNADEL

AIGUILLE DE PERÇAGE À ULTRASONS

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EP-A1- 1 426 011
WO-A-01/26554
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JP-A- 2004 181 095
US-A- 5 759 154
US-A- 6 053 870

- **STEPHANTS C.G. ET AL: 'Trihedral rectangular ultrasonic reflector for distance measurements.' NDT E INT. vol. 28, no. 2, April 1995, pages 95 - 96, XP002991400**

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EP 1 908 406 B1

Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to a puncture needle for a medical application, and more particularly, to a puncture needle used under displaying ultrasonic image.

2. RELATED ART

[0002] In the medical field, a puncture needle (biopsy needle, insulated electrode needle) is used, for example, for gathering a part of a tissue or a cell of a human organism is gathered for the purpose of diagnostic confirmation of a lesion, or for precisely finding a location of a nerve. For this case, an ultrasonic diagnostic equipment is used from a requirement of precisely recognizing a location of the puncture needle, particularly a location of tip end thereof. For example, in a case of using a biopsy needle, needle puncturing is conducted while observing an ultrasonic echo from the tip end of the puncture needle by displaying a pictorial image, to precisely finding as to whether a tissue collecting part of the tip end of the puncture needle (a needle point or a notch) reaches the lesion. Further, this biopsy needle often has a dual structure comprising an inner tube and an outer tube.

[0003] On the other hand, another puncture needle called as an insulated electrode block needle in general has a single tube structure (single-needle), in that an electrical insulation coating is provided on a surface of the needle tube except an edge surface thereof. The insulated electrode block needle is generally used for searching the nerve by using a muscle contraction caused by an electric stimulation, in order to conduct a nerve block by dosing anesthetics or painkiller to the nerve. In recent years, a manual technique to puncture the needle while observing the ultrasonic image together with energization by a conventional nerve stimulator (puncturing under irradiation of the ultrasonic wave and confirmation by the nerve stimulator) has been widely used in an approach of the nerve search.

[0004] The ultrasonic image is an image obtained by irradiating an ultrasonic wave from an ultrasonic probe (ultrasonic transducer) as a transmitting and receiving device of the ultrasonic wave to the puncture needle via a medium, receiving a reflected wave (ultrasonic echo) from the puncture needle at the ultrasonic probe, and conducting an image processing on the reflected wave to display an image on a display unit.

[0005] As the conventional puncture needles to be used while displaying the ultrasonic image, for example, a puncture needle provided with a protrusion, a V-groove or the like at its outer periphery surface of the tip end (for example, see patent document 1). a puncture needle provided with a circular groove at its outer periphery surface (for example, see patent documents 2, 3), a puncture needle provided with an enhanced portion comprising a cylindrical protruding portion and a circular groove at its tip end (for example, see patent documents 4. 5) are known. Configuration of the protrusion, the groove and the like provided at the tip end of any of these puncture needles is designed for easily generating a reflection of the ultrasonic wave.

Patent document **1:** Japanese Patent Laid-Open No. 3-228748
Patent document **2:** Japanese Patent Laid-Open No. 11-76254
Patent document **3:** Japanese Utility Model Laid-Open No. 3-73113
Patent document **4:** Japanese Patent Laid-Open No. 2004-181095
Patent document **5:** Japanese Patent Laid-Open No. 2003-144436

Further puncture needles are known from EP 1 426 011, US 5,759,154 and US 6,053,870.

[0006] However, according to the conventional puncture needles in which the ultrasonic wave is reflected back by machining the tip end, an angle made by an irradiation path of the ultrasonic wave and an axis of the puncture needle is small. In particular, when the angle is not great than **45**°, a level of the ultrasonic echo returned to the ultrasonic probe is decreased, so that the ultrasonic image of the puncture needle becomes unclear, and as a result, it is difficult to recognize a precise location of the puncture needle.

[0007] According to the present invention there is provided an ultrasonic puncture needle for conducting puncturing while observing a puncturing condition by an ultrasonic image, and comprising: a needle tube main body having an edge at its tip end characterized in that: a plurality of corner cube mirrors are provided at a region in the vicinity of the edge and are formed in plural lines in a longitudinal direction of a surface of the needle tube main body, and each corner cube mirror comprises three mirror surfaces, wherein the corner cube mirrors are formed along lines with a predetermined interval in a circumferential direction of the needle tube main body.

[0008] Accordingly it is an advantage of the present invention to provide a puncture needle, which can be clearly imaged, even though an irradiation angle of a detection wave such as an ultrasonic wave of an ultrasonic probe and an

axis of the puncture needle is small.

[0009] According to a feature of the present invention, so as to solve the above problem, an ultrasonic puncture needle for conducting puncturing while observing a puncturing condition by an ultrasonic image, comprising a needle tube main body comprising an edge at its tip end characterized in that: at least one corner cube mirror configured by three mirror surfaces that are perpendicular to each other is provided at a predetermined position of the needle tube main body. Herein, the needle tube main body
may comprise an inner needle or an outer needle of a double needle, a single tube structure, or other kinds of needles. The corner cube mirror is provided at an outer surface or an edge surface thereof, regardless the needle tube main body comprises the inner needle, the outer needle, or the single tube structure.

[Effects of the Invention]

[0010] According to the puncture needle of the present invention, it is possible to clearly image a needle tube main body, particular a tip end of the needle tube main body, even though an angle made by an irradiation angle of a detection wave such as an ultrasonic wave of an ultrasonic probe and an axis of the puncture needle is small.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG.1 shows a puncture needle in a preferred embodiment according to the present invention, wherein **FIG.1A** is a perspective view thereof, and **FIG.1B** is a cross sectional view thereof along A-A line in **FIG.1A**;
FIG.2 shows a corner cube mirror shown in **FIG.1**, wherein **FIG.2A** is an explanatory diagram showing a structure and a function of the corner cube mirror, and **FIG.2B** is an explanatory diagram showing an example of application; and
FIG.3 shows a double needle provided with the corner cube mirror, wherein **FIG.3A** is a perspective view of a structure in which the corner cube mirror is provided at an edge surface of an inner needle, and **FIG.3**B is a perspective view of a structure in which the corner cube mirror is provided at an inner periphery surface of an outer needle.

[Reference numerals]

[0012]

1	puncture needle
11	puncture needle main body
12	comer cube mirror
12a, 12b, 12c	first to third mirror surfaces
13	edge
14	edge surface
20	ultrasonic probe
21	outer needle
22	edge surface of the inner needle
24	edge surface of the outer needle
30	double needle

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

BEST MODE FOR CARRYING OUT THE INVENTION

[0013] **FIG.1** shows a puncture needle in a preferred embodiment according to the present invention. In **FIG.1**, **FIG. A** is a perspective view thereof, and **FIG.1B** is a cross sectional view thereof along A-A line in **FIG.1A.**

[0014] An ultrasonic puncture needle (hereinafter referred as "puncture needle") **1**, which is a needle tube, comprises a puncture needle main body **11** which is a needle tube main body comprising a metal capillary made of stainless steel or the like, and a plurality of corner cube mirrors **12** provided at an outer surface (outer periphery surface) of a tip end of the puncture needle main body **11.**

[0015] The puncture needle main body **11** comprises an edge **13** including an edge surface **14** made by diagonally cutting its tip portion. The corner cube mirror **12** comprises a triangular pyramid-shaped recess provided at a surface of the puncture needle main body **11** at a region in vicinity of the edge **13,** and the corner cube mirrors **12** are formed along three lines with a predetermined interval in a circumferential direction of the puncture needle main body **11**. For example,

the corner cube mirrors **12** are disposed with an interval of **45°** with respect to a center of the needle tube, and eight mirrors are formed per one line. In addition, the number of the corner cube mirrors **12** to be used and the number of lines are not limited to eight and three respectively as described above, and may be arbitrary numbers. The corner cube mirrors **12** are provided at the surface of the puncture needle main body **11,** however, the present invention is not limited thereto, and may be provided at an inner periphery surface of the puncture needle main body **11** or both of them.

[0016] It is preferable to form the corner cube mirror **12** in vicinity of the edge **13,** so as to clarify an imaging of the tip end. For example, the corner cube mirror **12** may be formed by electric discharge machining. Alternatively, the corner cube mirror 12 may be punched by a tool such as punches.

[0017] **FIG.2** shows a function of the corner cube mirror. This corner cube mirror **12** is configured by three mirror surfaces that are perpendicular to each other, and an incident wave is reflected back by the three mirror surfaces, and emitted as an output wave that is parallel to the incident wave.

[0018] As shown in **FIG.2A,** three faces (ABFE, EFGH, AEHD) of a cube (ABCD-EFGH) are provided as mirror surfaces, and AFH is opened. An opening with a triangular-pyramid shape having a base point E and a top face AFH is provided as the corner cube mirror **12.**

[0019] In **FIG.2A,** an incident wave L_1 which is incident to the corner cube mirror **12** is reflected at a reflecting point R_1 of a first mirror surface **12a** in the AEHD face to provide a reflected wave L_2, the reflected wave L_2 is reflected at a reflecting point R_2 of a second mirror surface **12b** in the ABFE face to provide a reflected wave L_3, and the reflected wave L_3 is reflected at a reflecting point R_3 of a third mirror surface **12c** in the EFGH face to provide an output wave L_4.

[0020] In **FIG.2B,** the incident wave L_1 is emitted from an ultrasonic probe **20,** and the output wave L_4 is received by the ultrasonic probe **20.** According to this structure it is possible to detect the edge **13** including the edge surfaces **14** of the puncture needle main body **11** of the puncture needle **1** by virtue of the corner cube mirrors **12.**

[0021] As described above, the incident wave and the reflected wave of the ultrasonic wave which is incident to the corner cube mirrors **12** are parallel or substantially parallel to each other. Therefore, the ultrasonic wave transmitted from the ultrasonic probe **20** is necessarily reflected at the corner cube mirror **12** to be returned to the ultrasonic probe **20,** so that the reflected wave is directed to an output direction of the incident wave of the ultrasonic wave and surely returned to the ultrasonic probe **20** that is an emitting side of the ultrasonic wave, even when the angle made by the irradiation path of the ultrasonic wave and the axis of the puncture needle is small.

[0022] **FIG.3** shows a double needle **30** provided with the corner cube mirrors, wherein **FIG.3A** is a perspective view of the double needle **30** in which an inner needle (no reference numeral) having an edge surface **22** is inserted into an outer needle **21** having an edge surface **24,** and **FIG.3B** is a perspective view of the outer needle **21** from which the inner needle is detached.

[0023] In **FIG.3A,** the inner needle comprises the corner cube mirrors **12** provided on the edge surface **22.** According to this structure, it is possible to precisely detect a tip end of the double needle **30.**

[0024] In **FIG.3**B, the corner cube mirror **12** is provided on an inner periphery surface of the edge surface **24** of the outer needle **21.** According to this structure, it is possible to precisely detect a tip end of the outer needle **21** in the state that the inner needle is detached.

(Effect of the preferred embodiment)

[0025] According to this preferred embodiment, following effects can be obtained

(a) By providing the puncture needle with the corner cube mirror, the incident wave and the reflected wave of the ultrasonic wave in the puncture needle are made parallel or substantially parallel to each other, so that the ultrasonic wave output from the ultrasonic probe is reflected at the puncture needle and returned to the ultrasonic probe. Therefore, even though the angle made by the irradiation path of the ultrasonic wave and the axis of the puncture needle is reduced, the ultrasonic wave is reflected by the corner cube mirror and returned to the ultrasonic probe, so that it is possible to clearly image the puncture needle, particularly, the tip end thereof.

(b) By providing the corner cube mirror in vicinity of the edge, it is possible to clarify the imaging of the tip end.

(c) By providing a plurality of the corner cube mirrors at a periphery of the puncture needle, the incident wave and the reflected wave of the ultrasonic wave in the puncture needle are made parallel or substantially parallel to each other regardless the orientation of the puncture needle, so that it is possible to clearly image the puncture needle regardless the orientation of the puncture needle.

(d) By providing the corner cube mirrors in plural lines, it is possible to surely generate the reflected wave.

(e) Since the corner cube mirror has a good reflecting efficiency, so that it is possible to obtain a good reflecting property regardless the type of the puncture needle. In particular, by providing the corner cube mirror at the outer surface of the inner needle of the double needle, it was possible to obtain an excellent reflecting property by a synergistic effect with an air layer existing between the inner needle and the outer needle. However, it was also possible to obtain the excellent reflecting property according to a structure in which the corner cube mirror is provided

at an outer surface of the single tube structure and a coating is provided at the outer periphery thereof.

[Other preferred embodiments]

[0026] The present invention is not limited to the preferred embodiment described above, and may be modified without going beyond or transforming a technical concept of the present invention.

[0027] For example, the present invention may be applied to all puncture needles to be punctured to a target while observing a location of the needle tube punctured into the human body by the ultrasonic echo, such as a PTC (Percutaneous Transhepatic Cholangiography) needle for cholangiography, a puncture needle for an ultrasonic endoscope, and the like.

[0028] In case that a fluorine resin is coated on a part other than the edge **13** in the puncture needle provided with the corner cube mirror **12**, in order to compose an insulated electrode block needle, it possible to clearly image the insulated electrode block needle, similarly to the above. By the way, since the conventional insulated electrode block needle does not comprise the corner cube mirror **12**, the image was unclear due to an attenuation caused by the insulation coating.

[0029] In addition, the present invention is not limited to the use of the ultrasonic wave, and may be applied, for example, to a light such as a laser beam, electron beam, or the like. Therefore, the present invention may be applied to an application for confirming a location of an article to be detected such as needle by using the reflected wave of an electromagnetic wave by the corner cube mirror. Further, the reflecting surface of the corner cube mirror **12** is not necessarily a plane surface.

[Industrial applicability]

[0030] The corner cube mirror formed at the outer surface of the needle tube can generate the reflected wave that is parallel or substantially parallel to the incident wave of the detection wave of the ultrasonic wave or the like, so that it is applicable to a purpose for clarifying the image of the needle tube existing in a range to which the detection wave of the ultrasonic wave or the like output from the ultrasonic probe or the like reaches, for example, a medical apparatus and a medical equipment.

Claims

1. An ultrasonic puncture needle (1) for conducting puncturing while observing a puncturing condition by an ultrasonic image, and comprising: a needle tube main body (11) having an edge at its tip end wherein:

   a plurality of corner cube mirrors (12) are provided at a region in the vicinity of the edge and are formed in plural lines in a longitudinal direction of a surface of the needle tube main body, and
   each corner cube mirror comprises three mirror surfaces (12a, 12b, 12c) wherein the corner cube mirrors are formed along lines with a predetermined interval in a circumferential direction of the needle tube main body.

2. The ultrasonic puncture needle, according to Claim 1, wherein the plurality of corner cube mirrors (12) are provided at an outer surface of the needle tube main body (11).

3. The ultrasonic puncture needle, according to any one of Claims 1 or 2, wherein the needle tube main body (11) comprises a single tube structure, an inner needle of a double needle or an outer needle of the double needle.

4. The ultrasonic puncture needle, according to Claim 1, wherein the needle tube main body (11) comprises the outer needle of a double needle and the plurality of corner cube mirrors are provided at an inner surface of an outer needle.

5. The ultrasonic puncture needle, according to any one of Claims 1 to 4, wherein the needle tube main body (11) is provided with a resin coating at a part other than the edge (13).

6. The ultrasonic puncture needle, according to any one of Claims 1 to 5, wherein the three mirror surfaces (12a, 12b, 12c) of the each corner cube mirror (12) define a detection hole having a first reflecting surface (12a) for receiving a detection wave from outside the puncture needle and reflecting a first reflected wave, and a third reflecting surface (12c) for receiving the first reflected wave via a second reflecting surface (12b) and reflecting a second reflected wave that is parallel or substantially parallel to the detection wave.

7. The ultrasonic puncture needle, according to Claim 1, wherein at least one of the corner cube mirrors is provided

adjacent an edge of the needle tube main body (12).

8. The ultrasonic puncture needle, according to Claim 3, wherein at least one of the corner cube mirrors is provided at an inner surface adjacent an edge of the outer needle.

9. The ultrasonic puncture needle, according to Claim 1, wherein a plurality of the corner cube mirrors is formed per one line.

Patentansprüche

1. Ultraschallpunktionsnadel (1) zum Vornehmen von Punktion und dabei Beobachten eines Punktionszustands mittels eines Ultraschallbilds, die Folgendes umfasst: einen Nadelröhren-Hauptkörper (11) mit einer Schneide an ihrem Spitzenende, wobei:

   eine Vielzahl von Eckwürfelreflektoren (12) in einer Region in der Nähe der Schneide vorgesehen sind und in mehreren Linien in einer Längsrichtung auf einer Oberfläche des Nadelröhren-Hauptkörpers gebildet sind, und jeder Eckwürfelreflektor drei Reflektorflächen (12a, 12b, 12c) umfasst, wobei die Eckwürfelreflektoren entlang Linien mit einem vorherbestimmten Abstand in einer Umfangsrichtung des Nadelröhren-Hauptkörpers gebildet sind.

2. Ultraschallpunktionsnadel nach Anspruch 1, wobei die Vielzahl von Eckwürfelreflektoren (12) an einer Außenfläche des Nadelröhren-Hauptkörpers (11) vorgesehen sind.

3. Ultraschallpunktionsnadel nach einem der Ansprüche 1 oder 2, wobei der Nadelröhren-Hauptkörper (11) eine Einröhrenstruktur, eine innere Nadel einer Doppelnadel oder eine äußere Nadel der Doppelnadel umfasst.

4. Ultraschallpunktionsnadel nach Anspruch 1, wobei der Nadelröhren-Hauptkörper (11) die äußere Nadel einer Doppelnadel umfasst und die Vielzahl von Eckwürfelreflektoren an einer Innenfläche einer äußeren Nadel vorgesehen sind.

5. Ultraschallpunktionsnadel nach einem der Ansprüche 1 bis 4, wobei der Nadelröhren-Hauptkörper (11) an einem anderen Teil als der Schneide (13) mit einer Harzbeschichtung versehen ist.

6. Ultraschallpunktionsnadel nach einem der Ansprüche 1 bis 5, wobei die drei Reflektorflächen (12a, 12b, 12c) jedes Eckwürfelreflektors (12) Folgendes definieren: ein Detektionsloch mit einer ersten reflektierenden Fläche (12a) zum Empfangen einer Detektionswelle von außerhalb der Punktionsnadel und Reflektieren einer ersten reflektierten Welle und eine dritte reflektierende Fläche (12c) zum Empfangen der ersten reflektierten Welle über eine zweite reflektierende Fläche (12b) und Reflektieren einer zweiten reflektierenden Welle, die zur Detektionswelle parallel oder im Wesentlichen parallel ist.

7. Ultraschallpunktionsnadel nach Anspruch 1, wobei mindestens einer der Eckwürfelreflektoren benachbart zu einer Schneide des Nadelröhren-Hauptkörpers (12) vorgesehen ist.

8. Ultraschallpunktionsnadel nach Anspruch 3, wobei mindestens einer der Eckwürfelreflektoren an einer Innenfläche benachbart zu einer Schneide der äußeren Nadel vorgesehen ist.

9. Ultraschallpunktionsnadel nach Anspruch 1, wobei pro Linie eine Vielzahl der Eckwürfelreflektoren gebildet ist.

Revendications

1. Aiguille de perçage à ultra-sons (1) pour réaliser un perçage tout en observant une condition de perçage au moyen d'une image à ultrasons, et comprenant : un corps principal tubulaire d'aiguille (11) ayant un bord au niveau de son extrémité de pointe dans laquelle :

   une pluralité de miroirs prismatiques (12) est fournie au niveau d'une région au voisinage du bord et est formée sur plusieurs lignes dans un sens longitudinal d'une surface du corps principal tubulaire d'aiguille, et

chaque miroir prismatique comprend trois surfaces de miroir (12a, 12b, 12c), les miroirs prismatiques étant formés le long de lignes avec un intervalle prédéterminé dans un sens circonférentiel du corps principal tubulaire d'aiguille.

2. Aiguille de perçage à ultra-sons, selon la revendication 1, dans laquelle la pluralité de miroirs prismatiques (12) est fournie au niveau d'une surface externe du corps principal tubulaire d'aiguille (11).

3. Aiguille de perçage à ultra-sons, selon l'une quelconque des revendications 1 ou 2, dans laquelle le corps principal tubulaire d'aiguille (11) comprend une structure tubulaire unique, une aiguille interne d'une double aiguille ou une aiguille externe de la double aiguille.

4. Aiguille de perçage à ultra-sons, selon la revendication 1, dans laquelle le corps principal tubulaire d'aiguille (11) comprend l'aiguille externe d'une double aiguille et la pluralité de miroirs prismatiques est fournie au niveau d'une surface interne d'une aiguille externe.

5. Aiguille de perçage à ultra-sons, selon l'une quelconque des revendications 1 à 4, dans laquelle le corps principal tubulaire d'aiguille (11) est doté d'un revêtement de résine au niveau d'une partie autre que le bord (13).

6. Aiguille de perçage à ultra-sons, selon l'une quelconque des revendications 1 à 5, dans laquelle les trois surfaces de miroir (12a, 12b, 12c) dudit chaque miroir prismatique (12) définissent un trou de détection ayant une première surface réfléchissante (12a) pour recevoir une onde de détection depuis l'extérieur de l'aiguille de perçage et réfléchir une première onde réfléchie, et une troisième surface réfléchissante (12c) pour recevoir la première onde réfléchie par l'intermédiaire d'une deuxième surface réfléchissante (12b) et réfléchir une seconde onde réfléchie qui est parallèle ou sensiblement parallèle à l'onde de détection.

7. Aiguille de perçage à ultra-sons, selon la revendication 1, dans laquelle au moins l'un des miroirs prismatiques est fourni adjacent à un bord du corps principal tubulaire d'aiguille (12).

8. Aiguille de perçage à ultra-sons, selon la revendication 3, dans laquelle au moins l'un des miroirs prismatiques est fourni au niveau d'une surface interne adjacente à un bord de l'aiguille externe.

9. Aiguille de perçage à ultra-sons, selon la revendication 1, dans laquelle une pluralité des miroirs prismatiques est formée sur une même ligne.

FIG.1A

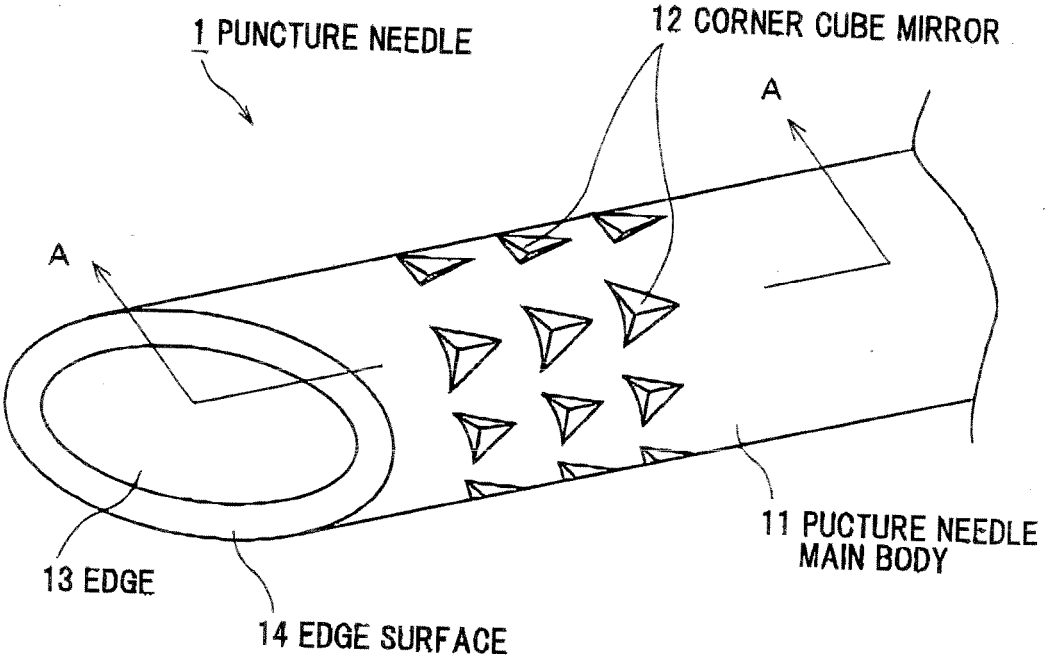

1 PUNCTURE NEEDLE
12 CORNER CUBE MIRROR
A
A
11 PUCTURE NEEDLE MAIN BODY
13 EDGE
14 EDGE SURFACE

FIG.1B

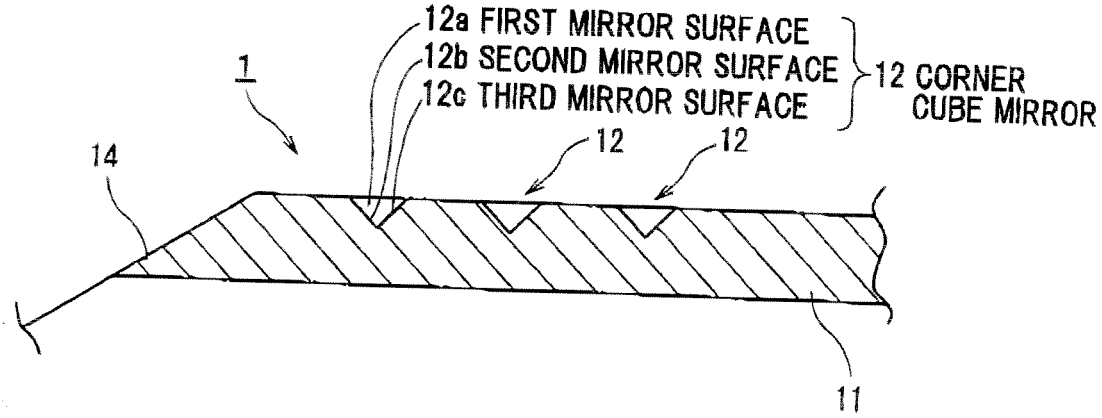

12a FIRST MIRROR SURFACE
12b SECOND MIRROR SURFACE
12c THIRD MIRROR SURFACE
12 CORNER CUBE MIRROR
1
14
12
12
11

FIG.2A

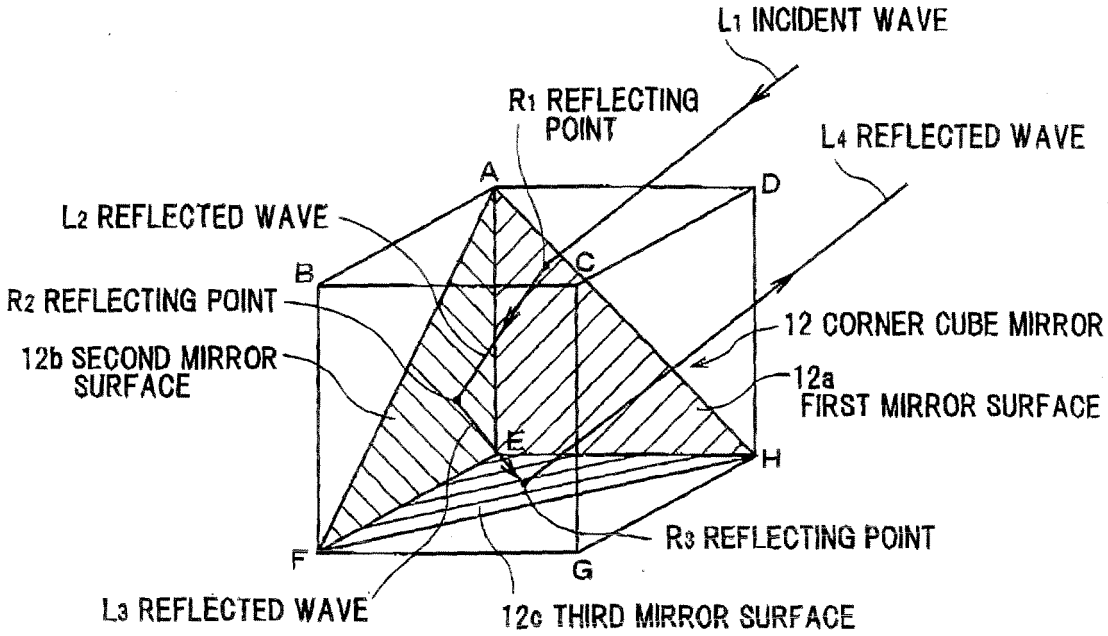

L1 INCIDENT WAVE
R1 REFLECTING POINT
L4 REFLECTED WAVE
A
D
L2 REFLECTED WAVE
B
C
R2 REFLECTING POINT
12 CORNER CUBE MIRROR
12b SECOND MIRROR SURFACE
12a FIRST MIRROR SURFACE
E
H
R3 REFLECTING POINT
F
G
L3 REFLECTED WAVE
12c THIRD MIRROR SURFACE

FIG.2B

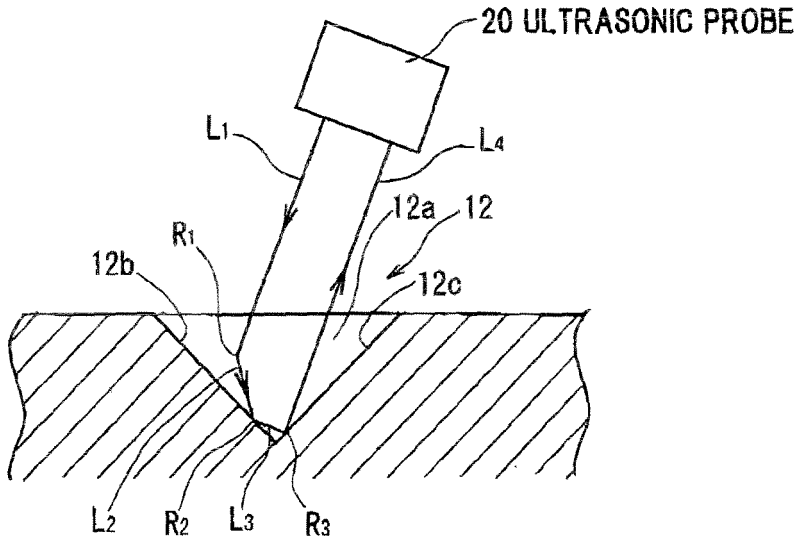

20 ULTRASONIC PROBE
L1
L4
12a
12
R1
12b
12c
L2
R2
L3
R3

FIG.3A

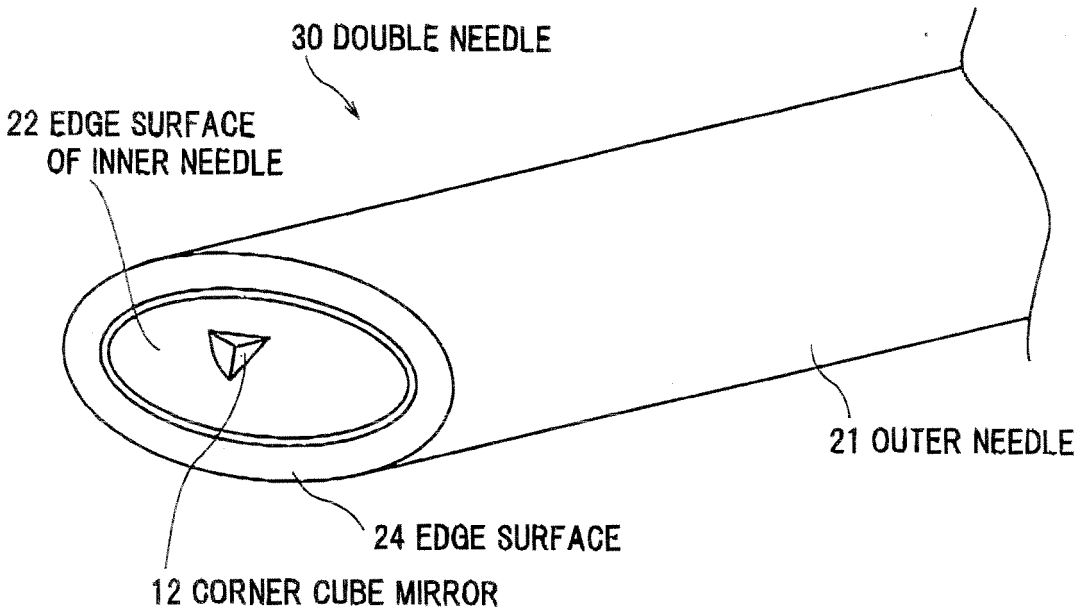
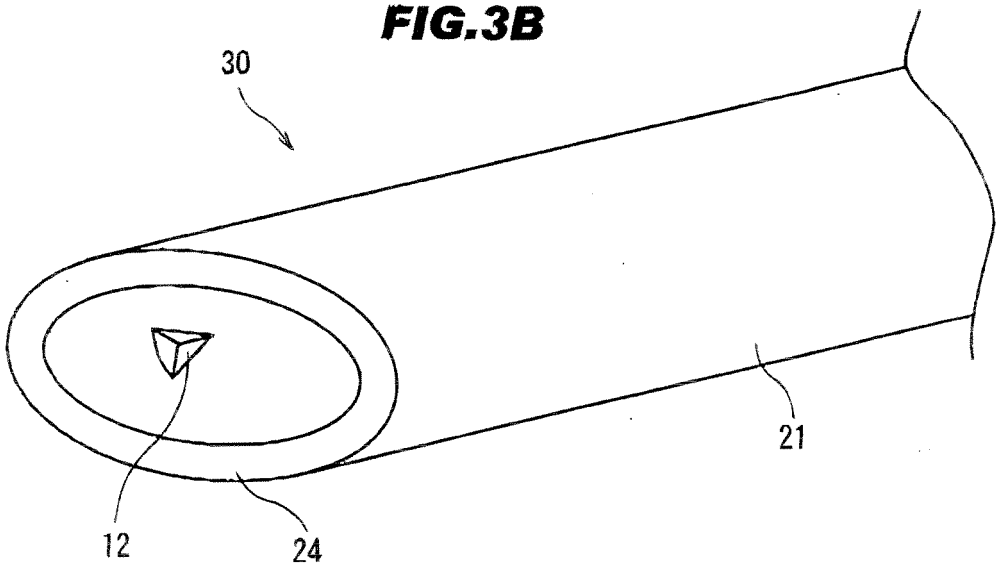

30 DOUBLE NEEDLE
22 EDGE SURFACE OF INNER NEEDLE
21 OUTER NEEDLE
24 EDGE SURFACE
12 CORNER CUBE MIRROR

FIG.3B


30
21
12
24

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	超声波穿刺针		
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摘要(译)

即使与超声波探头的超声波等检测波的照射方向的角度较小，也能够清晰拍摄的穿刺针。根据一个实施例，在穿刺针主体（11）的尖端处形成有边缘（13），其在通过超声图像观察刺穿状态的同时进行穿刺的超声波穿刺针（1），并且形成于穿刺针主体（11）的指定位置，其具有至少一个由三角锥形凹部形成的角隅棱镜（12）。由于从超声波探头振荡的超声波从角隅角镜（12）反射而返回到超声波探头，因此反射波在与超声波的入射方向相同的方向上前进，以确定地返回探头。即使当超声波的照射路径与穿刺针的轴线形成的角度很小时也是如此。

FIG. 1A

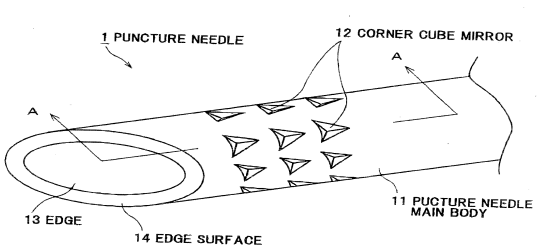

FIG. 1B