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(54) SENTINEL LYMPH NODE DETECTING METHOD

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(52) **U.S. Cl.** **600/425**

(57) **ABSTRACT**

A sentinel lymph node detecting system comprises an inserting portion with a small diameter which can be inserted into the body cavity, an X-ray detecting unit for two-dimensionally detecting X-rays, and an optical imaging unit **3** for taking visible-light images, which are mounted to the tip of the inserting portion. The X-ray detecting unit and the optical imaging unit are disposed along the longitudinal direction of the inserting portion, and are closely disposed one to another so as to observe in the same direction. A radioactive tracer accumulated in sentinel lymph nodes is detected by the X-ray detecting unit. The X-ray detected image is smaller in size than the image taken by the optical imaging unit. Thus, sentinel lymph nodes can be quickly identified in a sure manner, and further, the load placed on a patient, such as the need to perform laparotomy, can be reduced.

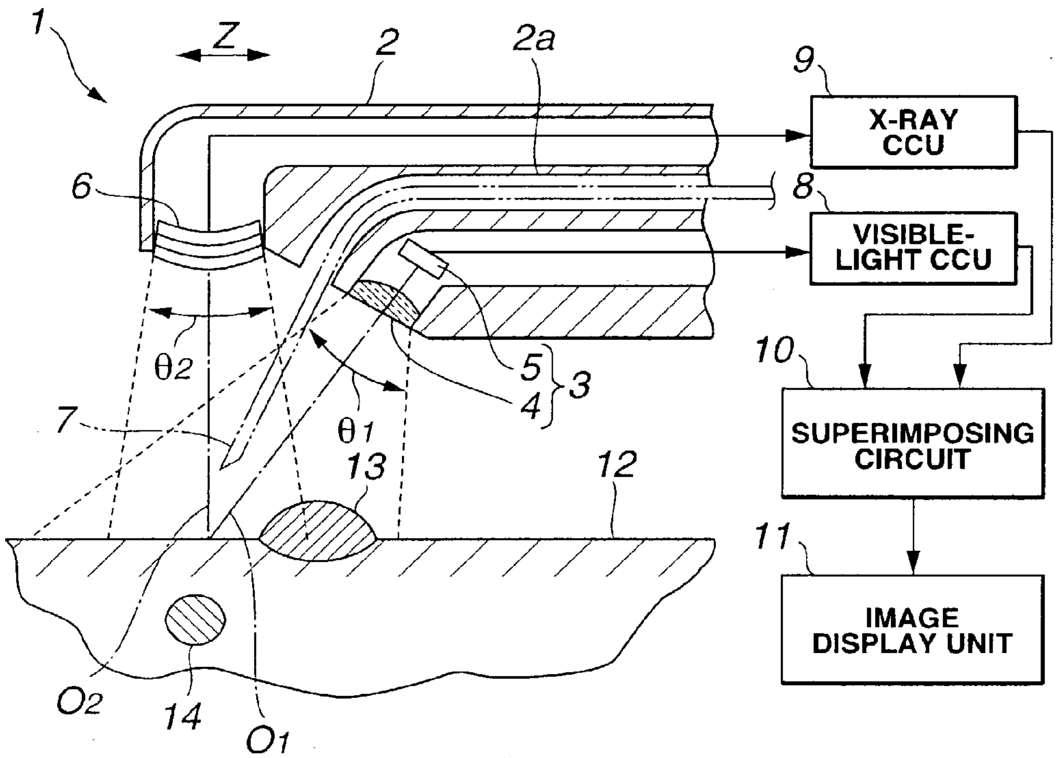


FIG.1

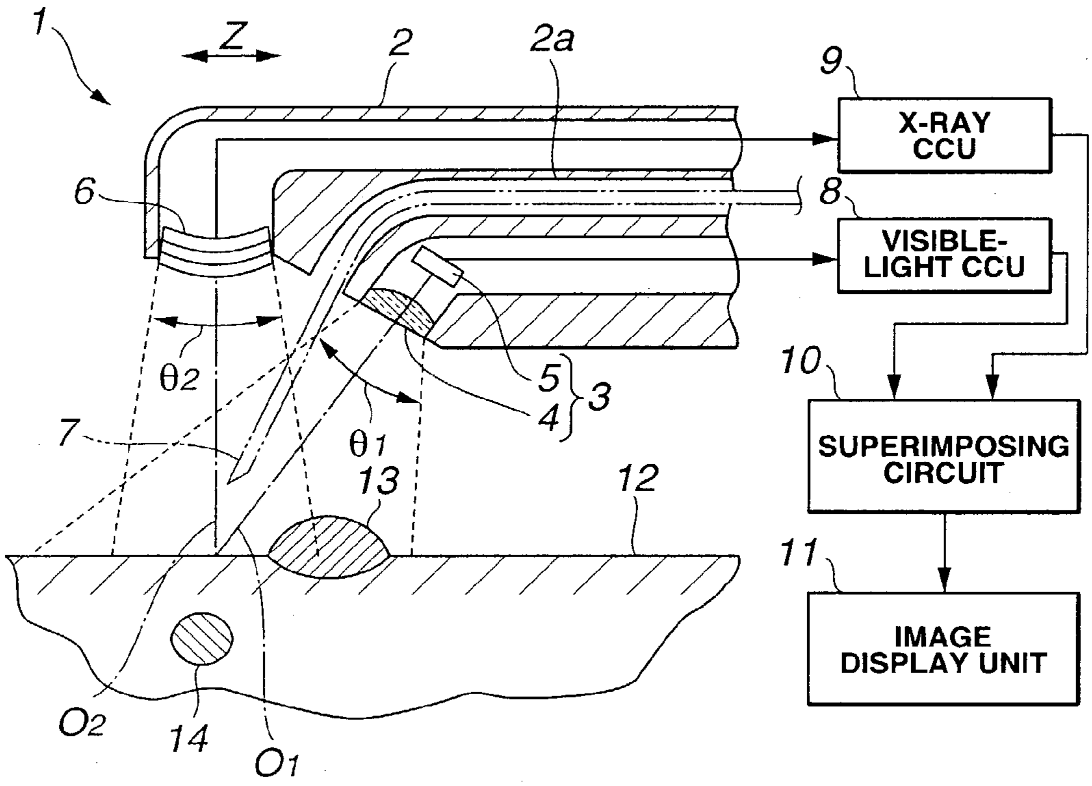

1
Z
2
2a
9
X-RAY CCU
6
8
VISIBLE-LIGHT CCU
θ2
5
3
4
θ1
10
7
13
12
SUPERIMPOSING CIRCUIT
11
IMAGE DISPLAY UNIT
O2
14
O1

FIG.2

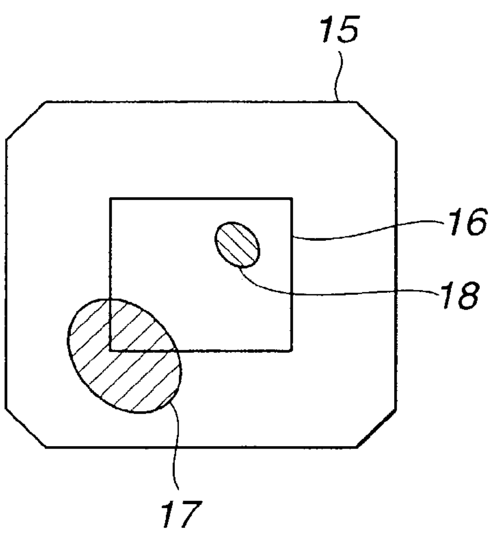

15
16
18
17

FIG.3

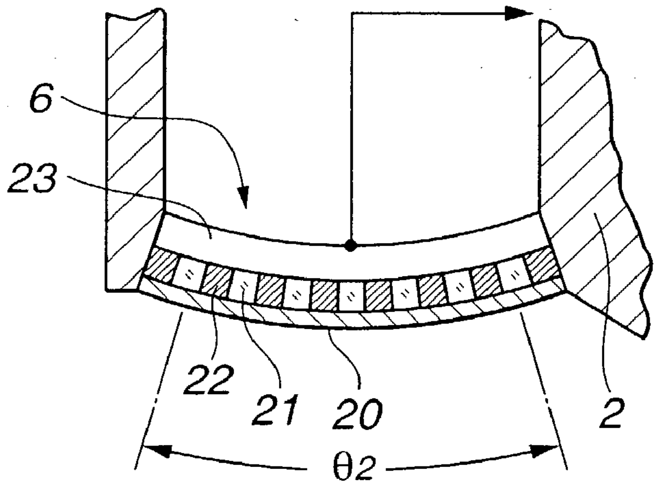


FIG.4

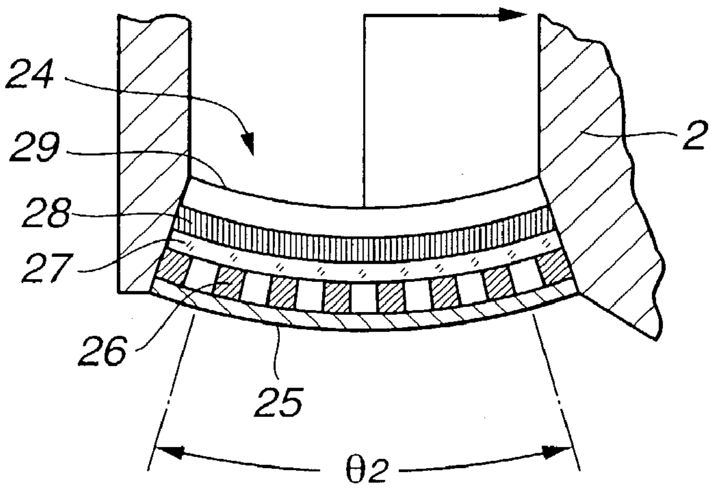


FIG.5

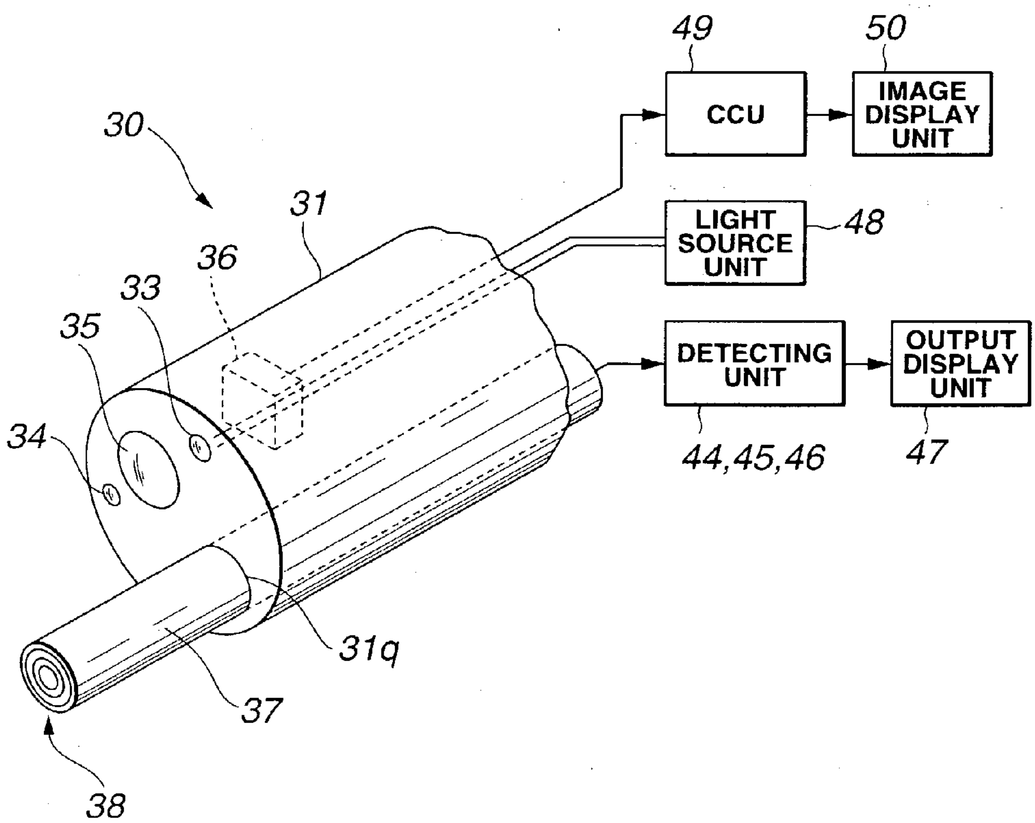

49
50
CCU
IMAGE DISPLAY UNIT
30
31
LIGHT SOURCE UNIT
48
36
33
35
DETECTING UNIT
OUTPUT DISPLAY UNIT
34
44,45,46
47
31q
37
38

FIG.6

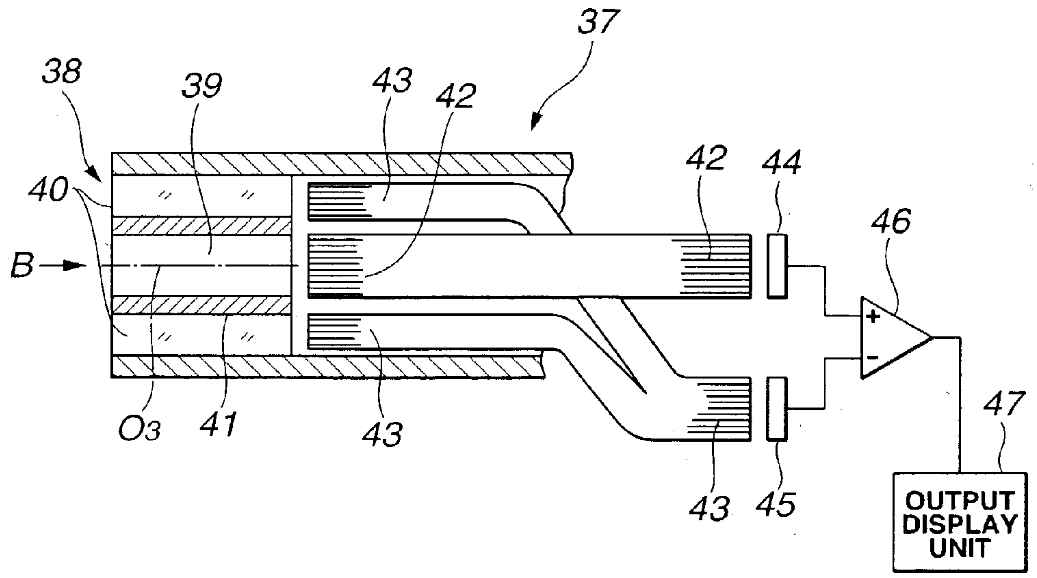

37
38
39
43
42
42
44
40
46
B
O3
41
43
47
43
45
OUTPUT DISPLAY UNIT

FIG.7

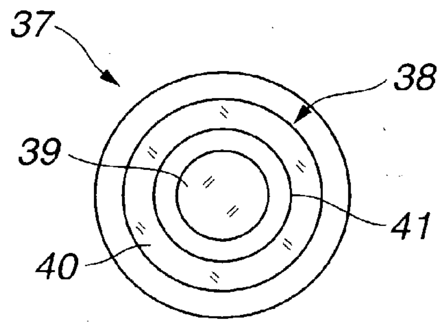


FIG.8

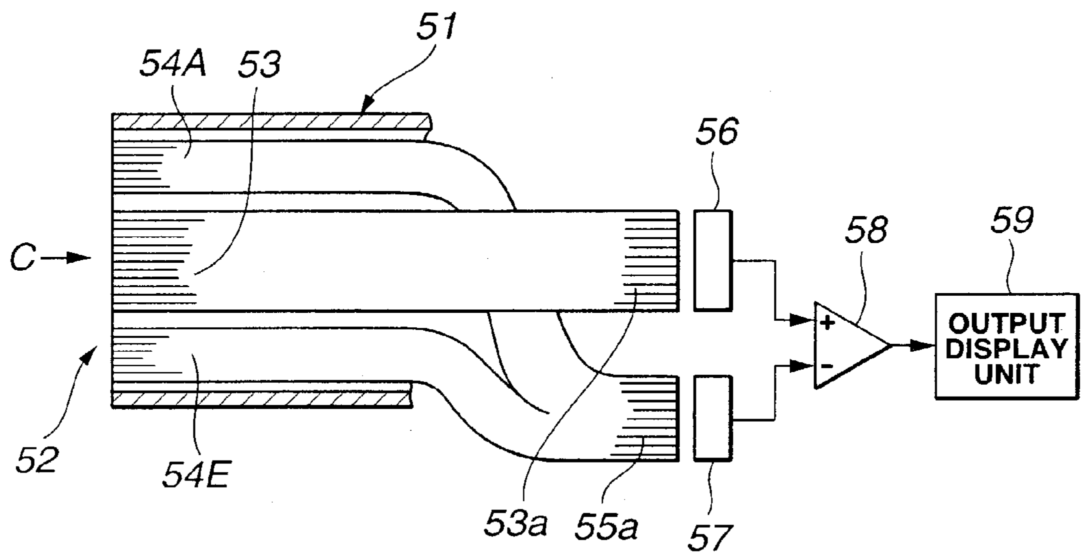


FIG.9

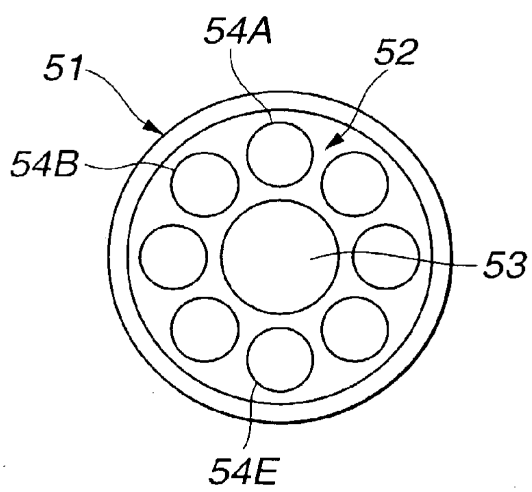


FIG.10

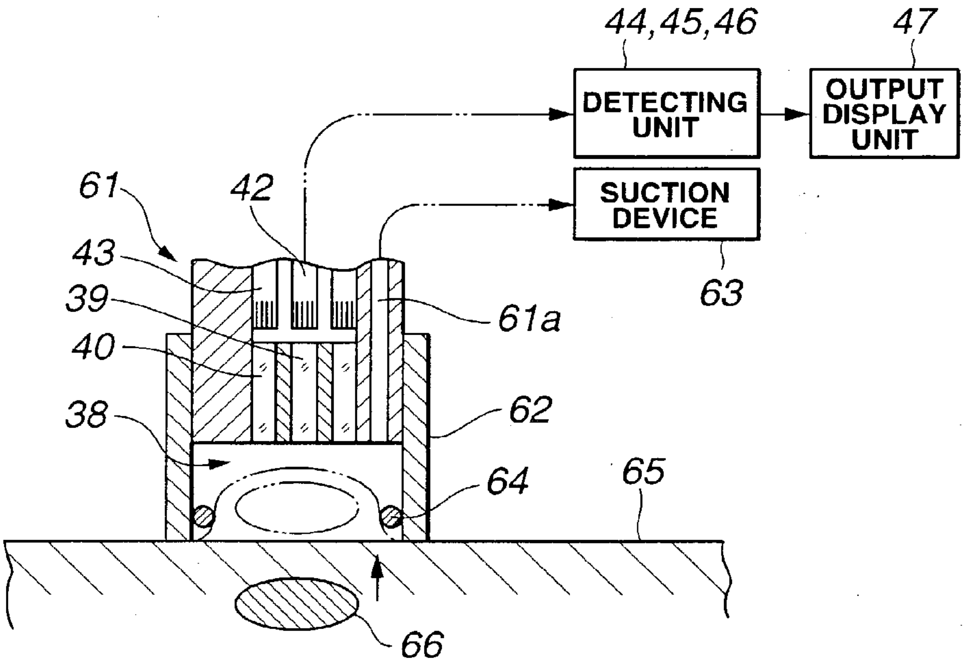

44,45,46
47
DETECTING UNIT
OUTPUT DISPLAY UNIT
SUCTION DEVICE
61
42
43
39
40
38
61a
63
62
64
65
66

FIG.11

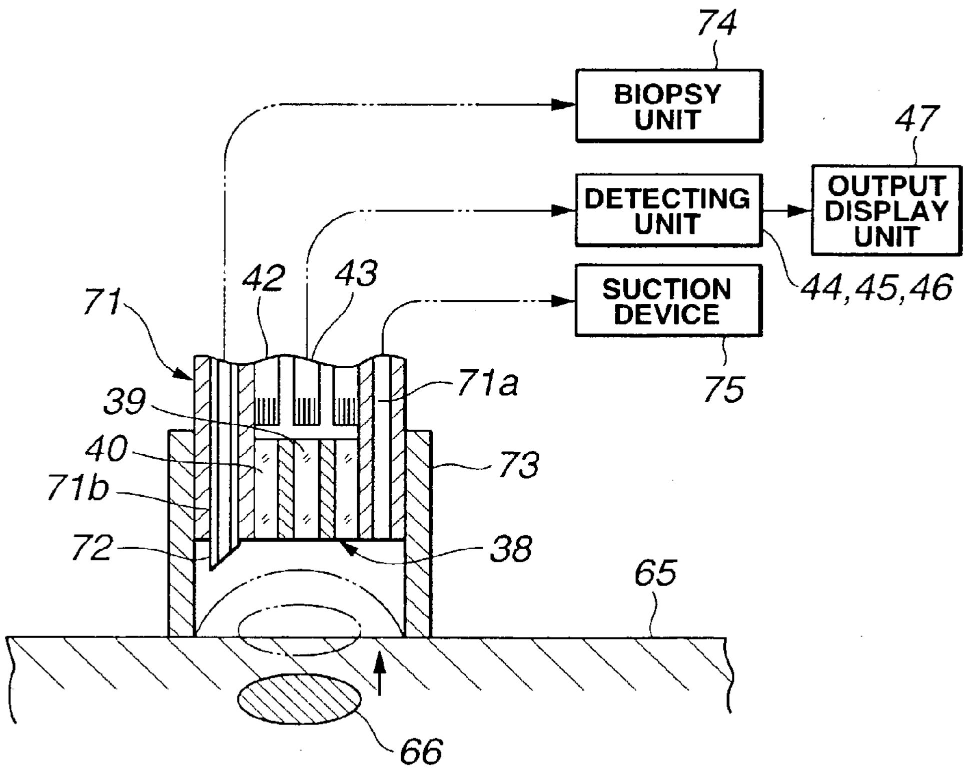

74
BIOPSY UNIT
47
DETECTING UNIT
OUTPUT DISPLAY UNIT
SUCTION DEVICE
44,45,46
71
42
43
71a
75
39
40
71b
72
73
38
65
66

FIG.12

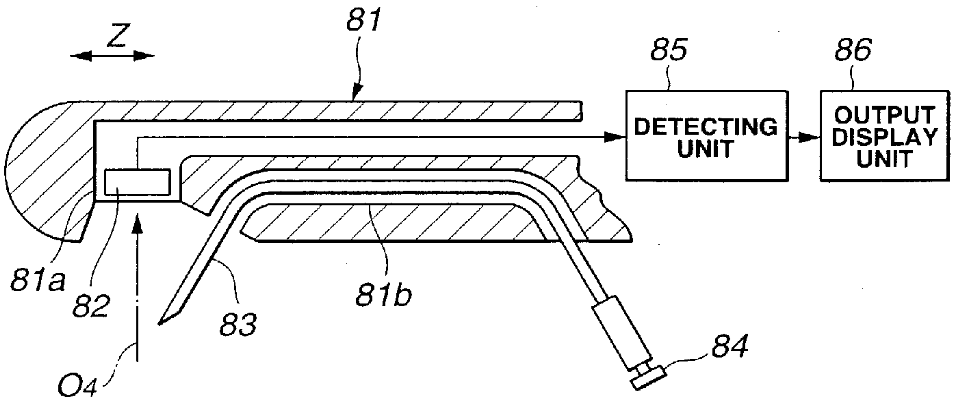
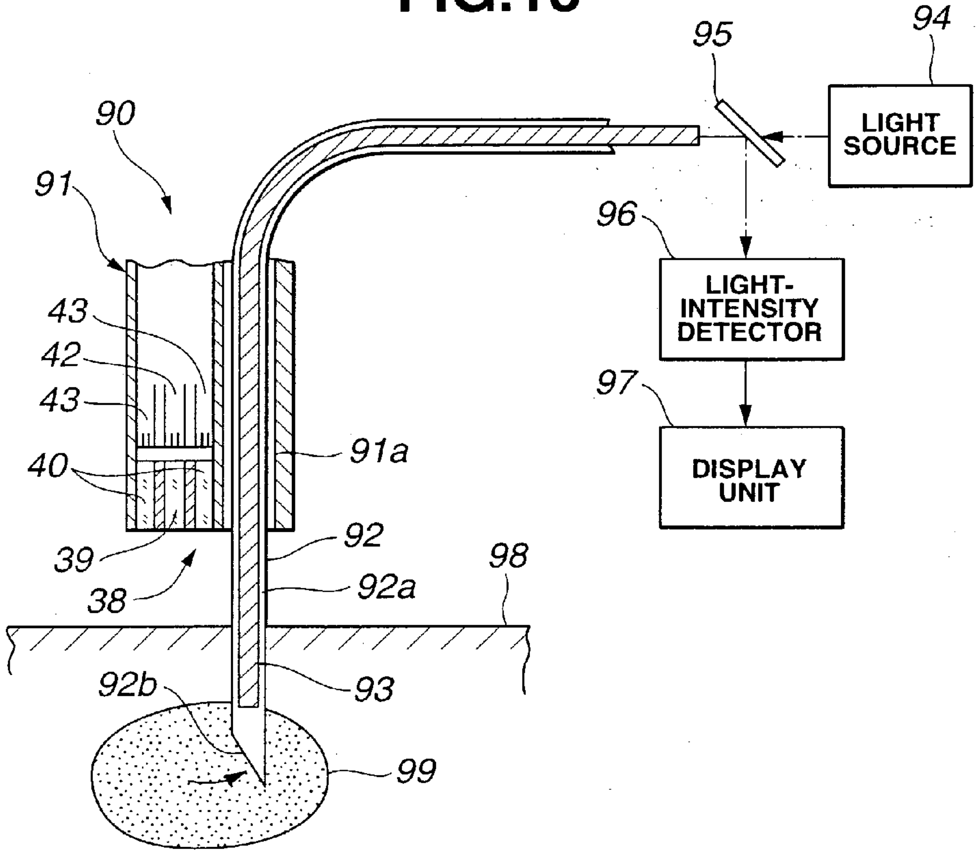
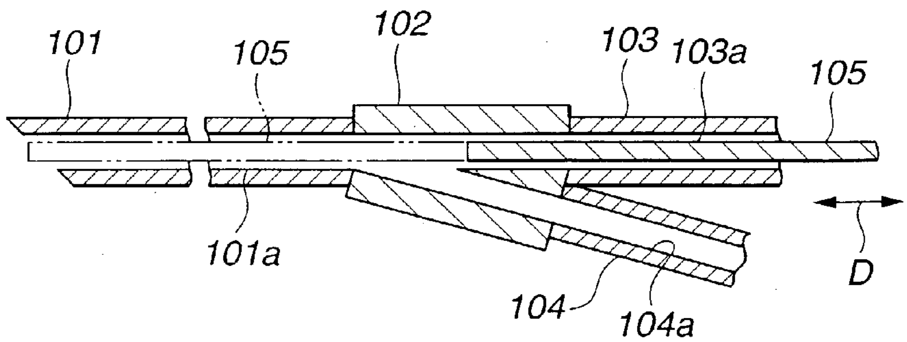

Z
81
85
86
DETECTING UNIT
OUTPUT DISPLAY UNIT
81a
82
83
81b
84
O4

FIG.13



94
95
LIGHT SOURCE
90
91
96
LIGHT-INTENSITY DETECTOR
43
42
43
97
91a
40
DISPLAY UNIT
92
39
98
92a
38
92b
93
99

FIG.14



101
105
102
103
103a
105
101a
D
104
104a

FIG.15

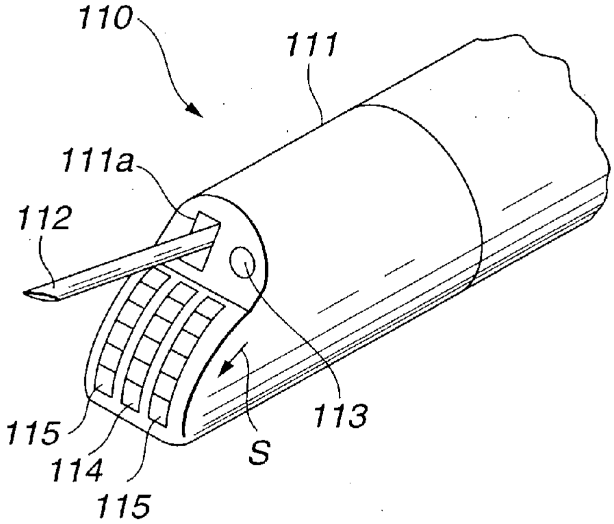

110
111
111a
112
113
115
114
115
S

FIG.16

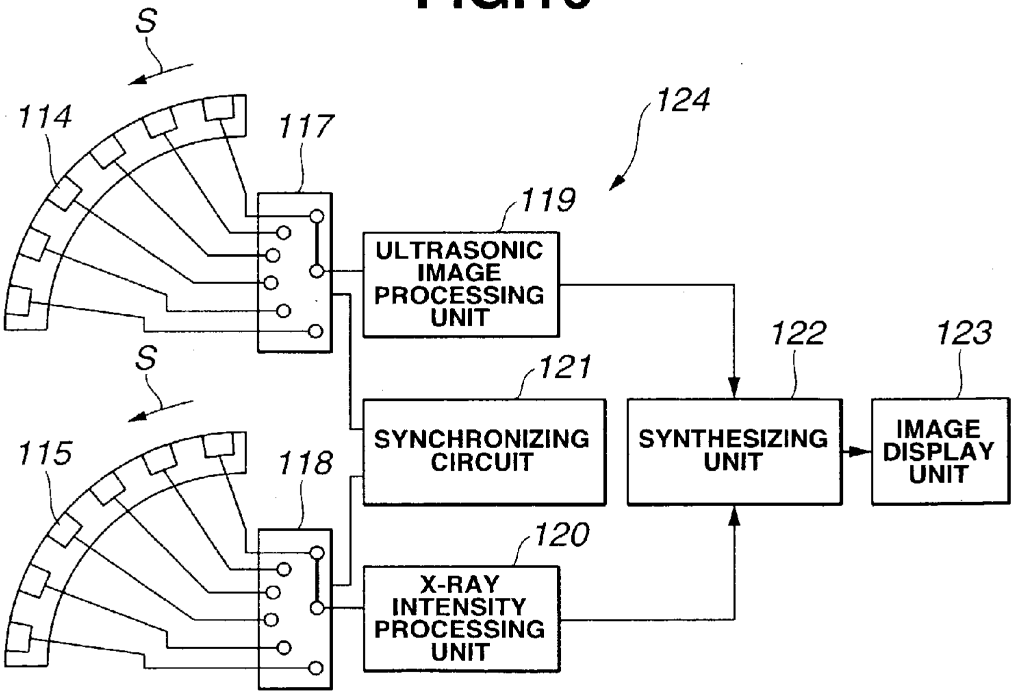

S
114
117
124
119
ULTRASONIC IMAGE PROCESSING UNIT
S
121
122
123
115
118
SYNCHRONIZING CIRCUIT
SYNTHESIZING UNIT
IMAGE DISPLAY UNIT
120
X-RAY INTENSITY PROCESSING UNIT

FIG.17

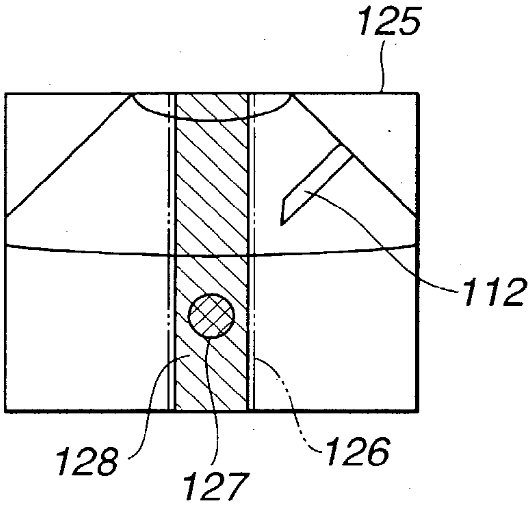


FIG.18

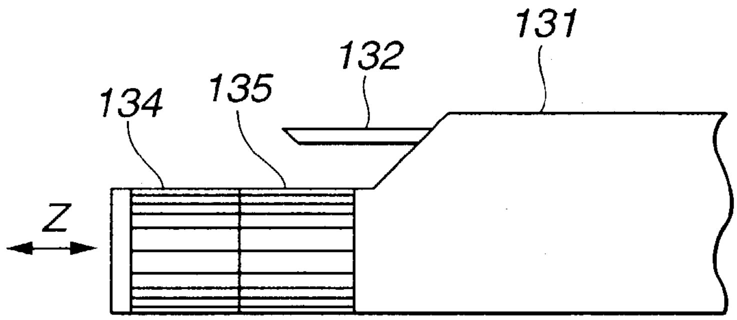


FIG.19

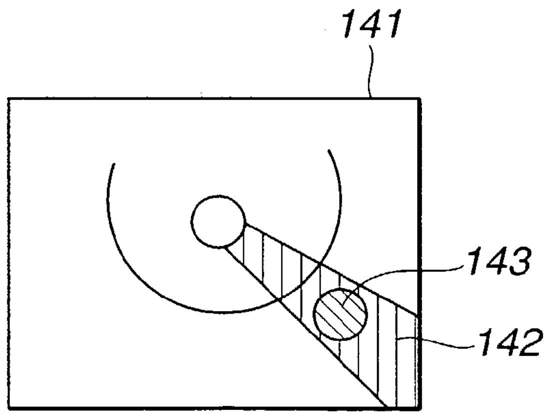


FIG.20

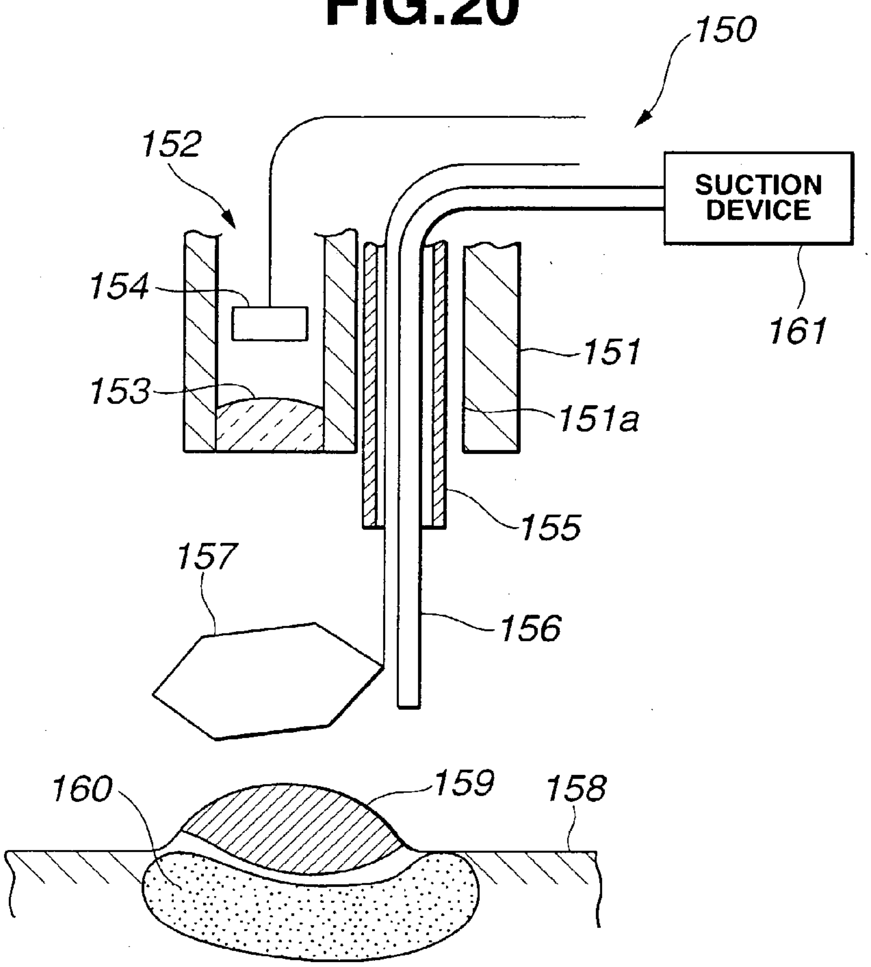

150
152
154
153
SUCTION DEVICE
161
151
151a
155
157
156
160
159
158

FIG.21

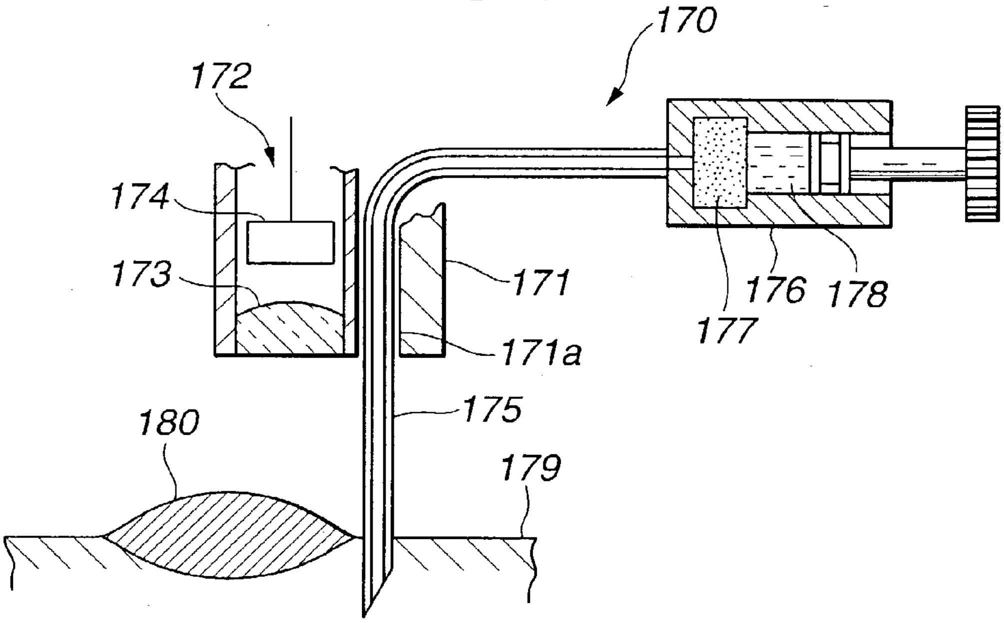

170
172
174
173
171
171a
176
178
177
175
180
179

FIG.22

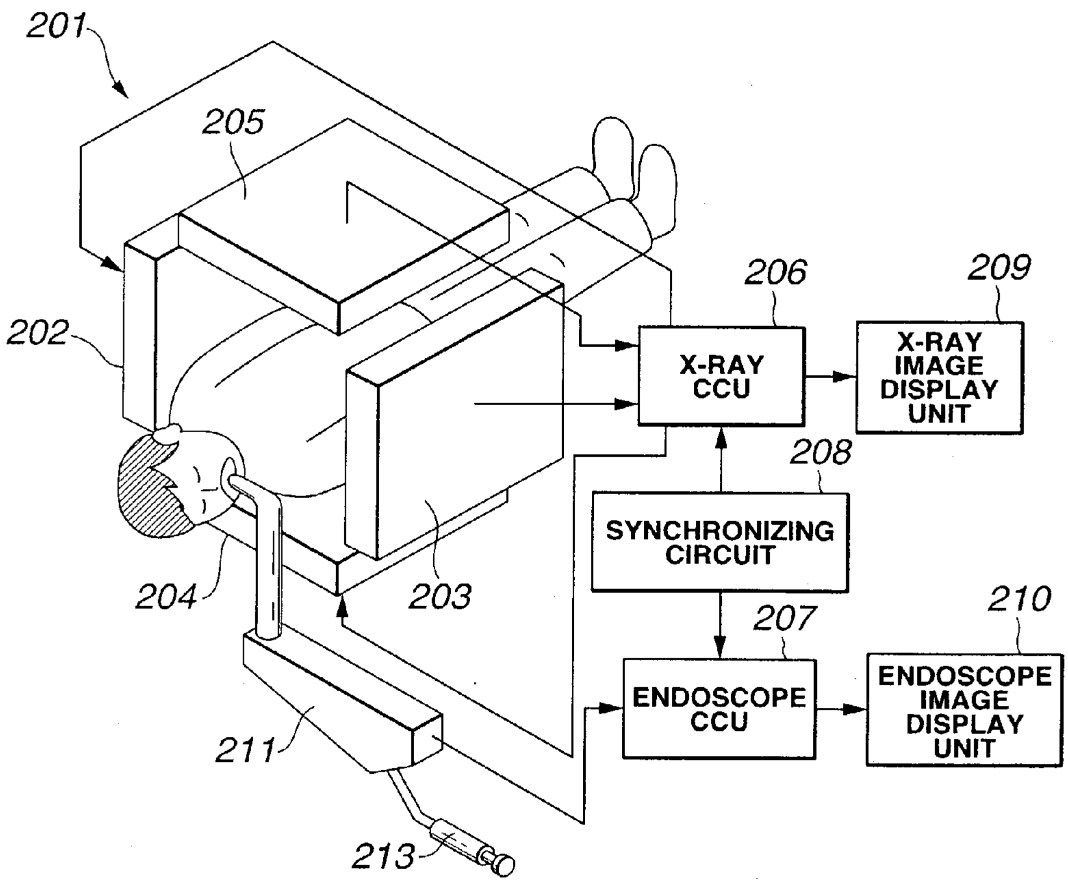


FIG.23A

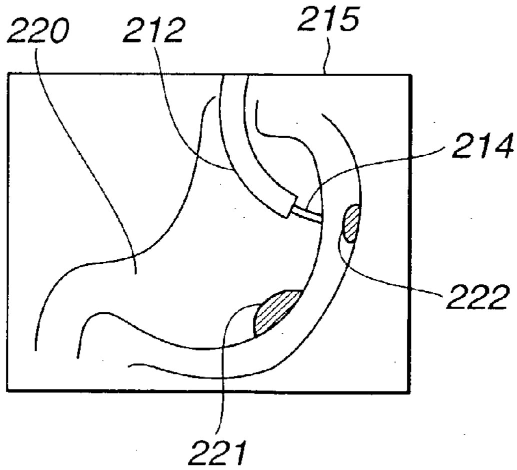


FIG.23B

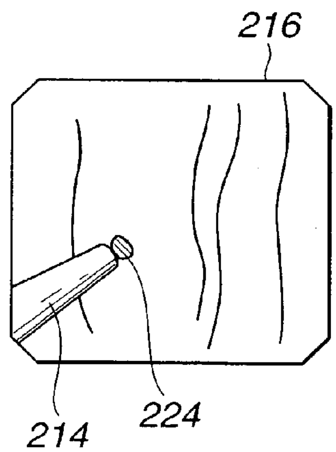


FIG.24

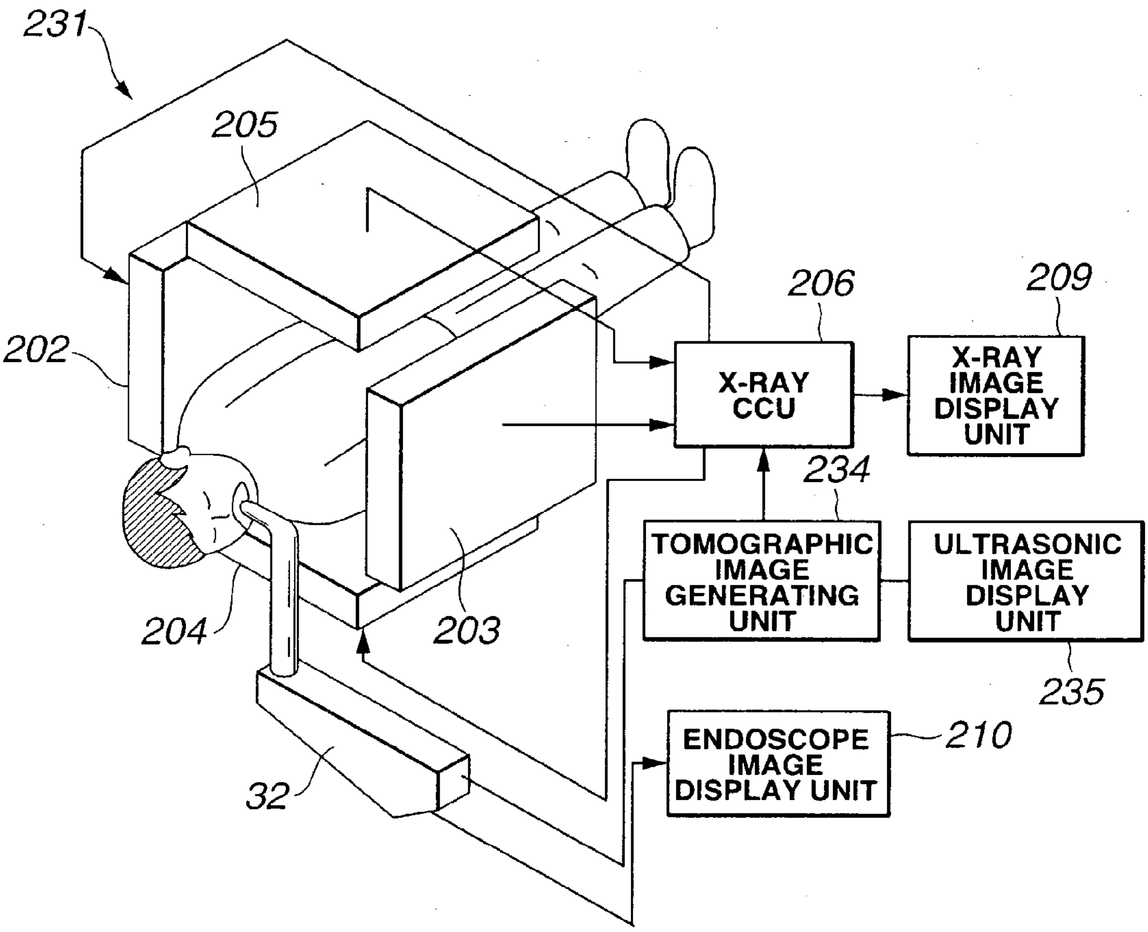


FIG.25B

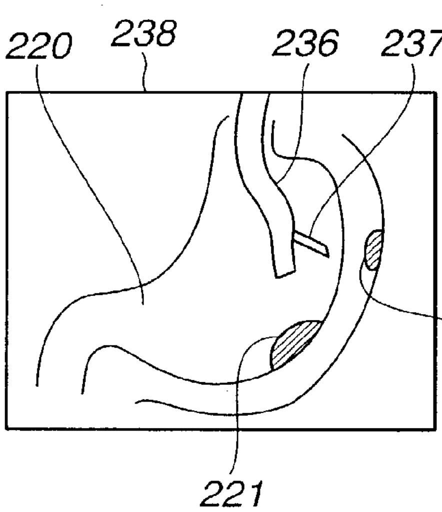


FIG.25A

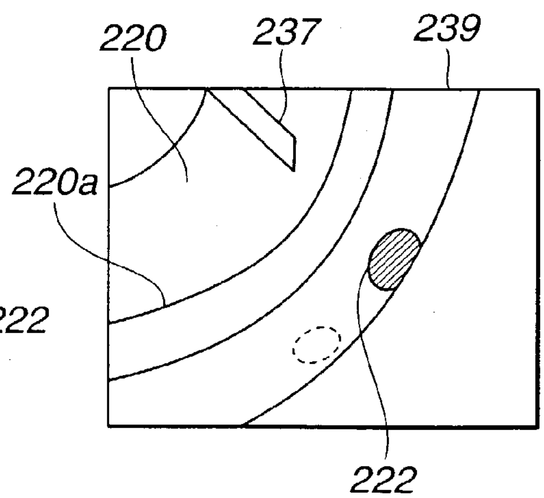


FIG.26

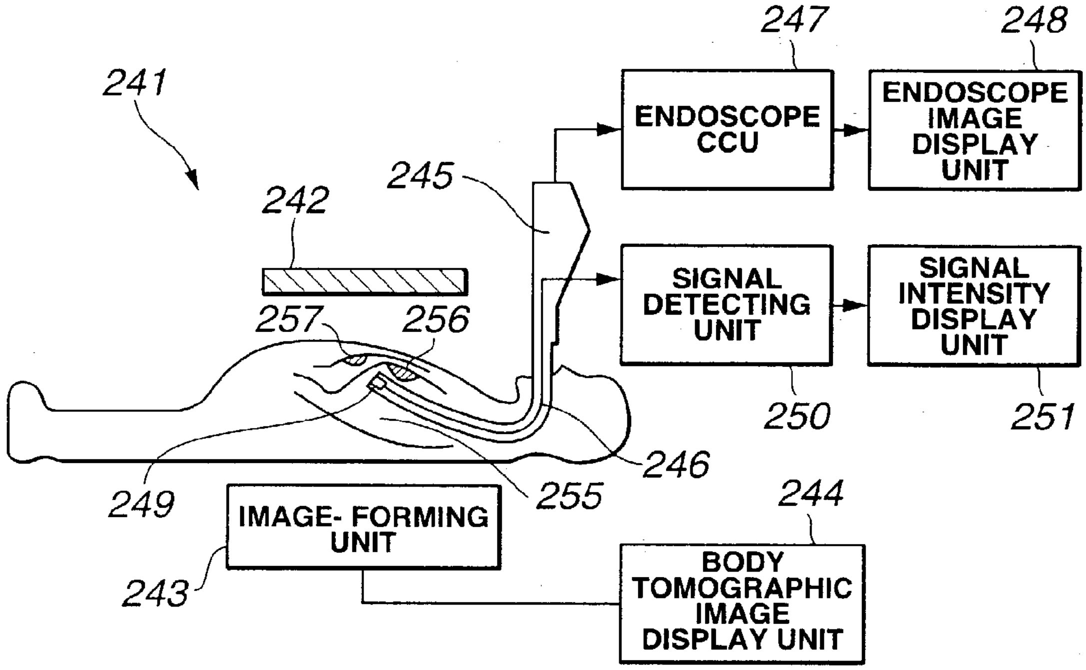

247
248
241
ENDOSCOPE CCU
ENDOSCOPE IMAGE DISPLAY UNIT
245
242
SIGNAL DETECTING UNIT
SIGNAL INTENSITY DISPLAY UNIT
257
256
250
251
246
249
255
244
IMAGE- FORMING UNIT
243
BODY TOMOGRAPHIC IMAGE DISPLAY UNIT

FIG.27

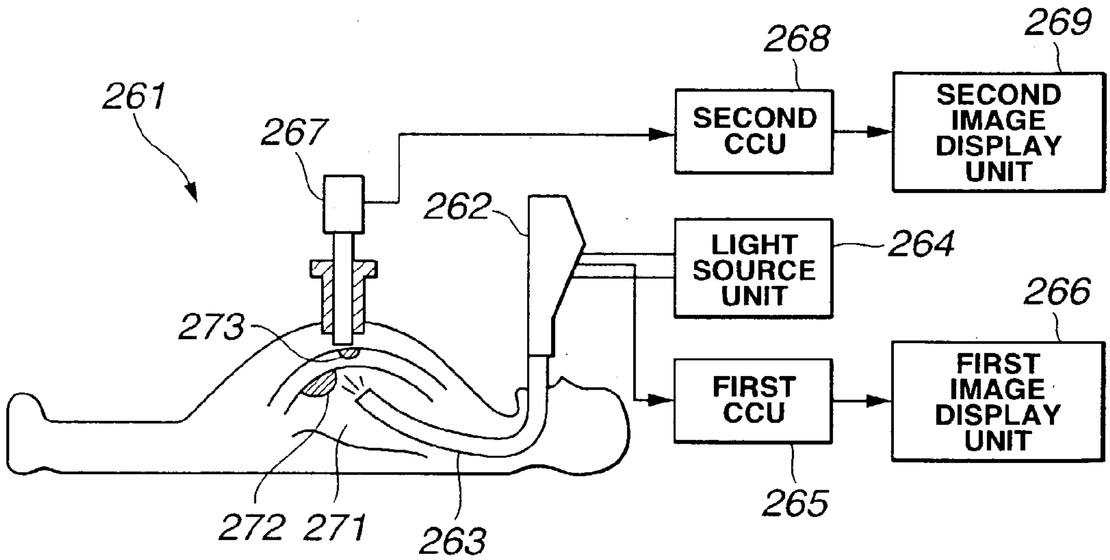
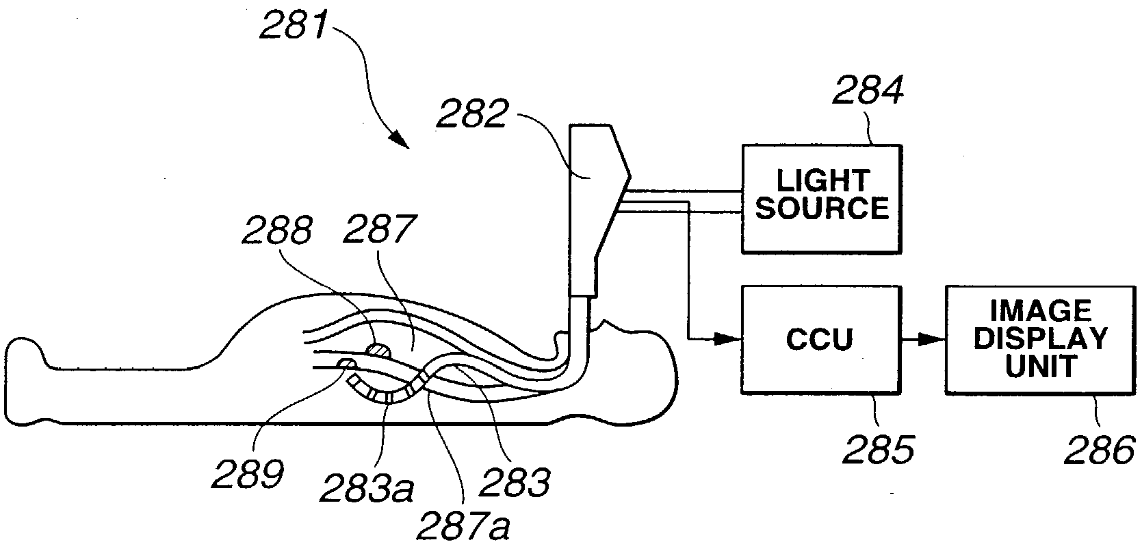

268
269
261
SECOND CCU
SECOND IMAGE DISPLAY UNIT
267
262
LIGHT SOURCE UNIT
264
266
273
FIRST CCU
FIRST IMAGE DISPLAY UNIT
265
272
271
263

FIG.28


281
282
284
LIGHT SOURCE
288
287
CCU
IMAGE DISPLAY UNIT
289
283a
283
287a
285
286

SENTINEL LYMPH NODE DETECTING METHOD

[0001] This application claims benefit of Japanese Applications No. 2002-97423 filed in Japan on Mar. 29, 2002 and No. 2002-97422 filed in Japan on Mar. 29, 2002, the contents of which are incorporated by this reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a sentinel lymph node detecting method for identifying sentinel lymph nodes near affected portions in the body cavity.

[0004] 2. Description of the Related Art

[0005] Presently, examination for the presence or absence of metastasis or scattering of tumors is a primary decision factor for effective treatment for a patient with cancer. Tumor cells which spread from the primary origin of the tumor, which is an affected portion, to lymphatic vessels first reach sentinel lymph nodes. In the early stage of cancer, it is known that the probability of metastasis to lymph nodes is approximately 20%, and metastasis does not occur in the remaining 80%. In the event that metastasis does not occur, a complete recovery can be expected by excision within the range of the primary origin of the tumor. The sentinel lymph nodes are in the lower portion of the affected portion which is on the surface of the body cavity such as the stomach, large intestine, or the like, so the sentinel lymph nodes cannot be directly observed by external observation. Accordingly, examination is required wherein the sentinel lymph nodes near the affected portion are indirectly detected and accurately identified, and the cells of the sentinel lymph nodes are sampled and sent to a laboratory.

[0006] Now, as a reliable system for identifying the sentinel lymph nodes, the sentinel lymph node detecting method disclosed in Japanese Unexamined Patent Application Publication No. 2001-299676 is known. In this detecting method, indocyanine-green, which is an infrared fluorescent dye, is locally injected around the tumor as a tracer. Following a predetermined time period, laparotomy is performed, and near-infrared excitation light is cast on the portion to be observed. Near-infrared fluorescence is generated from the sentinel lymph nodes due to accumulation of the indocyanine-green. The near-infrared fluorescence is converted into visible light and is observed as a visible image, so that the sentinel lymph nodes can be detected.

[0007] However, with the sentinel lymph node detecting method disclosed in the aforementioned Japanese Unexamined Patent Application Publication No. 2001-299676, there is the problem that laparotomy is required at the time of the examination.

[0008] Also, a system for specifying the position of sentinel lymph nodes, disclosed in Japanese Unexamined Patent Application Publication No. 9-189770, is known. The system specifies the position of the sentinel lymph nodes by detecting photon emission sources, and more specifically, a radioactive substance in the lymphatic vessels is traced by means of a conventional hand-held probe under laparotomy, and the position of the sentinel lymph nodes containing the radioactive substance at high density therein is specified. Note that the above-described probe is a gamma-ray probe which employs crystals of cadmium telluride as a photon-radiation detecting sensor.

[0009] However, with the system for specifying the position of sentinel lymph nodes disclosed in Japanese Unexamined Patent Application Publication No. 9-189770, the conventional probe is employed, so laparotomy is required for the examination, and giving consideration to the QOL (quality of life) of the patient, the burden placed on the patient is great. Also, even if the sentinel lymph nodes are detected, confirmation of the spread of cancer is required following the detection. This means that a surgeon might lose sight of the position of the sentinel lymph nodes in the step of sampling tissue from the portion. Also, the sentinel lymph nodes are identified as points, leading to problems of taking a long time for detection.

SUMMARY OF THE INVENTION

[0010] Accordingly, it is an object of the present invention to solve the above problems and provide a sentinel lymph node detecting method wherein sentinel lymph nodes can be quickly identified in a sure manner, and the load placed on a patient, such as the need to perform laparotomy, can be reduced.

[0011] According to a first aspect of the present invention, a sentinel lymph node detecting method uses a sentinel lymph node observation system which comprises: an inserting portion with a small diameter which can be inserted into the body cavity; an X-ray detector at the tip of the inserting portion for two-dimensionally detecting X-rays; and an optical imaging device for taking visible-light images; wherein the X-ray detector and the optical imaging device are positioned at the inserting portion in the longitudinal direction thereof, and are closely positioned one to another so as to observe in the same direction; and wherein sentinel lymph nodes in which a radioactive tracer has been accumulated are detected by the X-ray detector.

[0012] According to another aspect of the present invention, a sentinel lymph node detecting method uses: an X-ray source and an X-ray camera, for observing sentinel lymph nodes near affected portions in which an imaging agent for absorbing X-rays has been accumulated beforehand; an endoscope for observing the body cavity; and a marking means inserted from a forceps opening of the endoscope; wherein marking is made with the marking means onto the inner wall of the body cavity organ near the portion in which the imaging agent has been accumulated.

[0013] Other features and advantages of the present invention will become apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is a diagram which illustrates the configuration of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a first embodiment of the present invention has been applied;

[0015] **FIG. 2** illustrates a display screen on an image display unit of the sentinel lymph node observation system shown in **FIG. 1**;

[0016] **FIG. 3** is a cross-sectional view which illustrates the detailed configuration of an X-ray camera unit of the sentinel lymph node observation system shown in **FIG. 1**;

[0017] **FIG. 4** is a cross-sectional view which illustrates a modification of an X-ray camera of the sentinel lymph node observation system shown in **FIG. 1**;

[0018] **FIG. 5** is a diagram which illustrates the configuration of a sentinel lymph node observation system according to a second embodiment of the present invention;

[0019] **FIG. 6** is a cross-sectional view which illustrates the configuration of a scintillator probe unit for application to the sentinel lymph node observation system according to the second embodiment shown in **FIG. 5**;

[0020] **FIG. 7** is a view taken along the arrow B in **FIG. 6**;

[0021] **FIG. 8** is a cross-sectional view of a first modification of the scintillation probe for application to the sentinel lymph node observation system according to the second embodiment shown in **FIG. 5**;

[0022] **FIG. 9** is a view taken along the arrow C in **FIG. 8**;

[0023] **FIG. 10** is a cross-sectional view which illustrates the tip of a scintillation probe of a second modification corresponding to the scintillation probe for application to the sentinel lymph node observation system according to the second embodiment shown in **FIG. 5**;

[0024] **FIG. 11** is a cross-sectional view which illustrates the tip of a scintillation probe of a third modification corresponding to the scintillation probe for application to the sentinel lymph node observation system according to the second embodiment shown in **FIG. 5**;

[0025] **FIG. 12** is a cross-sectional view which illustrates the tip of a scintillation probe of a fourth modification corresponding to the scintillation probe for application to the sentinel lymph node observation system according to the second embodiment shown in **FIG. 5**;

[0026] **FIG. 13** is a diagram which illustrates the configuration of a sentinel lymph node observation system according to a third embodiment of the present invention, and a cross-section of an X-ray detecting unit making up the system;

[0027] **FIG. 14** is a cross-sectional view which illustrates a modification of a puncture needle for application to the sentinel lymph node observation system according to the third embodiment shown in **FIG. 13**;

[0028] **FIG. 15** is a perspective view which illustrates the tip of an inserting portion of an endoscope of a sentinel lymph node observation system according to a forth embodiment of the present invention;

[0029] **FIG. 16** is a block configuration diagram which illustrates an ultrasonic transducer/X-ray detector control unit of the sentinel lymph node observation system according to the fourth embodiment shown in **FIG. 15**;

[0030] **FIG. 17** illustrates a display screen of an ultrasonic/X-ray image while observing an SN position using the sentinel lymph node observation system according to the fourth embodiment shown in **FIG. 15**;

[0031] **FIG. 18** is a side view which illustrates a modification of an inserting portion of an endoscope of the sentinel lymph node observation system according to the fourth embodiment shown in **FIG. 15**;

[0032] **FIG. 19** is a diagram which illustrates a display screen on an image display unit in the event of applying the inserting portion of the endoscope of the modification shown in **FIG. 18**;

[0033] **FIG. 20** is a cross-sectional view which illustrates an inserting portion of an endoscope of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a fifth embodiment of the present invention has been applied;

[0034] **FIG. 21** is a cross-sectional view which illustrates an inserting portion of an endoscope of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a sixth embodiment of the present invention has been applied;

[0035] **FIG. 22** is a diagram which illustrates the configuration of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a seventh embodiment of the present invention has been applied;

[0036] **FIG. 23A** is a diagram which illustrates a display screen on an X-ray image display unit of the sentinel lymph node observation system according to the seventh embodiment shown in **FIG. 22**;

[0037] **FIG. 23B** is a diagram which illustrates a display screen on an endoscope image display unit of the sentinel lymph node observation system according to the seventh embodiment shown in **FIG. 22**;

[0038] **FIG. 24** is a diagram which illustrates the configuration of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to an eighth embodiment of the present invention has been applied;

[0039] **FIG. 25A** is a diagram which illustrates a display screen on an X-ray image display unit of the sentinel lymph node observation system according to the eighth embodiment shown in **FIG. 24**;

[0040] **FIG. 25B** is a diagram which illustrates a display screen on an ultrasonic image display unit of the sentinel lymph node observation system according to the eighth embodiment shown in **FIG. 24**;

[0041] **FIG. 26** is a diagram which illustrates the configuration of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a ninth embodiment of the present invention has been applied;

[0042] **FIG. 27** is a diagram which illustrates the configuration of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a tenth embodiment of the present invention has been applied;

[0043] **FIG. 28** is a diagram which illustrates the configuration of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to an eleventh embodiment of the present invention has been applied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0044] Embodiments according to the present invention will be described below with reference to the drawings.

[0045] **FIG. 1** is a diagram which illustrates the configuration of a sentinel lymph node observation system to which a sentinel lymph node detecting method as a first embodiment of the present invention has been applied. **FIG. 2** illustrates a display screen of an image display unit of the system. **FIG. 3** is a cross-sectional view which illustrates the configuration of an X-ray camera unit according to the system in detail.

[0046] A sentinel lymph node observation system **1** of the present embodiment is a system for detecting radioactive substances (tracers), which flow into a sentinel lymph node (which will be referred to as "SN") **14** positioned underneath an affected portion **13** on the wall of a body cavity **12** of an internal organ such as the stomach, by means of an X-ray camera, and identifying the SN.

[0047] The above-described sentinel lymph observation system **1** generally comprises a flexible endoscope (not shown) having an inserting portion **2** with a small diameter capable of being inserted into the body cavity, a visible-light CCU (camera control unit) **8** for a visible-light camera, an X-ray CCU (camera control unit) **9** for an X-ray camera, a superimposing circuit **10** for superimposing an output image from the X-ray CCU **9** on an output image from the visible-light CCU **8**, and an image display unit **11** for displaying an output image from the superimposing circuit **10**.

[0048] A visible-light camera unit **3** and an X-ray camera unit **6** are disposed at the tip of the inserting portion **2**, which are close one to another along the longitudinal direction Z of the inserting portion. The visible-light camera unit **3** and the X-ray camera unit **6** are camera units which can take visible-light images and X-ray images of the body cavity alongside the longitudinal direction Z. Furthermore, a marker injection needle **7** or an aspiration biopsy needle can be slidably inserted into a forceps opening **2***a* so as to protrude at the position between the visible-light camera unit **3** and the X-ray camera unit **6** at the tip of the inserting portion **2**.

[0049] The visible-light camera **3** comprises an object lens **4** and a CCD **5** which is an optical imaging device, has an imaging optic axis O1 inclined at a predetermined angle with regard to the inserting unit longitudinal direction Z, and has an imaging angular field of view θ**1**.

[0050] The X-ray camera unit **6** consists of an X-ray detecting unit having the directivity of a predetermined angular range. The X-ray detecting unit comprises a curved convex shield **20** for shielding visible light and passing X-rays, a scintillator **21** which is an X-ray detecting device, a collimator **22** which is a collimating means, and a curved CCD **23** disposed along the inner face of the scintillator **21**, for converting a visible-light image converted at each element of the scintillator **21** into electric signals.

[0051] The collimator **22** is made up of a material which can block X-rays (radial rays), such as lead or flint glass. Moreover, the collimator **22** has a great number of apertures each of which have an element of the scintillator **21** so as to be surrounded thereby.

[0052] The scintillator **21** is an X-ray detecting device consisting of multiple minute elements which are disposed in a convex manner along the inside face of the shield **20** when two-dimensionally viewed. Each element of the scintillator **21** generates light-photons from X-rays which have reached the element.

[0053] Each element of the scintillator **21** is disposed in an aperture of the collimator **22** in a curved shape when two-dimensionally viewed, for yielding directivity. The array pitch of the apertures of the collimator **22** defines the spatial resolution of the camera. On the other hand, the scintillator **21** of which elements are disposed in a curved shape when two-dimensionally viewed defines an X-ray imaging angular field of view θ**2** of the X-ray camera unit **6**, when two-dimensionally viewed. Let us say that the X-ray imaging angular field of view θ**2** is smaller than the angular field of view θ1 of the visible-light camera unit **3**. Here, the range in which the X-ray camera unit **6** can take images is less than that in which the visible-camera **3** can take images. Moreover, the X-ray imaging axis O**2** which is a center axis of the X-ray imaging angular field of view θ**2** of the X-ray camera unit **6** is generally orthogonal to the inserting portion longitudinal direction Z. Furthermore, the X-ray imaging axis O**2** and the imaging axis O1 of the visible camera unit **3** intersect, or the X-ray imaging axis O2 passes through near the imaging axis O**1**.

[0054] The X-ray camera unit **6** detects the intensity of the X-rays from an RI colloid of a radioactive substance, accumulated in the affected portion or the SN, and the X-ray output is acquired by the X-ray camera CCU **9**.

[0055] Now, description will be made with regard to displaying images on the image display unit **11**, taken by the visible-light camera unit **3** and the X-ray camera unit **6**. As shown in **FIG. 2**, an image which has been taken by the visible-light camera unit **3** is displayed on the entire area of a visible-light image displaying screen frame **15**. Furthermore, a two-dimensional X-ray image acquired from the X-ray camera unit **6** is displayed on an X-ray image displaying screen frame **16** which is smaller than the above-described display screen frame **15**, in a superimposed manner.

[0056] The injection needle **7** is a needle for injecting an RI colloid agent as a tracer around the affected portion **13** on the wall of the body cavity.

[0057] Now, description will be made with regard to a case of identifying the SN position by means of the sentinel lymph node observation system **1** according to the present invention having the configuration as described above. First of all, a user inserts the injection needle **7** into the corner of the affected portion **13** on the wall of the body cavity **12**, and injects an RI colloid agent as an SN detecting tracer while observing the visible-light image acquired from the visible-light camera unit **3** and displayed on the image display unit **11**. Note that an RI colloid agent such as Tc-Sn colloid, for example, is employed, giving consideration to the nature of inflow for SNs and the nature of accumulation.

[0058] Following a predetermined time period, the RI colloid reaches the SN portion. At that time, the image of the area around the affected portion **13** acquired from the visible-light camera unit **3** is displayed on the displaying screen frame **15** of the image display unit **11**. At the same time, the X-ray image acquired from the X-ray camera unit **6** is displayed on the displaying screen frame **16** within the above-described displaying screen frame **15** in a superimposed manner. In the event that the SN **14** is within the imaging angular field of view θ**2** of the X-ray camera unit **6**, the X-rays emitted from the RI colloid agent accumulated in the SN **14** are detected, and are displayed on the displaying screen frame **16**. The SN image **18** acquired from the X-ray camera unit **6** is superimposed on the image acquired from the visible-light camera unit **3**, and is displayed on the displaying screen frame **16** as shown in **FIG. 2**, so that the SN position is detected (identified). Other SNs are identified while moving the inserting portion **2** around the affected portion **13** and observing the X-ray image displayed on the displaying screen frame **16**.

[0059] Also, a tissue sample can be taken by marking the detected SN position with the injection needle **7**, or inserting the aspiration biopsy needle into the forceps opening **2***a* of the inserting portion **2**, and then inserting the injection needle into the SN **14** while observing the image displayed on the displaying screens **15** and **16**.

[0060] With the sentinel lymph node observation system **1** according to the embodiment as described above, while the visible-light images and the X-ray images of the body cavity in a predetermined direction of the inserting portion **2** are simultaneously taken by the visible-light camera unit **3** and the X-ray camera unit **6**, the X-ray image is superimposed on the visible-light image, so that the SN positions can be easily identified. In the case of the present embodiment, in particular, the collimator means is disposed at the X-ray input area of the X-ray camera **6**, so the directivity of the scintillator disposed two-dimensionally is expanded, and thus X-ray images can be taken over a wide range. Accordingly, the SN can be efficiently detected over a even wider range.

[0061] Also, the portions of the X-ray image which is to be superimposed on the display screen of the image display unit **11** wherein the X-ray intensity is high, that is to say the SN portions, are displayed as a computer color-enhanced image, so the SN positions can be detected more easily.

[0062] Next, a modification with regard to the configuration of the X-ray camera **6** applied to the sentinel lymph node observation system **1** of the first embodiment as described above will be described with reference to a cross-sectional view illustrating the X-ray camera of the modification shown in **FIG. 4**.

[0063] An X-ray camera unit **24** of the present modification consists of an X-ray detecting unit having directivity of expanded imaging angular field of view, the same as the above-described X-ray camera unit **6**. The present modification is different from the first embodiment as described above in that a curved convex scintillator sheet and an optical fiber sheet is mounted instead of multiple scintillator elements **21** applied to the X-ray camera unit **6**. That is to say, the X-ray camera unit **24** comprises a curved convex shield **25** for shielding visible light and so forth and passing X-rays, a collimator **26** which is a collimator means disposed at the inside of the shield **25**, a scintillator sheet **27** which is an X-ray detecting device disposed at the inside of the collimator **26**, an optical fiber sheet **28** disposed at the inside of the scintillator sheet **27**, and a CCD **29** disposed at the inside of the optical fiber sheet **28** as shown in **FIG. 4**.

[0064] The collimator **26** is disposed along the inside face of the shield **25**, and is made up of an X-ray shielding material having multiple apertures for yielding the directivity of incident X-rays.

[0065] The scintillator sheet **27** is a curved convex X-ray detecting device expanding two-dimensionally along the inside of the collimator **26**, and the scintillator sheet **27** converts X-rays into photons.

[0066] The optical fiber sheet **28** is a curved convex fiber sheet disposed along the inside of the scintillator sheet **27**, and allows transmission of only visible light which has been converted from X-rays by the scintillator sheet **27**, input in the direction of the directivity thereof.

[0067] The CCD **29** is a curved convex CCD disposed along the inside of the scintillator sheet **27**, and converts the visible light from each fiber unit, which has been passed through the optical fiber sheet **28**, into electric signals as X-ray image signals.

[0068] The X-ray camera unit **24** has an X-ray imaging angular field of view θ2 expanding two-dimensionally, the same as in the case of the above-described X-ray camera unit **6**. The X-ray imaging angular field of view θ2 is smaller than the imaging angular field of view θ1 of the visible-light camera unit **3**. Also, only the light incoming along the direction of the directivity, which is visible light converted from X-rays by the scintillator sheet **27**, passes through the optical fiber sheet **28**, reaches the CCD sheet **29**, and is acquired as X-ray image signals. Note that the X-rays which have not been converted into visible light and have not been cast along the direction of the directivity do not pass through the optical fiber sheet **28**, and accordingly the CCD sheet **29** is protected from X-rays.

[0069] With the X-ray camera unit **24** according to the present modification, a film-shaped scintillator sheet **27** can be employed instead of a great number of scintillator elements, thereby facilitating manufacturing of the X-ray camera unit, and thus a low-cost X-ray camera can be provided.

[0070] Next, a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a second embodiment of the present invention has been applied, will be described with reference to **FIGS. 5 through 7**.

[0071] **FIG. 5** is a diagram which illustrates the configuration of the sentinel lymph node observation system according to the present embodiment, and **FIG. 6** is a cross-sectional view which illustrates the configuration of the scintillator probe unit employed in the sentinel lymph node observation system. **FIG. 7** is a view taken along the arrow B in **FIG. 6**.

[0072] As shown in **FIG. 5, a** sentinel lymph node observation system **30** of the present embodiment generally comprises an endoscope (not shown) having an inserting portion **31** which is capable of being inserted into the body cavity, a lighting unit **48** for lighting the body cavity, a CCU **49** built in the inserting portion **31** for controlling a visible-light camera CCD **36**, an image display unit **50** for acquiring image information from the CCU **49** and displaying visible-light images, a scintillation probe **37** which is an inserting portion with a small diameter, a scintillator output detecting unit which will be described later, and a scintillator output display unit **47**.

[0073] Illumination lenses **33** and **34**, an objective lens **35**, and a visible-light CCD **36**, are disposed at the tip of the inserting portion **31**, and furthermore, the scintillation probe **37** is inserted into a forceps opening **31***a* of the inserting portion **31**.

[0074] The scintillator output detecting unit comprises two photoelectric multiplier tubes PMT(A) **44** and PMT(B)

45, and a differential motion amplifier **46** which is a detecting means to which the outputs of the PMT(A) **44** and the PMT(B) **45** are input.

[0075] The scintillation probe **37** includes an X-ray detecting unit **38** at the tip thereof, which comprises a center scintillator unit **39** as a minute rod-shaped inner detecting unit having an axis parallel to the probe longitudinal direction Z, and a peripheral scintillator unit **40** as a minute cylinder-shaped outer detecting unit positioned at the outside of the center scintillator **39**. Furthermore, an X-ray shielding wall portion **41** is formed between the scintillator units **39** and **40**. Moreover, optical fibers **42** and **43**, serving as light-input units, are disposed at the back of the center scintillator **39** and the peripheral scintillator **40**, respectively, so as to face one to another. The X-ray detecting axis O3 of the X-ray detecting unit **38** is parallel with the Z direction, and has directivity parallel thereto.

[0076] The optical fibers **42** and **43** are extended into the tip of the base portion of the endoscope, and the light-output units of the optical fibers **42** and **43** are positioned so as to face to the PMT(A) **44** and the PMT(B) **45**, respectively, positioned at the tip of the base.

[0077] With the scintillation probe **37** as described above, X-rays incident to the center scintillator unit **39** along the Z direction are converted into visible light in the interior of the scintillator, the visible light is input to the receiving face of the PMT(A) **44** via the optical fiber **42**, and the amount of light is detected. On the other hand, X-rays incident to the peripheral scintillator unit **40** along the Z direction are converted into visible light in the interior of the scintillator, the visible light is input to the receiving face of the above-described PMT(B) **45** via the optical fiber **43**, and the amount of light is detected.

[0078] The detected output from the PMT(A) **44** and PMT(B) **45** is input to the positive terminal or the negative terminal of the differential motion amplifier **46**. In the event that the X-ray intensities input to the center scintillator and the peripheral scintillator are different one from another, the output of the differential motion amplifier **46** changes to the positive or the negative. The differential output from the differential motion amplifier **46** is output to the output display unit **47**, and the output value is displayed. The user can judge whether the X-ray density of the center scintillator unit **39** or the peripheral scintillator unit **40** is greater, from the displayed value.

[0079] Now, the method for identifying the SN position by the sentinel lymph node observation system **30** according to the present embodiment having the above-described configuration will be described.

[0080] In the case of the present system, an RI colloid serving as a radioactive substance tracer is also injected around the affected portion on the body cavity, and the RI colloid is accumulated in the SN corresponding to the affected portion. In this state, the inserting portion **31** is inserted into the body cavity, and the tip of the scintillation probe **37** is positioned near the affected portion so as to face one to another while observing the images displayed on the image display unit **50** from the visible-light camera. Subsequently, X-rays emitted from the RI colloid accumulated in the SN are detected by the tip of the scintillation probe **37**, and the intensity is displayed on the output display unit **47** to be judged.

[0081] In the event that a positive value is displayed on the output display unit **47**, judgment is made that the SN is positioned in front of the center scintillator unit **39**. Conversely, in the event that a negative value is displayed on the output display unit **47**, judgment is made that the SN is not positioned in front of the center scintillator unit **39**, but is positioned in front of the peripheral scintillator unit **40**, that is to say, is positioned offset from the front of the center scintillator unit **39**. In the event that zero or an undetermined value is displayed, judgment is made that the SN is not positioned near the front of the scintillation probe **37**.

[0082] A state wherein the SN is positioned in front of the center scintillator unit **39** is searched for, by moving the scintillation probe **37** in the body cavity and observing the images on the output display unit **47**, and the SN position is identified. In the event that the SN position is identified, the state of metastasis can be confirmed by marking the position to take a tissue sample later, or directly inserting a puncture needle to take a tissue sample.

[0083] With the sentinel lymph node observation system **30** according to the present embodiment, simply monitoring the output display unit **47** while moving the tip of the scintillation probe **37** in the body cavity enables accurate identification of the SN position by simple procedures.

[0084] Now, a scintillation probe of a first modification according to the scintillation probe **37** applied to the sentinel lymph node observation system **30** according to the above-described second embodiment will be described with reference to **FIGS. 8 and 9**.

[0085] **FIG. 8** is a cross-sectional view illustrating the scintillation probe of the modification, and **FIG. 9** is a view taken along the arrow C in **FIG. 8**.

[0086] The scintillation probe **51** of the present modification includes an X-ray detecting unit **52** which comprises a center scintillation fiber **53** stored in the probe, and multiple peripheral scintillation fibers **54**A, **54**B, . . . , **54**E, . . . , disposed around the center scintillation fiber **53** as shown in **FIGS. 8 and 9**. The scintillation fibers **53** and **54**A, **54**B, . . . , **54**E, . . . , are extended to the base of the endoscope. The light-output unit **53***a* of the center scintillation fiber **53** is positioned so as to face a PMT(A) **56**, which is a photoelectric multiplier tube, at the base portion. The peripheral scintillation fibers **54**A, **54**B, . . . , **54**E, . . . , are bundled into one, and a light-output unit **55***a* of the bundled fiber is positioned so as to face a PMT(B) **57**, which is a photoelectric multiplier tube.

[0087] The detected outputs from the PMT(A) **56** and the PMT(B) **57** are input to the positive terminal of the differential motion amplifier **58** and the negative terminal, respectively. The differential output from the differential motion amplifier **58** is output to the output display unit **59**, and the output value is displayed thereon.

[0088] With the above-described scintillation probe **51**, X-rays cast into the center scintillation fiber **53** are converted into visible light in the interior of the scintillation fiber, and the quantity of light is detected by the PMT(A) **56**, the same as the above-described scintillation probe **37**. On the other hand, X-rays cast into the peripheral scintillation fibers **54**A, **54**B, . . . , **54**E, . . . , are converted into visible light in the interior of the scintillation fiber, and the quantity of light is detected by the PMT(B) **57**. In the event that the

X-ray intensities input to the center scintillation fiber **53** and the peripheral scintillation fibers **54**A, **54**B, . . . , **54**E, . . . , are different one from another, the output of the differential motion amplifier **58** changes to the positive or negative, and the value is displayed on the output display unit **59**. The user can judge whether X-ray intensity of the center scintillation fiber or the peripheral scintillation fibers is greater, from the displayed value.

[0089] The method for identifying the SN position by the sentinel lymph node observation system employing the scintillation probe **51** of the present modification having the above-described configuration is the same as the sentinel lymph node observation system **30** according to the above-described second embodiment.

[0090] With the scintillation probe **51** according to the present modification, scintillation fibers are employed instead of scintillators and optical fibers, and thus the number of components can be reduced, thereby enabling providing of a scintillation probe having a simple configuration, requiring no X-ray shield portion.

[0091] Note that with the scintillation probe **51** according to the above-described modification, an arrangement, wherein the light-output units of the peripheral scintillation fibers **54**A, **54**B, . . . , **54**E, . . . , are not bundled into one, but rather are bundled into two or four, and each quantity of light is detected by a separate PMT, and the output from each PMT is input to the differential amplifier so as to detect the difference between the quantities of light from the center scintillation fiber **53** and each bundled peripheral scintillation fiber, enables detecting of the direction of the SN position in the event that the SN is at a near position other than the center position.

[0092] Now, a scintillation probe of a second modification corresponding to the scintillation probe **37** applied to the sentinel lymph node observation system **30** according to the above-described second modification will be described with reference to **FIG. 10**.

[0093] **FIG. 10** is a cross-sectional view illustrating the tip of a scintillation probe according to the present embodiment.

[0094] As shown in **FIG. 10, a** suction passage **61***a* is provided to a scintillation probe **61** of the present modification as well as the X-ray detecting unit **38**, and furthermore, an opening cap **62** holding a detachable rubber ring **64** within the inner circumference thereof is mounted to the tip of the probe. Moreover, a scintillator output detecting unit for the X-ray detecting unit **38**, which will be described later, and a suction device **63** which is connected to the suction passage **61***a,* are disposed at the base of the scintillation probe **61**.

[0095] The X-ray detecting unit **38** has the same configuration as that included in the scintillation probe **37** according to the above-described second embodiment.

[0096] The scintillator output detecting unit also has the same configuration as that included in the scintillation probe **37** of the observation system according to the above-described second embodiment, and comprises the PMT(A) **44** and the PMT(B) **45**, which are photoelectric multiplier tubes, and the differential motion amplifier **46** to which the outputs of the PMT(A) **44** and the PMT(B) **45** are input. The differential motion output from the differential motion amplifier **46** is input to the output display unit **47**, and the state of X-rays cast on the X-ray detecting unit **38** is displayed, the same as the above-described scintillation probe **37**.

[0097] Using the scintillation, probe **61** of the present modification, the SN **66** underneath the wall of the body cavity **65** can be detected with the same method as the above-described first embodiment. Following detecting of the SN **66**, the opening cap **62** at the tip of the probe **61** is pressed into contact against the wall underneath which the SN **66** is positioned. Subsequently, the SN **66** is sucked upward along with the wall portion of the body cavity **65** by suctioning air using suction device **63** as shown **FIG. 10**. The rubber ring **64** is snapped onto the wall of the cavity body **65** which is bulged, containing the SN **66** therein by the sucking action, and thus the SN position is marked. Subsequently, a surgeon inserts an aspiration biopsy needle into the SN **66** onto which the rubber ring is snapped so that a tissue sample of the SN **66** can be taken.

[0098] In the event that the scintillation probe **61** according to the present modification is used, marking of the SN **66** can be easily made.

[0099] Now, a scintillation probe of a third modification corresponding to the scintillation probe **37** applied to the sentinel lymph node observation system **30** according to the above-described second embodiment will be described with reference to **FIG. 11**.

[0100] **FIG. 11** is a cross-sectional view illustrating the tip of a scintillation probe of the present modification.

[0101] As shown in **FIG. 11, a** suction passage **71***a* and a needle inserting opening **71***b* for inserting an aspiration biopsy needle **72** are provided to a scintillation probe **71** as well as the X-ray detecting unit **38**, and furthermore, a opening cap **73** is mounted to the tip of the probe. Moreover, the scintillator output detecting unit for the X-ray detecting unit **38** and a suction device **75** for being connected to the suction passage **71***a* are provided to the base of the scintillation probe **71**.

[0102] The X-ray detecting unit **38** has the same configuration as that included in the scintillation probe **37** according to the above-described second embodiment.

[0103] The scintillator output detecting unit also has the same configuration as that included in the scintillation probe **37** of the observation system according to the above-described second embodiment, and comprises the PMT(A) **44** and the PMT(B) **45**, which are two photoelectric multiplier tubes, and the differential motion amplifier **46** to which the outputs from the PMT(A) **44** and the PMT(B) **45** are input. The differential motion output of the differential motion amplifier **46** is output to the output display unit **47**, and the state of X-rays casting on the X-ray detecting unit **38** is displayed thereon, the same as the above-described scintillation probe **37**.

[0104] Using the scintillation probe **71** of the present modification, the SN **66** underneath the wall of the body cavity **65** can be detected with the same method as the above-described first embodiment. Following the detecting, the opening cap **73** at the tip of the probe **71** is pressed into contact against the wall underneath which the detected SN **66** is positioned. Subsequently, the SN **66** is sucked upward along with the wall of the body cavity **65** by suctioning using the suction device **75** as shown in **FIG. 11**. The tissue sample of the SN **66** can be taken by inserting the aspiration biopsy needle **72** into the SN **66** while being sucked due to suction.

[0105] By using the scintillation probe **71** according to the present modification, biopsy can be performed in a sure manner while sucking the SN **66** along with the surrounding portion.

[0106] Now, a scintillation probe of a fourth modification corresponding to the scintillation probe **37** applied to the sentinel lymph node observation system **30** according to the above-described second embodiment will be described with reference to **FIG. 12**.

[0107] **FIG. 12** is a cross-sectional view illustrating the tip of a scintillation probe according to the present modification.

[0108] While the X-ray detecting unit **38** of the scintillation probe **37** according to the above-described second embodiment detects X-rays cast thereon from the front in the probe longitudinal direction Z, an X-ray detecting unit **82** of a scintillation probe **81** according to the present modification can detect X-rays from a direction from the side of the probe longitudinal direction Z. That is to say, the X-ray detecting axis O4 of the X-ray detecting unit **82** is orthogonal to the probe longitudinal direction Z.

[0109] As shown in **FIG. 12**, the scintillation probe **81** of the present modification generally comprises the X-ray detecting unit **82** consisting of an X-ray detector made up of a scintillator, mounted to a side opening unit **81***a* of the probe, an aspiration biopsy needle **83** which is inserted along an inserting opening **81***b* of the probe, a puncture needle operating unit **84**, a detecting unit **85** for detecting the quantity of visible light obtained by converting X-rays acquired by the X-ray detecting unit **82**, and an output display unit **86** for displaying the output of the detecting unit.

[0110] In the event of detecting the SN position using the scintillation probe **81** of the present modification, following injecting an RI colloid around the affected portion, while positioning the probe **81** so that the side of the probe **81** faces around the affected portion, the change in the X-ray intensity is observed on the output display unit **86**, and the SN position is detected based upon the displayed state. Following detecting of the SN position, a surgeon inserts the aspiration biopsy needle **83** into the SN position so as to take a tissue sample, or place a mark.

[0111] With the scintillation probe **81** according to the present modification, SNs at narrow portions which cannot be readily detected by viewing the body cavity from the front can be detected.

[0112] Now, a sentinel lymph node observation system to which the sentinel lymph node detecting method of a third embodiment according to the present invention is applied will be described with reference to **FIG. 13**.

[0113] **FIG. 13** illustrates the configuration of a sentinel lymph node observation system and a cross-sectional view of an X-ray detecting unit making up the system according to the present embodiment.

[0114] A sentinel lymph node observation system **90** of the present embodiment employs an aspiration biopsy needle wherein an optical fiber is inserted into the inner tube thereof, disposed along the side of the X-ray detecting unit, in the event of taking a tissue sample of the SN with an aspiration biopsy needle following identifying the SN position. Judgment can be made in a sure manner regarding whether or not the portion, into which the puncture needle is inserted, is the SN in which the radioactive substance is accumulated, based upon the information with regard to the change in the light intensity obtained from the optical fiber.

[0115] The sentinel lymph node observation system **90** of the present embodiment comprises a scintillation probe **91**, the X-ray detecting unit **38** disposed at the tip of the probe **91**, an aspiration biopsy needle **92** inserted into an inserting opening **91***a* on the side of the X-ray detecting unit **38**, an optical fiber **93** inserted into an inner tube **92***a* of the aspiration biopsy needle **92**, a half mirror **95** disposed in a tilted position so as to face the optical fiber **93**, a light source **94** for generating white light or monochromatic light, a light intensity detecting unit **96**, a display unit **97** for displaying output values from the light intensity detecting unit **96**, and further an output display unit (not shown) for displaying X-ray information detected by the X-ray detecting unit **38**, and so forth.

[0116] The X-ray detecting unit **38** comprises the scintillators **39** and **40**, optical fibers **42** and **43**, and so forth, the same as the X-ray detecting unit (see **FIG. 2**) applied to the above-described second embodiment.

[0117] The optical fiber **93** guides light from the light source **94** to the tip of the aspiration biopsy needle **92**, and guides reflected light from the tissue to the base of the endoscope.

[0118] The light intensity detecting unit **96** detects the quantity of reflected light obtained by the optical fiber **93**.

[0119] The SN position can be identified using the sentinel lymph node observation system **90** of the present embodiment having the above-described configuration, with the same method as the observation system **30** according to the above-described second embodiment.

[0120] In the event of taking a tissue sample of the SN **99** positioned within the wall of the body cavity **98** using the present observation system **90** following identifying the SN position, light from the light source **94** is guided to the tip of the optical fiber via the half mirror **95**. A surgeon inserts the aspiration biopsy needle **92** into the wall of the body cavity **98** in this state. Upon the tip **92***b* of the aspiration biopsy needle **92** reaching the position of the SN **99**, the quantity of reflected light at the tip of the optical fiber **93** markedly changes due to the RI colloid accumulated in the SN **99**. The change of reflected light is detected in the light density detecting unit **96** via the half mirror **95**, and is displayed on the light density display unit **97**. A surgeon can recognize that the aspiration biopsy needle **92** has reached the SN **99** by observing the change of the displayed state.

[0121] Note that the light density display unit **97** may notify the user that the aspiration biopsy needle **92** has reached the SN **99** by sound as well as by displaying on the screen.

[0122] Following the aspiration biopsy needle **92** reaching the SN **99**, the optical fiber **93** is extracted from the inner tube of the aspiration biopsy needle **92**, and a tissue sample of the SN **99** can be taken by suctioning.

[0123] The sentinel lymph node observation system **90** of the present embodiment has the same advantages as the observation system **30** of the above-described second embodiment, and in particular, in the event of taking the identified SN tissue sample, the sentinel lymph node observation system **90** can detect the depth-wise position of the SN **99** within the wall of the body cavity using the reflect light from the optical fiber **93** in a sure manner.

[0124] Now a modification of the aspiration biopsy needle **92** applied to the above-described third embodiment will be described with reference to a cross-sectional view illustrating a puncture needle of the present modification shown in **FIG. 14**.

[0125] With the aspiration biopsy needle **92** applied to the above-described third embodiment, the optical fiber **93** is inserted into the inner tube of the aspiration biopsy needle **92** for specifying the depth of the SN, and it is necessary that the optical fiber **93** be extracted from the inner tube by moving the optical fiber **93** for a long distance when sucking a tissue sample. With the aspiration biopsy needle **101** of the present modification, the movement distance of the optical fiber is reduced, thereby improving operability.

[0126] As shown in **FIG. 14**, with the aspiration biopsy needle **101** according to the present modification, a forked tube **102** is connected to a needle side inner tube portion **101***a* of the aspiration biopsy needle **101**, and the forked tube **102** is branched into a fiber inserting tube **103** and a suction tube **104** on the probe base side. An optical fiber **105** can be inserted into an inner tube portion **103***a* of the fiber inserting tube **103**, and a suction device, which is not shown in drawings, is connected to an inner tube portion **104***a* of the suction tube **104**.

[0127] In the event of inserting the aspiration biopsy needle **101** into the SN position within the wall of the body cavity for taking a tissue sampling, the optical fiber **105** is inserted into the tip of the inner tube portion **101***a* of the aspiration biopsy needle **101**. Following inserting the aspiration biopsy needle **101** into the wall of the body cavity and confirming the SN position by the reflection of light from the optical fiber **105**, the optical fiber **105** is retracted to the forked tube **102**, which is a relatively short distance. The SN tissue sample can be sucked through the inner tube portion **104***a* of the suction tube **104** and the inner tube portion **101***a* by operating the suction device with the optical fiber **105** retracted.

[0128] With the aspiration biopsy needle **101** of the present modification, it is not necessary that the optical fiber **105** be completely extracted from the aspiration biopsy needle **101** following inserting the aspiration biopsy needle **101** and confirming the SN position, and a tissue sample can be taken with the aspiration biopsy needle **101** by simply moving the optical fiber **105** up to the position of the forked tube **102** for a short distance.

[0129] Now, a sentinel lymph node observation system to which a sentinel lymph node observation method of a fourth embodiment according to the present invention is applied will be described with reference to **FIGS. 15 through 17**.

[0130] Note that **FIG. 15** is a perspective view illustrating the tip of an endoscope inserting portion of a sentinel lymph node observation system according to the present embodiment. **FIG. 16** is a block diagram which illustrates an ultrasonic transducer/X-ray detector control unit of the present sentinel lymph node observation system. **FIG. 17** illustrates a display screen on which an ultrasonic/X-ray image is displayed in the event of observing the SN position by means of the present sentinel lymph node observation system.

[0131] The sentinel lymph node observation system **110** of the present embodiment generally comprises an endoscope which is not shown in drawings, an endoscope inserting portion **111** mounted to the endoscope, an ultrasonic transducer/X-ray detector control unit **124** (see **FIG. 16**).

[0132] As shown in **FIG. 15**, an injection needle **112** for being inserted into a forceps opening **111***a* and a visible-light camera unit **113** are disposed at the upper part front part of the tip portion of the inserting portion **111**, a convex ultrasonic transducer **114** is disposed at the middle front part of the curved face, and arc-shaped linear-array X-ray detectors **115** are disposed at both sides thereof.

[0133] The convex ultrasonic transducer **114** comprises multiple ultrasonic transducer units disposed in an arc shape. In the same way, the linear-array X-ray detector **115** comprises multiple X-ray detector units disposed along an arc face.

[0134] As shown in **FIG. 16**, the ultrasonic/X-ray detecting control unit **124** comprises a switching circuit unit **117**, an ultrasonic image processing unit **119** for driving the ultrasonic transducer **114** via the switching circuit unit **117**, acquiring echo signals, and performing ultrasonic tomographic image processing, a switching circuit unit **118**, an X-ray intensity processing unit **120** for acquiring X-ray signals via the switching circuit unit **118** and performing processing for images indicating the X-ray intensity, a synchronous circuit unit **121** for driving the switching circuit units **117** and **118** in a synchronous manner, a synthesizing circuit unit **122** for synthesizing the output from the ultrasonic image processing unit **119** and the output from the X-ray intensity processing unit **120**, and an image display unit **123** for displaying an ultrasonic tomographic image and an X-ray intensity image in a superimposed manner based upon the output from the synthesizing circuit unit **122**.

[0135] The switching circuit unit **117** sequentially switches the connection with each ultrasonic transducer unit of the ultrasonic transducer **114** in the S direction along the arc. In the same way, the switching circuit unit **118** sequentially switches the connection with each X-ray detector unit of the X-ray detector unit **115** in the S direction along the arc according to the output from the synchronous circuit unit **121**.

[0136] Now, a method for identifying the SN position using the sentinel lymph node observation system of the present embodiment having the above-described configuration will be described. First of all, an RI colloid, which is a radioactive substance, is injected around the affected portion with the injection needle **112**. Following a predetermined time period, the RI colloid flows into the SN position. Following the RI colloid being accumulated in the SN position, the tip of the inserting portion **111** is positioned near the affected position, each transducer unit of the ultrasonic transducer **114** is driven by being sequentially switched in the S direction by the switching circuit unit **117**, thereby obtaining ultrasonic tomographic image information near the affected portion in the body. The ultrasonic tomographic image information displays both of the SN lymph nodes and the non-SN lymph nodes.

[0137] On the other hand, each X-ray detector unit of the X-ray detector **115** is driven by being sequentially switched in the S direction by the switching circuit unit **118** with the X-ray detector **115** synchronous with the ultrasonic transducer **114**, thereby obtaining X-ray intensity information for each X-ray detector unit on the scanning line in front of the inserting portion **111**. In the event that the detected X-ray intensity is high, the X-ray intensity display image is displayed as a computer color-enhanced image.

[0138] The ultrasonic tomographic image information, and the X-ray intensity image information which is synchronized with the ultrasonic tomographic image information in the S direction scanning are synthesized in the synthesizing circuit unit **122**, and the synthesized image is displayed on the image display unit **123**.

[0139] **FIG. 17** illustrates an example of the synthesized image displayed on the image display unit **123**. As shown in the drawing, for example, let us say that a lymph node **127** is displayed in a partial ultrasonic tomographic image **126** from a certain transducer unit of the ultrasonic transducer **114** while being driven. In the event that the lymph node **127** is an SN lymph node, the X-ray intensity detected by the corresponding X-ray detector unit of the X-ray detector **115** which is synchronously driven is high. Accordingly, a partial X-ray intensity display image **128** from the X-ray detector unit, which is superimposed on the partial ultrasonic tomographic image **126**, is displayed as a computer color-enhanced image, and accordingly, the user can easily recognize that the lymph node **127** is an SN on an ultrasonic tomographic image.

[0140] In the event that the lymph node **127** is a non-SN lymph node, the X-ray intensity in the portion is low, so the partial X-ray intensity display image **128** is not displayed as a computer color-enhanced image, and accordingly the user can recognize that the lymph node is not an SN.

[0141] Following specifying the SN by the above-described method, a surgeon can take a tissue sample by inserting the aspiration biopsy needle into the portion at which the SN is positioned while observing ultrasonic tomographic images.

[0142] With the sentinel lymph node observation system **110** of the present embodiment, the convex ultrasonic transducer **114** and the linear-array X-ray detector **115**, which are disposed at the tip of the inserting portion **111**, are synchronously driven, ultrasonic tomographic images and X-ray images are synchronously displayed, and a partial X-ray image with high X-ray intensity is displayed as a computer color-enhanced image, so that the user can easily judge whether or not a lymph node displayed on an ultrasonic tomographic image is an SN.

[0143] Now, a modification of the inserting portion **111** of the endoscope of the sentinel lymph node observation system **110** according to the fourth embodiment will be described with reference to a side view of an inserting portion in **FIG. 18** and a diagram illustrating a display screen on an image display unit shown in **FIG. 19**.

[0144] An inserting portion **131** of the endoscope according to the present modification comprises an injection needle **132** disposed at an upper part of the tip, a visible-light camera which is not shown in the drawing, a linear-array X-ray detector **134** made up of multiple X-ray detector elements, wrapped around the face of the cylinder parallel to the probe longitudinal direction Z of the tip cylinder portion, a linear-array ultrasonic transducer **135** made up of multiple ultrasonic transducer elements, wrapped around the face of the cylinder behind the X-ray detectors **134**.

[0145] The X-ray detector **134** made up of multiple X-ray detector elements and the ultrasonic transducer **135** made up of multiple ultrasonic transducer elements are synchronously driven in the same way as the above-described fourth embodiment, and ultrasonic tomographic image information, and X-ray image information indicating the X-ray intensity in the same circumferential direction is acquired.

[0146] **FIG. 19** illustrates an example of a screen **141** on the image display unit which displays the ultrasonic tomographic image and the X-ray image in a superimposed manner. In the event that a lymph node **143** is displayed on the ultrasonic tomographic image and the lymph node is an SN, the X-ray intensity detected in the portion is high, and an X-ray image **142** is displayed as a computer color-enhanced image. Accordingly, the user can easily recognize that the lymph node **143** is an SN.

[0147] With the inserting portion **131** of the endoscope according to the present modification, the same advantages as the inserting portion **111** according to the fourth embodiment can be obtained, and in particular, a linear-array ultrasonic transducer **135** made up of multiple ultrasonic transducer elements and a linear-array X-ray detector **134** made up of multiple X-ray detector elements are disposed along the face of the cylinder at the tip of the probe, and accordingly, two-dimensional ultrasonic images and X-ray images for each cross section around the affected portion are simultaneously obtained, and thus the user can identify SNs quickly.

[0148] Now, an inserting portion of an endoscope of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a fifth embodiment of the present invention has been applied will be described with reference to a cross-sectional view of the inserting portion as shown in **FIG. 20**.

[0149] As shown in **FIG. 20**, an inserting portion **151** of an endoscope of a sentinel lymph node observation system **150** according to the present embodiment comprises an object lens **153** and a CCD **154**, making up a body cavity imaging camera unit **152**, a surgical tool **155** which is inserted into a forceps opening **151***a* and a suction device **161**.

[0150] A suction catheter **156** connected to the suction device **161** and a snare **157** are inserted into the surgical tool **155**.

[0151] In the event of identifying an SN, a tracer **160** such as an RI colloid is injected around an affected portion **159** of a wall portion in the body cavity **158**, but the tracer **160** left around the affected portion **159** interferes with SN detection. Accordingly, with the present sentinel lymph node observation system **150**, the affected portion **159** is removed with the snare **157** mounted to the surgical tool **155** of the inserting portion **151**, and subsequently, the tracer **160** left around the affected portion **159** is sucked so as to be removed using the suction catheter **156**. An SN detecting probe is inserted into the body cavity in this state, and the SN is identified by detecting only the tracer accumulated in the SN.

[0152] With the sentinel lymph node observation system **150** of the present embodiment, the tracer **160** left around the affected portion **159** is removed, thereby facilitating detection of SNs, and thus the SN can be identified in a sure manner.

[0153] Now, an inserting portion of an endoscope of a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a sixth embodiment of the present invention has been applied will be described with reference to a cross-sectional view of the inserting portion shown in **FIG. 21**.

[0154] As shown in **FIG. 21**, an inserting portion **171** of an endoscope of a sentinel lymph node observation system **170** according to the present embodiment comprises an object lens **173** and a CCD **174**, making up a body cavity portion imaging camera unit **172**, an injection needle **175** which is inserted into a forceps opening **171***a,* and a tracer syringe **176** which is connected to the injection needle **175**.

[0155] The tracer syringe **176** includes a filter **177** for filtering and removing large colloidal particles contained in a tracer **178** employing an RI colloid or the like.

[0156] In the event of identifying the SN by the sentinel lymph node observation system **170** of the present embodiment, the inserting portion **171** of the endoscope is inserted into the body cavity and the injection needle **175** is inserted around an affected portion **180** on the wall of the body cavity **179**, the tracer **178** is filtered by the filter **177** of the syringe **176**, and is injected around the affected portion **180**.

[0157] The injected tracer **178** has been subjected to removal of large colloidal particles, and accordingly, situations wherein the lymph node clogs up with the tracer **178** can be avoided, so the tracer flows into the SN, and is accumulated in the SN in a sure manner.

[0158] With the sentinel lymph node observation system **170** of the present embodiment described above, in the event of identifying the SN, the injected tracer **178** flows without the lymph node being clogged thereby, so the SN can be identified in a sure manner.

[0159] With the first through the sixth embodiments described above, the X-ray detector and the optical imaging device are disposed along the longitudinal direction of the inserting portion so as to observe in the same direction, thereby enabling the SN image being superimposed on the image from the optical imaging device and displaying the superimposed image, and thus enabling providing of a sentinel lymph node detecting method for identifying the SN position in a simple manner.

[0160] Now, a sentinel lymph node observation system to which a sentinel lymph node observation method according to a seventh embodiment of the present invention has been applied will be described with reference to **FIGS. 22 through** 23B.

[0161] **FIG. 22** is a diagram which illustrates the configuration of a sentinel lymph node observation system according to the seventh embodiment. **FIG. 23A** illustrates a display screen on an X-ray display unit according to the system, and **FIG. 23B** illustrates a display screen on an endoscope image display unit according to the system.

[0162] The sentinel lymph node observation system **201** of the present embodiment generally comprises a flexible endoscope **211**, a first X-ray source **202** and a first X-ray camera **203** for generating vertical cross-sectional X-ray images, a second X-ray source **204** and a second X-ray camera **205** for generating horizontal cross-sectional X-ray images, an X-ray CCU (camera control unit) **206** for controlling X-ray cameras for generating X-ray images, an endoscope CCU (camera control unit) **207** for controlling an endoscope camera for generating endoscope images, a synchronizing circuit **208**, an X-ray image display unit **209** for displaying a two-dimensional X-ray image by switching between the images from the first and the second X-ray cameras, and an endoscope image display unit **210** for displaying a visible image from the endoscope camera.

[0163] The endoscope **211** comprises an inserting portion **212** having a built-in endoscope camera for visible light, which can be inserted into the body cavity (for example, an internal organ such as the stomach), and a marking device **213** which is a marking means.

[0164] The marking device **213** includes a dye injector and a marking needle **214** which can be inserted from a forceps opening of the endoscope **211**, and marking is made with the marking needle **214** at the corresponding position on the wall of the body cavity underneath which the identified SN is positioned. Note that the marking needle **214** is made of a needle member which absorbs X-rays. Accordingly, the position of the marking needle **214** is displayed on the X-ray image.

[0165] The first and second X-ray cameras **203** and **205** detect vertical cross-sectional and horizontal cross-sectional X-ray imaging signals of the body, respectively, that is to say, the first and second X-ray cameras **203** and **205** detect X-rays which have been cast from the X-ray sources **202** and **204**, and have not been absorbed by the body. Accordingly, the SN portion in which an X-ray imaging agent is accumulated is detected by the X-ray camera as a portion which does not transmit X-rays.

[0166] The X-ray CCU **206** acquires X-ray imaging signals with regard to the vertical and horizontal sections from the first X-ray camera **203** and the second X-ray camera **205**, and generates two-dimensional X-ray image information with regard to the vertical and horizontal sections, thereby obtaining three-dimensional information with regard to the body cavity **220**.

[0167] The synchronizing circuit **208** controls X-ray exposure timing for the X-ray sources **202** and **204** via the X-ray CCU **206**, and image output timing for the endoscope CCU **207**. That is to say, at the time of X-ray imaging by the X-ray cameras **203** and **205**, the endoscope imaging signals are switched to "off". Conversely, at the time of imaging by the endoscope camera, the X-ray sources **202** and **204** are controlled so as to be "off".

[0168] The sentinel lymph node observation system **201** detects an SN corresponding to an affected portion **221** on the body cavity **220** (see **FIG. 23A**), and identifies the position of the SN. Prior to the identifying processing, an

X-ray imaging agent is injected with an injection needle at around four points deep in the mucous tissue around the affected portion **221**. Following the X-ray imaging agent reaching the SN, the examination begins. Note that the X-ray imaging agent is an imaging agent which absorbs X-rays.

[0169] In the event of identifying the SN using the sentinel lymph node observation system **201**, X-rays are cast from the first and second X-ray sources **202** and **204**, vertical cross-sectional and horizontal cross-sectional X-ray images of the body cavity organ of the patient are taken by the first X-ray camera **203** and the second X-ray camera **205**, the X-ray CCU **206** outputs X-ray image information, and an X-ray image is displayed on an X-ray image screen **215** of X-ray image display unit **209** as shown in **FIG. 23A**.

[0170] In the event that a surgeon recognizes a portion in which the imaging agent is accumulated in the body cavity **220** which is displayed on the X-ray image screen **215**, besides portions near the affected portion **221**, judgment is made that the portion is an SN **222** corresponding to the affected portion **221**.

[0171] In the event that the SN **222** is identified as described above, the tip of the marking needle **214** inserted into the inserting portion **212** of the endoscope **211** is accurately positioned at the wall of the cavity underneath which the SN **222** is positioned as shown in **FIG. 23A**. Note that positioning of the marking needle **214** is performed while observing both X-ray image screens from the first and the second X-ray cameras **203** and **205**.

[0172] Visible-light endoscope images from the endoscope camera are acquired by the endoscope CCU **207** and are displayed on the endoscope image display unit **210** with the marking needle **214** being positioned as described above (see **FIG. 23B**). A surgeon operates the marking device **213** so as to place a mark **224** onto the position on the wall of the body cavity corresponding to the SN **222**. Note that in the case of the affected portion **221** shown in **FIG. 23A**, there is only one SN **222**. However, there might be multiple SNs, and in this case, multiple marks are placed onto the wall of the body cavity corresponding to the SNs, respectively.

[0173] Identification of the SN ends with the above-described processing. Subsequently, an aspiration biopsy needle is inserted into the endoscope **211**, and a surgeon inserts the aspiration biopsy needle into the wall of the cavity from the position of the mark **224** so as to take a tissue sample of the SN **222** while observing endoscope images from the endoscope camera. Judgment is made whether or not the affected portion **221** has spread to the SN based upon the examination results of the tissue sample.

[0174] With the examination method using the sentinel lymph node observation system **201** of the present embodiment as described above, the SN can be quickly and accurately identified without laparotomy of the body cavity **220** containing the affected portion **221**.

[0175] While the sentinel lymph node observation system **201** of the above-described present embodiment employs two sets of an X-ray source and an X-ray camera in two directions for horizontal section and vertical section, it is needless to say that an arrangement may be made wherein only one set of an X-ray source and an X-ray camera in one direction is employed, and the examination is made by rotationally moving the set of the X-ray source and the X-ray camera or rotationally moving the patient.

[0176] Now, a sentinel lymph node observation system to which a sentinel lymph node observation method according to an eighth embodiment of the present invention has been applied will be described with reference to **FIGS. 24 through 25B**.

[0177] **FIG. 24** is a diagram which illustrates the configuration of a sentinel lymph node observation system of the eighth embodiment according to the present invention. **FIG. 25A** illustrates a display screen on an X-ray display unit according to the system. **FIG. 25B** illustrates a display screen on an ultrasonic image display unit according to the system.

[0178] As shown in **FIG. 24, a** sentinel lymph node observation system **231** includes an ultrasonic endoscope **232** instead of the endoscope **211** of the system **201** according to the above-described seventh embodiment, and further includes a tomographic image generating unit **234** for ultrasonic images, and an ultrasonic image display unit **235**. An endoscope camera (not shown), an ultrasonic transducer (not shown), and an aspiration biopsy needle **237**, are mounted to an inserting portion **236** of the ultrasonic endoscope **232**. Furthermore, the sentinel lymph node observation system **231** of the present embodiment includes the first X-ray source **202**, the first X-ray camera **203**, the second X-ray source **204**, the second X-ray camera **205**, the X-ray CCU **206**, the X-ray display unit **209**, and the endoscope image display unit **211** for displaying a visible-light image from the endoscope camera in the same way as the seventh embodiment.

[0179] Now, procedures for identifying an SN using the sentinel lymph node observation system **231** of the present embodiment will be described. First of all, an X-ray imaging agent is injected around the affected portion **221** in the same way as the system **201** according to the above-described seventh embodiment. Subsequently, X-ray images of the body cavity **220** are taken by the X-ray cameras **203** and **205**, and the SN **222** corresponding to the affected portion **221**, in which the X-ray imaging agent is accumulated, is displayed on a display screen **238** on the X-ray display unit **209** as shown in **FIG. 25A**, and is recognized. Note that an X-ray imaging agent which absorbs ultrasonic waves as well as X-rays is employed as the X-ray imaging agent to be injected.

[0180] Following detecting of the SN **222**, the aspiration biopsy needle **237** of the inserting portion **236**, which is inserted into the body cavity **220**, is inserted while observing the display screen **238** on the X-ray image display unit **209** displaying images from both of the first and the second X-ray cameras **203** and **205**, and the tip thereof is positioned so as to face the wall of the body cavity underneath which the SN **222** is positioned. Note that the aspiration biopsy needle **237** is formed of a material which absorbs X-rays. Accordingly, the user can recognize the inserting position of the aspiration biopsy needle **237** on an X-ray image.

[0181] Subsequently, the first and the second X-ray sources are switched to "off". Tomographic image information containing the SN **222** around the aspiration biopsy needle **237** of the inserting portion **236** is then acquired by the ultrasonic transducer and the tomographic image generating unit **234**. The ultrasonic image display unit **235** displays a tomographic image on the display screen **239** as shown in **FIG. 25B**. A surgeon takes a tissue sample of the SN **222** by inserting the aspiration biopsy needle **237** into the SN **222** underneath the wall of the body cavity and sucking the tissue sample of the SN **222**.

[0182] With the sentinel lymph node observation system **231** of the present embodiment as described above, marking operations for the identified SN are not required, so biopsy for the SN can be performed quickly. Furthermore, sampling operations for tissue of the SN **222** can be performed while observing ultrasonic tomographic images.

[0183] Now, a sentinel lymph node observation system to which a sentinel lymph node detecting method according to a ninth embodiment of the present invention has been applied will be described with reference to a system configuration diagram of the present embodiment shown in **FIG. 26**.

[0184] The present sentinel lymph node observation system **241** is a system which performs identification of an SN using the MRI (magnetic resonance imaging) method, and employs ferrofluid such as Feridex (a registered trademark of an MRI liver imaging agent produced by Eiken Chemical Co., Ltd., generally referred to as "ferumoxides"), as an imaging agent to be injected around the affected portion. Body tomographic image information with regard to the SN around the affected portion is obtained from NMR signals (nuclear magnetic resonance signals) occurring due to the magnetic field of the imaging agent. An antenna portion for detecting the NMR signals is mounted to the probe tip of the inserting portion of the endoscope in order to identify the SN position, the antenna portion is moved so as to detect the SN position, and marking or the like is made so as to identify the SN.

[0185] As shown in **FIG. 26**, the present system **241** generally comprises a magnet **242** which is a magnetic field generating means for generating a magnetic field from the outside of the body in order to obtain two-dimensional or three-dimensional images, a imaging unit **243** which is an imaging means for detecting the nuclear magnetic resonance state occurring due to the magnetic field and generating an MRI image, a body tomographic image display unit **244** for displaying a body tomographic image, an endoscope **245**, a probe **246** which is a probe means which is inserted to a forceps opening of the endoscope **245**, a coil-shaped antenna **249** which is disposed at the tip of the probe **246**, a signal detecting unit **250** for acquiring NMR signals from the antenna **249**, a signal intensity display unit **251** for displaying the output intensity from the signal detecting unit **250** by image or sound, an endoscope CCU **247**, and an endoscope image display unit **248**.

[0186] The body tomographic image display unit **244** is a display unit for displaying a two-dimensional or three-dimensional image from MRI imaging signals obtained by the imaging unit **243**.

[0187] The probe **246** is a probe with a small diameter, which includes a built-in antenna **249** and can be inserted into the body cavity **255** in order to observe the body cavity **255**.

[0188] The antenna **249** is a coil-shaped antenna for detecting NMR signals occurring due to the magnetic field, which is positioned at the tip of the probe **246**.

[0189] Now, procedures for identifying an SN using the sentinel lymph node observation system **241** of the present embodiment will be described. First of all, ferrofluid is injected around an affected portion **256** as an imaging agent so that the imaging agent is accumulated in an SN **257** corresponding to the affected portion **256** under observation by the endoscope **245**. An image indicating the position of the SN **257** is displayed on the body tomographic image display unit **244** by the imaging unit **243**.

[0190] Subsequently, the tip of the probe **246** of the endoscope **245** is moved within the body cavity **255** while observing images displayed on the endoscope image display unit **248** as well as images displayed on the body tomographic image display unit **244**, and positioning of the tip of the probe **246** is made at the position wherein NMR signals from the antenna **249** are maximal. At this time, the tip of the probe **246** points to the position of the wall of the body cavity underneath which the SN **257** is positioned.

[0191] Marking is then made onto the wall of the body cavity to which the tip of the probe **246** points, with a marking needle, so that the SN position is identified. Subsequently, a surgeon takes a tissue sample of the SN **257** by inserting a biopsy needle into the marked portion on the wall of the body cavity while observing images displayed on the endoscope image display unit **248** or tomographic images by the MRI.

[0192] Note that an arrangement may be made wherein, following identifying the position of the SN **257** using the antenna **249** of the probe **246**, a tissue sample of the SN **257** is taken by inserting a biopsy needle without marking while observing an ultrasonic tomographic screen using an ultrasonic endoscope. Or, the tissue sampling may be performed following marking.

[0193] The sentinel lymph node observation system **241** of the present embodiment requires no special X-ray equipment. Furthermore, high-speed MRI image processing also enables biopsy to be performed while observing displayed MRI images in real time, thereby providing an observation system with great ease-of-use.

[0194] Now, a sentinel lymph node observation system **261** to which a sentinel lymph node detecting method according to a tenth embodiment of the present invention has been applied will be described with reference to a system configuration diagram of the present embodiment shown in **FIG. 27**.

[0195] With the present sentinel lymph node observation system **261**, in the event of identifying an SN position corresponding an affected portion, a dye-type imaging agent is employed as a tracer, near-infrared light is cast from the body cavity on the SN in which the dye-type imaging agent is accumulated, so that the SN position is identified by a camera of a peritoneoscope inserted from the outside of the body.

[0196] As shown in **FIG. 27**, the sentinel lymph node observation system **261** of the present embodiment generally comprises a first endoscope **262** having an inserting portion **263** for being inserted into the body cavity **271**, a light source unit **264** for the endoscope, a first CCU **265** for controlling of imaging of a camera built in the endoscope, a first image display unit **266** for displaying images from the endoscope camera, a peritoneoscope **267** of a second endoscope which is inserted under partial laparotomy of the abdominal cavity of a patient, a second CCU **268** for controlling of imaging of a camera build in the peritoneoscope, and a second image display unit **269** for displaying images from the camera build in the peritoneoscope.

[0197] The present observation system employs an imaging agent which absorbs light in the range of visible light through infrared light, e.g., ICG, as a dye-type imaging agent for identifying an SN. The dye-type imaging agent is injected around an affected portion **272** from the side of the body cavity **271** with an injecting needle of the endoscope **262** while observing endoscope images.

[0198] The light source unit **264** is a light source unit which emits rays in the range of visible light through near-infrared light, in particular, emits near-infrared light which can readily penetrate a body. The near-infrared light is cast on the wall of the body cavity from the tip of the inserting portion **263** of the endoscope **262**.

[0199] The camera build in the tip of the peritoneoscope **267** is a near-infrared-light camera which can take images from near-infrared light.

[0200] Now, procedures for identifying the position of the SN **273** corresponding to the affected portion **272** using the sentinel lymph node observation system **261** of the present embodiment will be described. First of all, a patient is subjected to partial laparotomy of the abdominal cavity, and the peritoneoscope **267** is inserted thereinto. The abdominal cavity is kept inflated with CO_2 gas. While observing the display screen of the first image display unit **266** from the side of the body cavity, ICG, which is employed as an imaging agent, is injected around the affected portion **272** with the injecting needle of the endoscope **262**. Near-infrared light is cast on the wall of the body cavity **271** from the tip of the inserting portion **263** of the endoscope **262**.

[0201] The near-infrared light penetrates the inner wall and the outer wall of the body cavity **271**, and is cast on the camera mounted to the tip of the peritoneoscope **267**. In the event that the SN **273**, in which the ICG is accumulated, is positioned on the outer wall of the internal organ in front of the camera of the peritoneoscope **267**, the near-infrared light is absorbed in the SN **273**, so the shadow thereof is captured by the peritoneoscope, which is displayed on the second image display unit **269**. Note that the SN position is searched while changing the tilt of the peritoneoscope **267**.

[0202] A surgeon can take a tissue sample corresponding to the SN, which has been detected by the peritoneoscope **267**, by inserting a biopsy needle from the side of the peritoneoscope **267** or the side of the endoscope **262**.

[0203] With the above-described sentinel lymph node observation system **261**, in the event of identifying the SN position with near-infrared light which is cast from the side of the body cavity, even if the body internal organ is covered with fat the near-infrared light penetrates the fat, and accordingly, the image of the SN can be captured in a sure manner.

[0204] Now, a sentinel lymph node observation system **281** to which a sentinel lymph node detecting method according to a eleventh embodiment of the present invention has been applied will be described with reference to a system configuration diagram of the present embodiment shown in **FIG. 28**.

[0205] With the sentinel lymph node observation system **281** of the present embodiment, an inserting portion of an endoscope is inserted into the side of the abdominal cavity external of the internal organ through an opening provided on the body internal organ cavity. The SN position is identified based upon observed image information with regard to the abdominal cavity.

[0206] As shown in **FIG. 28**, the sentinel lymph node observation system **281** of the present embodiment generally comprises an endoscope **282** having an inserting portion **283**, an observing camera built in the tip of the inserting portion **283**, an endoscope light source unit **284**, an observing camera CCU **285**, and an image display unit **286** for displaying endoscope observed images.

[0207] The inserting portion **283** of the endoscope **282** has multiple bending portions **283*a*** along the tip thereof.

[0208] Now, procedures for identifying an SN position corresponding to an affected portion using the sentinel lymph node observation system **281** of the present embodiment having the above-described configuration will be described. First of all, a through hole **287*a*** to the abdominal cavity is provided on the wall of the body internal organ cavity **287** by means of an incision tool of the endoscope **282**. ICG, which is a dye-type imaging agent is injected at four points around an affected portion **288** of the body cavity **287** so that the ICG is accumulated in an SN **289**.

[0209] The inserting portion **283** of the endoscope **282** is inserted into the through hole **287*a*** on the wall of the body cavity **287** in the state that the injected ICG is accumulated. The dyed SN **289** is displayed on the image display unit **286** by observing the outer wall of the internal organ from the side of the abdominal cavity while bending the inserting portion **283** on the bending portions **283*a***.

[0210] Following the SN **289** being displayed on the display screen of the image display unit **286** and the position thereof being identified, a surgeon can take a tissue sample of the SN **289** by inserting an aspiration biopsy needle into the inserting portion **283**.

[0211] With the sentinel lymph node observation system **281** of the present embodiment, the SN **289** is observed from the outer wall of the internal organ, and thus the SN **289** which is generally positioned along the outer wall of the internal organ can be accurately identified.

What is claimed is:

1. A sentinel lymph node detecting method by a sentinel lymph node observation system, the system comprising:

an inserting portion with a small diameter which can be inserted into the body cavity;

an X-ray detector at the tip of the inserting portion for two-dimensionally detecting X-rays; and

an optical imaging device for taking visible-light images;

wherein the X-ray detector and the optical imaging device are positioned at the inserting portion in the longitudinal direction thereof, and are closely positioned one to another so as to observe in the same direction.

2. A sentinel lymph node detecting method according to claim 1, wherein the range over which the X-ray detector observes is less than the range over which the optical imaging device observes.

3. A sentinel lymph node detecting method according to claim 1, wherein a two-dimensional image from the X-ray detector is displayed on an image of the body cavity from the optical imaging device, in a superimposed manner.

4. A sentinel lymph node detecting method according to claim 3, wherein portions with high radiation density in a two-dimensional image from the X-ray detector are displayed as a computer color-enhanced image.

5. A sentinel lymph node detecting method according to claim 1, wherein the X-ray detector forms a curved face, and has directivity for detection in the direction orthogonal to the curved face.

6. A sentinel lymph node detecting method according to claim 5, wherein a layer having a plurality of collimator means for yielding directivity is disposed in front of the light-receiving face in the X-ray detector.

7. A sentinel lymph node detecting method by a sentinel lymph node observation system, the system comprising:

an inserting portion with a small diameter which can be inserted into a forceps opening of an endoscope; and

an X-ray detector disposed at the tip of the inserting portion for detecting X-rays;

wherein the X-ray detector is separated into an inner detecting unit and an outer detecting unit, and has a detecting means for detecting the differential between the X-ray intensities detected by the detecting portions.

8. A sentinel lymph node detecting method according to claim 7, wherein the outer detecting portion is made up of a plurality of detecting elements which generally cover the inner detecting portion.

9. A sentinel lymph node detecting method using a sentinel lymph node observation system, the system comprising:

an inserting portion with a small diameter which can be inserted into the body cavity;

an X-ray detector disposed at the tip of the inserting portion; and

an ultrasonic detector disposed at the tip of the inserting portion;

wherein the X-ray detector consists of a linear-array X-ray detector, and the ultrasonic transducer consists of a convex ultrasonic transducer;

and wherein the linear-array X-ray detector and the convex ultrasonic transducer are synchronously driven in the same direction by scanning;

and wherein tomographic image information obtained from the convex ultrasonic transducer and X-ray intensity image information detected by the liner-array X-ray detector is displayed in a synchronous manner.

10. A sentinel lymph node detecting method according to claim 9, wherein X-ray intensity image information detected by the liner-array X-ray detector is displayed as a computer color-enhanced image in the event that the detected X-ray intensity is high.

11. A sentinel lymph node detecting method using a sentinel lymph node observation system, the system comprising:

an inserting portion with a small diameter which can be inserted into the body cavity,

an ultrasonic detector disposed at the tip of the inserting portion, and

an X-ray detector disposed at the tip of the inserting portion;

wherein the ultrasonic transducer consists of a linear-array ultrasonic transducer made up of a plurality of ultrasonic transducer elements, wrapped around the cylinder face with the same axis as the cylinder face of the tip of the inserting portion,

and wherein the X-ray detector consists of a linear-array X-ray detector made up of a plurality of X-ray detector elements, wrapped around the cylinder face of the tip of the inserting portion,

and wherein the liner-array ultrasonic transducer and the liner-array X-ray detector are synchronously driven in the same direction,

and wherein tomographic image information obtained from the liner-array ultrasonic transducer and X-ray intensity image information detected by the liner-array X-ray detector is displayed in a synchronous manner.

12. A sentinel lymph node detecting method according to claim 11, wherein X-ray intensity image information detected by the liner-array X-ray detector is displayed as a computer color-enhanced image in the event that the detected X-ray intensity is high.

13. A sentinel lymph node detecting method comprising:

an X-ray source and an X-ray camera, for observing sentinel lymph nodes near affected portions in which an imaging agent for absorbing X-rays has been accumulated beforehand,

an endoscope for observing the body cavity, and marking means inserted from a forceps opening of the endoscope;

wherein marking is made with the marking means onto the inner wall of the body cavity organ near the portion in which the imaging agent has been accumulated.

14. A sentinel lymph node detecting method according to claim 13, wherein image signals for the X-ray camera and image signals for the endoscope are synchronous, so that at the time of taking of X-ray images, image signals for the endoscope are switched to "off".

15. A sentinel lymph node detecting method according to claim 13, wherein the marking means is made up of a material which absorbs X-rays.

16. A sentinel lymph node detecting method which uses:

magnetic field generating means for imaging sentinel lymph nodes near affected portions in which ferrofluid has been accumulated beforehand,

imaging means for imaging nuclear magnetic resonance occurring due to the magnetic field, and

probe means with a small diameter which can be inserted into the body cavity;

wherein an antenna is disposed at the tip of the probe means for detecting signals occurring due to the magnetic field.

17. A sentinel lymph node detecting method according to claim 16, wherein the antenna is a coil for detecting NMR signals.

18. A sentinel lymph node detecting method which uses:

a first endoscope for lighting up the body cavity containing affected portions around which a substance has been injected for imaging sentinel lymph nodes beforehand, and

a second endoscope for observing transmitted light from the first endoscope, from the abdominal cavity side.

19. A sentinel lymph node detecting method according to claim 18, wherein the second endoscope is a peritoneoscope.

20. A sentinel lymph node detecting method according to claim 18, wherein the substance absorbs light in the range of visible light through infrared light.

21. A sentinel lymph node detecting method according to claim 18, wherein the substance is ICG.

22. A sentinel lymph node detecting method which uses:

an X-ray source and an X-ray camera for observing sentinel lymph nodes near affected portions in which an imaging agent for absorbing X-rays and ultrasonic waves has been accumulated beforehand,

an endoscope comprising

an imaging device for observing the body cavity and

an ultrasonic transducer for imaging tomographic images of tissue; and

needle means inserted from a forceps opening of the endoscope;

wherein a tissue sample is taken of the portion in which the imaging agent has been accumulated.

23. A sentinel lymph node detecting method according to claim 22, wherein the tip of the needle means is made up of a material which absorbs X-rays.

* * * * *

patsnap

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摘要(译)

前哨淋巴结检测系统包括可插入体腔内的小直径插入部分，用于二维检测X射线的X射线检测单元，以及用于拍摄可见光图像的光学成像单元3它们安装在插入部分的顶端。 X射线检测单元和光学成像单元沿插入部分的纵向设置，并且彼此紧密地设置，以便在相同方向上观察。通过X射线检测单元检测累积在前哨淋巴结中的放射性示踪剂。 X射线检测图像的尺寸小于光学成像单元拍摄的图像。因此，可以以可靠的方式快速识别前哨淋巴结，并且可以减少施加在患者身上的负荷，例如需要进行剖腹手术。