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(54) Ultrasonic endoscope

(57) An ultrasonic endoscope by which a positional relationship can be grasped even in the width direction of ultrasonic transducers. The ultrasonic endoscope performs three-dimensional scanning operation by using an ultrasonic transducer array having plural two-dimensional ultrasonic transducer arrays (TA1 to TA12) arranged in a semicircle form or the like, and includes plural signal interconnections (EL_{1-1} to EL_{15-5}) each for inputting the same drive signal to the individual electrodes of the ultrasonic transducers located in the same row and column in the plural two-dimensional ultrasonic transducer arrays, and plural common interconnections (G1 to G12) each for connecting common electrodes of the plural ultrasonic transducers included in respective one of the plural two-dimensional ultrasonic transducer arrays to a fixed potential.

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an ultrasonic endoscope capable of being inserted into a body of a patient and imaging ultrasonic tomographic images for medical diagnoses and an ultrasonic endoscopic apparatus having such an ultrasonic endoscope.

Description of a Related Art

[0002] Conventionally, puncture treatment using an ultrasonic endoscope has been performed while confirming in real time the protrusion state of a puncture needle protruded from the tip of the insertion part of the ultrasonic endoscope inserted into a body on ultrasonic tomographic images obtained by using plural ultrasonic transducers (ultrasonic vibrators) provided at the tip of the insertion part of the ultrasonic endoscope. However, such puncture treatment using the ultrasonic endoscope is so difficult that it requires advanced techniques.

[0003] For example, Japanese Patent Application Publication JP-P2004-105289A discloses an ultrasonic endoscope that reduces the difficulty of puncture treatment by suppressing the reaction when the puncture needle is punctured into a target part even if the target part is a tissue that has become hard due to fibrosis or the like (paragraphs 0022 and 0023, and Fig. 2). In the ultrasonic endoscope, a magnetic force is applied from a magnetic generation device located outside of the body of a patient and a current is allowed to flow in an electromagnet provided in a position close to the curved part at the tip side of the flexible portion of the ultrasonic endoscope, and thereby, the position close to the curved part at the tip side of the flexible portion of the ultrasonic endoscope is attracted by a magnetic force and fixed to the luminal wall of the trachea of the patient. Thus, when the puncture needle is punctured into a target part within the body cavity by using the ultrasonic endoscope, the insertion part of the ultrasonic endoscope is prevented from bending due to the reaction of the puncture needle and the puncture needle can be punctured into the target part easily and reliably even if the target part is a tissue that has become hard due to fibrosis or the like.

[0004] However, a conventional ultrasonic endoscope images ultrasonic tomographic images by using a convex one-dimensional ultrasonic transducer array 101 including plural ultrasonic transducers arranged in a semicircle form as shown in Fig. 12A. As a result, even though it is seen that a puncture needle 102 has been able to be punctured into a target part 105 in a B-mode image, sometimes the center line of the puncture needle 102 and the target part 105 are actually misaligned in the width direction of the ultrasonic transducer because of the focus width in the width direction of the ultrasonic transducer.

[0005] Accordingly, in the case where the target part 105 has become hardened, the reaction when the puncture needle 102 is punctured can be suppressed as disclosed in JP-P2004-105289A, however, even in the case where the target part 105 has not become hardened, especially when the target part 105 is small, the difficulty of puncture treatment can not be reduced unless the misalignment between the center line of the puncture needle 102 and the target part 105 because of the focus width in the width direction of the ultrasonic transducer is eliminated.

SUMMARY OF THE INVENTION

[0006] The present invention is achieved in view of the above-mentionedproblems. An object of the present invention is to provide an ultrasonic endoscope and an ultrasonic endoscopic apparatus by which a positional relationship can be grasped even in the width direction of the ultrasonic transducer.

[0007] In order to solve the above-mentioned problems, an ultrasonic endoscope according to a first aspect of the present invention comprises: plural two-dimensional ultrasonic transducer arrays arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation; a first group of interconnections each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in the same row and the same column in the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit; and a second group of interconnections each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit.

[0008] An ultrasonic endoscope according to a second aspect of the present invention comprises: plural two-dimensional ultrasonic transducer arrays arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation; a first group of interconnections each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in the same row and the same column in the plural two-dimensional ultrasonic transducer arrays; plural variable delay line units having first terminals connected to the first group of interconnections, respectively; a second group of interconnections each for electrically connecting to one another second terminals of the plural variable delay line units connected to the plural ultrasonic transducers located in the same row in the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit; and a third group of interconnections each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit.

[0009] An ultrasonic endoscopic apparatus according to a first aspect of the present invention comprises: an ultrasonic endoscope including plural two-dimensional ultrasonic transducer arrays arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in the same row and the same column in the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a second group of interconnections each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in Respective one of the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit; transmitting means for generating drive signals and outputting the drive signals to the plural two-dimensional ultrasonic transducer arrays via the first group of interconnections; plural pieces of switch means connected to the second group of interconnections and a fixed potential; and control means for controlling whether or not each of the second group of interconnections is connected to the fixed potential by supplying control signals to the plural pieces of switch means so as to select one to be used from among the plural two-dimensional ultrasonic transducer arrays, and controlling delay amounts of the drive signals in the transmitting means such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

[0010] An ultrasonic endoscopic apparatus according to a second aspect of the present invention comprises: an ultrasonic endoscope including plural two-dimensional ultrasonic transducer arrays arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in the same row and the same column in the plural two-dimensional ultrasonic transducer arrays, plural variable delay line units having first terminals connected to the first group of interconnections, respectively, a second group of interconnections each for electrically connecting to one another second terminals of the plural variable delay line units connected to the plural ultrasonic transducers located in the same row in the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a third group of interconnections each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit; transmitting means for generating drive signals and outputting the drive signals to the plural two-dimensional ultrasonic transducer arrays via the second group of interconnections; plural pieces of switch means connected to the third group of interconnections and a fixed potential; and control means for controlling whether or not each of the third group of interconnections is connected to the fixed potential by supplying control signals to the plural pieces of switch means so as to select one to be used from among the plural two-dimensional ultrasonic transducer arrays, and supplying delay amount control signals for controlling delay amounts of the drive signals to the plural variable delay line units such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

[0011] An ultrasonic endoscopic apparatus according to a third aspect of the present invention comprises: an ultrasonic endoscope including plural two-dimensional ultrasonic transducer arrays arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in the same row and the same column in the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a second group of interconnections each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit; an adapter including plural pieces of switch means connected to the second group of interconnections and a fixed potential; and an ultrasonic observation apparatus including transmitting means for generating drive signals and outputting the drive signals to the plural two-dimensional ultrasonic transducer arrays via the first group of interconnections, and control means for controlling whether or not each of the second group of interconnections is connected to the fixed potential by supplying control signals to the plural pieces of switch means so as to select one to be used from among the plural two-dimensional ultrasonic transducer arrays, and controlling delay amounts of the drive signals in the transmitting means such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

[0012] An ultrasonic endoscopic apparatus according to a fourth aspect of the present invention comprises: an ultrasonic endoscope including plural two-dimensional ultrasonic transducer arrays arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in the same row and the same column in the plural two-dimensional ultrasonic transducer arrays, plural variable delay line units having first terminals connected to the first group of interconnections, respectively, a second group of interconnections each for electrically connecting to one another second terminals of the plural variable delay line units connected to the plural ultrasonic transducers located in the same row in the plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a third group of interconnections each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of the plural two-dimensional ultrasonic transducer array and electrically connecting a connection point thereof to an external circuit; an adapter including plural pieces of switch means connected to the third group of interconnections and a fixed potential; and an ultrasonic observation apparatus including transmitting means for generating drive signals and outputting the drive signals to the plural two-dimensional ultrasonic transducer arrays via the second group of interconnections, and control means for controlling whether or not each of the third group of interconnections is connected to the fixed potential by supplying control signals to the plural pieces of switch means so as to select one to be' used from among the plural two-dimensional ultrasonic transducer arrays, and supplying delay amount control signals for controlling delay amounts of the drive signals to the plural variable delay line units such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

[0013] According to the present invention, the positional relationship can be grasped even in the width direction of the ultrasonic transducer, and therefore, the centerline of the puncture needle can be precisely aligned with the target part even when the target part is small, for example.

[0014] Further, the number of interconnections within the ultrasonic transducer array can be drastically reduced. As a result, when the ultrasonic transducer array is formed by arranging plural two-dimensional ultrasonic transducer arrays in a semicircle form or polygonal form, the insertion part of the ultrasonic endoscope can be prevented from being thicker due to interconnections within the ultrasonic transducer array.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 shows a constitution of an ultrasonic endoscopic apparatus 1 according to a first embodiment of the present invention;

Fig. 2 shows a structure of an ultrasonic endoscope 2 shown in Fig. 1;

Figs. 3A and 3B show a structure of an ultrasonic transducer array 30 shown in Fig. 2;

Fig. 4 shows the structure of the ultrasonic transducer array 30 shown in Fig. 2;

Fig. 5 shows interconnections within the ultrasonic transducer array 30 shown in Fig. 2;

Fig. 6 is a chart for explanation of a method of generating drive pulse signals to be applied to individual electrodes of the respective ultrasonic transducers that form the ultrasonic transducer array 30 shown in Fig. 2;

Fig. 7 is a chart for explanation of a method of generating drive pulse signals to be applied to individual electrodes of the respective ultrasonic transducers that form the ultrasonic transducer array 30 shown in Fig. 2;

Fig. 8 is a diagram for explanation of sector scan with respect to the width direction of the ultrasonic transducer;

Fig. 9 shows a constitution of an ultrasonic endoscopic apparatus 200 according to a second embodiment of the present invention;

Fig. 10 shows interconnections within the ultrasonic transducer array 30 of the ultrasonic endoscopic apparatus 200 shown in Fig. 9;

Figs. 11A to 11D are diagrams for explanation of operation of variable delay line units shown in Fig. 10; and

Figs. 12A and 12B are diagrams for explanation of aproblem in a conventional ultrasonic endoscopic apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Hereinafter, the best modes for implementing the present invention will be described in detail by referring to the drawings. The same reference numbers will be assigned to the same component elements and the description thereof will be omitted.

[0017] As shown in Fig. 1, an ultrasonic endoscopic apparatus 1 according to a first embodiment of the present invention includes an ultrasonic endoscope 2, an ultrasonic observation apparatus 3 to which the ultrasonic endoscope 2 is connectable, and a display device 4 connected to the ultrasonic observation apparatus 3.

[0018] The ultrasonic observation apparatus 3 includes a console 11, a CPU (central processing unit) 12, firsttotwelfth switches SW1 and SW12, a transmitting circuit 14, a receiving circuit 15, a processing unit 16, a digital scan converter (DSC) 17, an image memory 18, and a digital/analog converter (D/A converter) 19.

[0019] As shown in Fig. 2, the ultrasonic endoscope 2 includes an insertion part 21, an operation part 22, a connecting cord 23, and a universal cord 24.

[0020] The insertion part 21 of the ultrasonic endoscope 2 has an elongated flexible tubular shape so as to be inserted into a body of a patient. The operation part 22 is provided at the base end of the insertion part 21, connected to the ultrasonic observation apparatus 3 via the connecting cord 23 and connected to a light source device and an optical observation device (not shown) via the universal cord 24.

[0021] In the insertion part 21 of the ultrasonic endoscope 2, an illumination window and an observation window are provided. An illumination lens for outputting illumination light supplied via a light guide from the light source device is attached to the illumination window. These form an illumination optical system. Further, an objective lens is attached to the observation window, and, in a position where the objective lens forms an image, an input end of an image guide or solid-state image sensor such as a CCD camera is disposed. These form an observation optical system.

[0022] Further, at the tip of the insertion part 21 of the ultrasonic endoscope 2, a convex ultrasonic transducer array 30 is provided. The ultrasonic transducer array 30 generates ultrasonic waves according to drive signals supplied from the transmitting circuit 14 of the ultrasonic observation apparatus 3, receives ultrasonic waves reflected from a target part or the like, and outputs plural reception signals to the receiving circuit 15 of the ultrasonic observation apparatus 3. Further, at the tip of the insertion part 21 of the ultrasonic endoscope 2, a hole from which a puncture needle 26 inserted from a treatment tool insertion hole 25 provided in the operation part 22 is protruded is formed.

[0023] As shown in Figs. 3A and 3B, the ultrasonic transducer array 30 is formed by arranging first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 in a semicircle form for three-dimensional scan with respect to each of the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12.

[0024] Here, each of the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 is formed *by arranging ultrasonic transducers in 15 rows in the circumferential direction of the ultrasonic transducer array 30 and five columns in the width direction thereof.

[0025] For example, as shown in Figs. 4 and 5, the first two-dimensional ultrasonic transducer array TA1 consists of 15 ultrasonic transducers T_{1-1-1} to T_{1-15-1} in the first column, 15 ultrasonic transducers T_{1-1-2} to T_{1-15-2} in the second column, 15 ultrasonic transducers T_{1-1-3} to T_{1-15-3} in the third column, 15 ultrasonic transducers T_{1-1-4} to T_{1-15-4} in the fourth column, and 15 ultrasonic transducers T_{1-1-5} to T_{1-15-5} in the fifth column. Other two-dimensional ultrasonic transducer arrays TA2 to TA12 similarly consist of the ultrasonic transducers.

[0026] Note that, in the ultrasonic imaging field, an ultrasonic transducer array including different numbers of ultrasonic transducers in rows and columns is generally called "1.5-dimensional ultrasonic transducer array" and an ultrasonic transducer array including the same number of ultrasonic transducers in rows and columns is generally called "two-dimensional ultrasonic transducer array", however, in the specification, both are referred to as "two-dimensional ultrasonic transducer array".

[0027] Each of the ultrasonic transducers T_{1-1-1} to $T_{12-15-5}$ includes an ultrasonic vibrator formed by sandwiching a piezoelectric element of PZT, PVDF, or the like between an individual electrode and a common electrode. When a drive signal is applied to the individual electrode while the common electrode is connected to a fixed potential (for example, a ground potential in the embodiment), the transducer transmits ultrasonic wave, and receives ultrasonic waves reflected from a target part or the like and generates a reception signal in the individual electrode.

[0028] In the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12, the individual electrodes of the ultrasonic transducers located in the same rows and columns are electrically connected to the same signal interconnections EL_{1-1} to EL_{15-5}, respectively, as shown in Fig. 5.

[0029] For example, in the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12, the individual electrodes of the 12 ultrasonic transducers T_{1-1-1}, T_{2-1-1}, T_{3-1-1}, T_{4-1-1}, T_{5-1-1}, T_{6-1-1}, T_{7-1-1}, T_{8-1-1}, T_{9-1-1}, T_{10-1-1}, T_{11-1-1}, and T_{12-1-1} located in the first row and the first column are electrically connected to the signal interconnection EL_{1-1}. Further, in the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12, the individual electrodes of the 12 ultrasonic transducers T_{1-2-1}, T_{2-2-1}, T_{3-2-1}, T_{4-2-1}, T_{5-2-1}, T_{6-2-1}, T_{7-2-1}, T_{8-2-1}, T_{9-2-1}, T_{10-2-1}, T_{11-2-1}, and T_{12-2-1} located in the second row and the first column are electrically connected to the signal interconnection EL_{2-1}.

[0030] Further, the common electrodes of the ultrasonic transducers T_{1-1-1} to $T_{12-15-5}$ that form the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 are electrically connected to the same common interconnections G1 to G12 with respect to each of the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 as shown in Fig. 5.

[0031] For example, the common electrodes of the 15 $\times$ 5 ultrasonic transducers T_{1-1-1} to T_{1-15-1}, T_{1-1-2} to T_{1-15-2}, T_{1-1-3} to T_{1-15-3}, T_{1-1-4} to T_{1-15-4}, and T_{1-1-5} to T_{1-15-5} that form the first two-dimensional ultrasonic transducer array TA1 are electrically connected to the common interconnection G1. Further, the common electrodes of the 15 $\times$ 5 ultrasonic transducers T_{2-1-1} to T_{2-15-1}, T_{2-1-2} to T_{2-15-2}, T_{2-1-3} to T_{2-15-3}, T_{2-1-4} to T_{2-15-4}, and T_{2-1-5} to T_{2-15-5} that form the second two-dimensional ultrasonic transducer array TA2 are electrically connected to the common interconnection G2.

[0032] Since the individual electrodes and the common electrodes of the ultrasonic transducers T_{1-1-1} to $T_{12-15-5}$ are thus interconnected, and then, the number of interconnections becomes "87" as the sum of "75" (= 15 × 5) as the number of signal interconnections EL_{1-1} to EL_{15-5} and "12" as the number of common interconnections G1 to G12. Consequently, the number of interconnections can be drastically reduced compared to the number of interconnections "901" (= 12 × 15 × 5 + 1) in the case where signal interconnections are provided to the individual electrodes of the ultrasonic transducers T_{1-1-1} to $T_{12-15-5}$, respectively, and one common interconnection is wired to the common electrodes.

[0033] The signal interconnections EL_{1-1} to EL_{15-5} are connected to the transmitting circuit 14 and the receiving circuit 15 of the ultrasonic observation apparatus 3 shown in Fig. 1 via the connecting cord 23 shown in Fig. 2, and the common interconnections G1 to G12 are connected to the first to twelfth switches SW1 to SW12 of the ultrasonic observation apparatus 3 via the connecting cord 23.

[0034] The console 11 of the ultrasonic observation apparatus 3 shown in Fig. 1 outputs control signal A for controlling start/stop of ultrasonic imaging operation in the ultrasonic endoscope 2 to the CPU 12.

[0035] The CPU 12 outputs first to twelfth switch control signals B1 to B12 for controlling ON/OFF of the first to twelfth switches SW1 to SW12 based on the control signal A input from the console 11 to the first to twelfth switches SW1 to SW12, respectively, and outputs transmitting circuit control signal A1 for controlling the start/stop of operation of the transmitting circuit 14 and delay times (delay amounts) of the drive signals to the transmitting circuit 14.

[0036] The first to twelfth switches SW1 to SW12 are turned ON/OFF according to the first to twelfth switch control signals B1 to B12 input from the CPU 12. When the first to twelfth switches SW1 to SW12 are turned ON, the common interconnections G1 to G12 are grounded, respectively, and, when the first to twelfth switches SW1 to SW12 are turned OFF, the common interconnections G1 to G12 are opened, respectively. Since the ultrasonic transducer operates only when the common electrode is grounded, the ultrasonic transducers T_{1-1-1} to $T_{12-15-5}$ can be operated with respect to each of the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12.

[0037] When the transmitting circuit control signal A1 for instructing the operation start of the transmitting circuit 14 is input from the CPU 12, the transmitting circuit 14 generates drive signals and outputs them onto the signal interconnections EL_{1-1} to EL_{15-5}.

[0038] The receiving circuit 15 amplifies the reception signals input from the plural ultrasonic transducers with the grounded common electrodes included in the ultrasonic transducer array via the signal interconnections EL_{1-1} to EL_{15-5} at a predetermined amplification degree, and then, converts the amplified reception signals into digital reception signals byperformingA/D conversion. Further, the receiving circuit 15 performs reception focus processing by performing processing of phase matching or the like on the digital reception signals to form sound ray data in which focal points of the ultrasonic echoes are narrowed.

[0039] The processing unit 16 performs correction of attenuation depending on the distance according to the depth of the reflection position of ultrasonic wave on the sound ray data formed by the receiving circuit 15 and performs envelope detection processing thereon to generate B-mode image data. Alternatively, the processing unit 16 generates Doppler image data formed by extracting only reflection components from bloodstream based on the sound ray data formed by the receiving circuit 15.

[0040] Since the B-mode image data or the Doppler image data generated in the processing unit 16 has been obtained by the scanning method different from the normal scanning method of television signal, the DSC 17 converts (raster conversion) the data into normal image data. The image memory 18 stores the image data generated in the DSC 17. The D/A converter 19 converts the digital image data read from the image memory 18 into analog image signals and outputs them to the display unit 4. Thereby, in the display unit 4, a three-dimensional ultrasonic tomographic image imaged by the ultrasonic endoscope 2 is displayed.

[0041] Next, an operation of the ultrasonic endoscopic apparatus 1 according to the embodiment will be described.

[0042] In the case where an ultrasonic tomographic image is imaged using the ultrasonic endoscope 2 shown in Fig. 2, the operator emits light from the light source device connected to one end of the universal cord 24 and outputs illumination light into the body of the patient from the illumination window provided at the tip of the insertion part 21, and inserts the insertion part 21 of the ultrasonic endoscope 2 into the body of the patient while observing the insertion state from the observation window.

[0043] When the insertion part 21 reaches a target position, the operator allows the console 11 to output the control signal A for starting the operation of the ultrasonic endoscope 2 to the CPU 12 (see Fig. 1). The CPU 12 outputs the first switch control signal B1 for turning ON the first switch SW1 to the first switch SW1 and outputs the transmitting circuit control signal A1 for starting the operation of the transmitting circuit 14 to the transmitting circuit 14 according to the control signal A.

[0044] When the first switch SW1 is turned ON, the common interconnection G1 is grounded and the common electrodes of the ultrasonic transducers T_{1-1-1} to T_{1-15-5} that form the first two-dimensional ultrasonic transducer array TA1 shown in Fig. 5 are grounded.

[0045] The transmitting circuit 14 respectively generates drive signals to be applied to the individual electrodes of the ultrasonic transducers T_{1-1-1} to T_{1-15-5} hat form the first two-dimensional ultrasonic transducer array TA1 via the signal interconnections EL_{1-1} to EL_{15-5}. Simultaneously, the transmitting circuit 14 provides delay times to the respective drive signals (pulse signals in the embodiment) based on the transmitting circuit control signal A1 from the CPU 12 in order to perform transmission beam forming and steering of transmission beam.

[0046] That is, the transmitting circuit 14 provides delay times as shown in Fig. 6 to the drive pulse signals to be applied to the 15 ultrasonic transducers T_{1-1-1} to T_{1-15-5} in the first column of the first two-dimensional ultrasonic transducer array TA1 via the signal interconnections EL_{1-1} to EL_{15-1} in order to perform transmission beam forming with respect to the circumferential direction of the ultrasonic transducer. Further, the transmitting circuit 14 changes the delay times of the drive signals with time such that the sector scan with viewing angle of about 60° is performed with respect to the circumferential direction of the ultrasonic transducer as shown in Fig. 4. The operation is the same for the drive pulse signals to be applied to the ultrasonic transducers in the second to fifth columns of the first two-dimensional ultrasonic transducer array TA1.

[0047] Further, the transmitting circuit 14 provides delay times as shown in Fig. 7 to the respective drive pulse signals to be applied to the five ultrasonic transducers T_{1-1-1}, T_{1-1-2}, T_{1-1-3}, T_{1-1-4}, and T_{1-1-5} in the first row of the first two-dimensional ultrasonic transducer array TA1 shown in Fig. 5 via the signal interconnections EL_{1-1}, EL_{1-2}, EL_{1-3}, EL_{1-4}, and EL_{1-5} in order to perform transmission beam forming with respect to the width direction of the ultrasonic transducer. Further, the transmitting circuit 14 changes the delay times of the drive pulse signals with time such that the sector scan with predetermined viewing angle is performed with respect to the width direction of the ultrasonic transducer. The operation is the same for the drive pulse signals to be applied to the ultrasonic transducers in the second to fifteenth rows of the first two-dimensional ultrasonic transducer array TA1.

[0048] Thereby, ultrasonic waves are emitted from the ultrasonic transducers T_{1-1-1} to T_{1-15-5} that form the first two-dimensional ultrasonic transducer array TA1, and the sector scan with viewing angle of about 60° is performed with respect to the circumferential direction of the ultrasonic transducer as shown in Fig. 4 and the sector scan is also performed with respect to the width direction as shown in Fig. 8.

[0049] The plural reception signals obtained by the sector scan are output to the receiving circuit 15, sound ray data is formed, the B-mode image data or the Doppler image data is generated in the processing unit 16, and then, the data is raster-converted in the DSC 17 and image data is formed. The image data is stored in the image memory 18.

[0050] When the sector scan by the first two-dimensional ultrasonic transducer array TAlis finished, the CPU 12 outputs the first switch control signal B1 for turning OFF the first switch SW1 to the first switch SW1 and outputs the second switch control signal B2 for turning ON the second switch SW2 to the second switch SW2. Thereby, the common interconnection G2 is grounded and the common electrodes of the ultrasonic transducers T_{2-1-1} to T_{2-15-5} that forms the second two-dimensional ultrasonic transducer array TA2 are grounded.

[0051] In the transmitting circuit 14, the drive pulse signals to be applied to the individual electrodes of the ultrasonic transducers T_{2-1-1} to T_{2-15-5} that form the second two-dimensional ultrasonic transducer array TA2 via the signal lines EL_{1-1} to EL_{15-5} are respectively generated as described above.

[0052] Thereby, ultrasonic waves are emitted from the ultrasonic transducers T_{2-1-1} to T_{2-15-5} that form the second two-dimensional ultrasonic transducer array TA2, and the sector scan with viewing angle of about 60° is performed with respect to the circumferential direction of the ultrasonic transducer as shown in Fig. 4 and the sector scan is also performed with respect to the width direction as shown in Fig. 8.

[0053] The plural reception signals obtained by the sector scan are output to the receiving circuit 15, sound ray data is formed, the B-mode image data or the Doppler image data is generated in the processing unit 16, and then, the data is raster-converted in the DSC 17 and image data is formed. The image data is stored in the image memory 18.

[0054] The above operation is repeated, and thereby, sector scan is performed with respect to each of the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 with respect to the circumferential direction of the ultrasonic transducer while performing sector scan with respect to the width direction of the ultrasonic transducer.

[0055] As a result, image data obtained by the three-dimensional scanning with the ultrasonic endoscope 2 is stored in the image memory 18. The image data is read from the image memory 18, and then, converted into analog image signals by the D/A converter 19, and output to the display device 4. Thereby, in the display unit 4, a three-dimensional ultrasonic tomographic image imaged by the ultrasonic endoscope 2 is displayed.

[0056] Since the three-dimensional ultrasonic tomographic image is formed also by scanning with respect to the width direction of the ultrasonic transducer, the operator can precisely puncture the puncture needle 26 into the target part by allowing the puncture needle 26 inserted from the treatment tool insertion hole 25 shown in Fig. 2 to protrude from the hole at the tip of the insertion part 21 while confirming the position of the target part in the three-dimensional ultrasonic tomographic image displayed in the display device 4.

[0057] Next, an ultrasonic endoscopic apparatus according to the second embodiment of the present invention will be described by referring to Figs. 9 to 11D.

[0058] An ultrasonic endoscopic apparatus 200 according to the embodiment differs from the ultrasonic endoscopic apparatus 1 according to the first embodiment shown in Fig. 1 in the following points (1) to (4) :

(1) As shown in Fig. 9, the CPU 12 of the ultrasonic observation apparatus 3 outputs a 3-bit delay amount control signal CONT for switching the delay amounts of variable delay line units DL_{1-1} to DL_{15-5} provided in the ultrasonic endoscope 2, which will be described later, to delay amount control lines 320 (Fig. 10) when the control signal A for instructing the start of the operation of the ultrasonic endoscope 2 from the console 11;

(2) The number of the signal interconnections EL_1 td EL_{15} output from the transmitting circuit 14 of the ultrasonic observation apparatus 3 is 15;

(3) As shown in Fig. 10, the signal interconnections EL1 to EL15 include plural first conducting lines L_{1-1} to L_{15-5} to which the individual electrodes of the ultrasonic transducers located in the same rows and columns in the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 are electrically connected and plural second conducting lines L1 to L15 for inputting the same drive pulse signals to the individual electrodes of the ultrasonic transducers located in the same rows and columns in the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12. Further, the variable delay line units DL_{1-1} to DL_{15-5} are respectively provided between the plural first conducting lines L_{1-1} to L_{15-5} and second conducting lines L1 to L15, and the delay amount control lines 320 for inputting the delay amount control signal CONT for controlling the delay amounts of the variable delay line units DL_{1-1} to DL_{15-5} to the variable delay line units DL_{1-1} to DL_{15-5} are connected to the variable delay line units DL_{1-1} to DL_{15-5}.

That is, the same drive pulse signals are input to the individual electrodes of the ultrasonic transducers T_{1-1-1} to $T_{12-15-5}$ located in the same rows and columns in the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 via, the variable delay line units DL_{1-1} to DL_{15-5}.

For example, the drive pulse signal output from the transmitting circuit 14 shown in Fig. 9 onto the signal interconnection EL_1 is input to the individual electrodes of the ultrasonic transducers T_{1-1-1}, T_{2-1-1}, T_{3-1-1}, T_{4-1-1}, T_{5-1-1}, T_{6-1-1}, T_{7-1-1}, T_{8-1-1}, T_{9-1-1}, T_{10-1-1}, T_{11-1-1}, and T_{12-1-1} located in the first row and the first column in the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 via the first conducting line L_{1-1}, the variable delay line unit DL_{1-1}, and the second conducting line L1. Further, the drive pulse signal output from the transmitting circuit 14 shown in Fig. 9 onto the signal interconnection EL_2 is input to the individual electrodes of the ultrasonic transducers T_{1-2-1}, T_{2-2-1}, T_{3-2-1}, T_{4-2-1}, T_{5-2-1}, T_{6-2-1}, T_{7-2-1}, T_{8-2-1}, T_{9-2-1}, T_{10-2-1}, T_{11-2-1}, and T_{12-2-1} located in the second row and the first column in the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 via the first conducting line L_{2-1}, the variable delay line unit DL_{2-1}, and the second conducting line L2.

Thereby, the number of interconnections within the ultrasonic transducer array 30 becomes 15 (signal interconnections EL_1 to EL_{15}) + 12 (common interconnections G1 to G12) + 3 (delay amount control lines 320) = 30, and the number can be drastically reduced compared to that in the ultrasonic endoscope 2 according to the first embodiment shown in Fig. 5.

The variable delay line units DL_{1-1} to DL_{15-5} connected to the same signal interconnections EL_1 to EL_{15} can change the combination of delay amounts by the 3-bit delay amount control signal CONT input from the CPU 12 via the delay amount control lines 320 among eight different combinations such that the sector scan in the width direction of the ultrasonic transducer can be performed as shown in Fig. 11A, for example.

When the delay amount control signal CONT (0, 0, 0) is input as shown in Fig. 11B, the variable delay line units DL_{1-1} to DL_{15-5} connected to the signal interconnection EL_1 are controlled to be provided with the same delay amount. When the delay amount control signal CONT (0, 0, 1) is input as shown in Fig. 11C, the delay amounts are controlled to be smaller by a first amount from the variable delay line unit DL_{1-1} toward the variable delay line unit DL_{1-5} . When the delay amount control signal CONT (0, 1, 1) is input as shown in Fig. 11D, the delay amounts are controlled to be smaller by a second amount, which is larger than the first amount, from the variable delay line unit DL_{1-1} toward the variable delay line unit DL_{1-5}.

(4) In the ultrasonic endoscope 2, as shown in Fig. 11A, an acoustic lens 330 for performing transmission beam forming with respect to the width direction of the ultrasonic transducer is provided on the ultrasonic transducer array 30.

[0059] Next, an operation of the ultrasonic endoscopic apparatus 200 according to the embodiment will be described, however, because the operation of the receiving circuit 15, the processing unit 16, the DSC 17, the image memory 18, the D/A converter 19, and the display device 4 is the same as the operation in the ultrasonic endoscopic apparatus 1 according to the first embodiment shown in Fig. 1, the description thereof will be omitted.

[0060] When the insertion part 21 reaches a target position, the operator allows the console 11 to output the control signal A for starting the operation of the ultrasonic endoscope 2 to the CPU 12. The CPU 12 sequentially outputs one delay amount control signal CONT of (0, 0, 0) to (1, 1, 1) onto the delay amount control lines 320 for sector scan in the width direction of the ultrasonic transducer, outputs the first switch control signal B1 for turning ON the first switch SW1 to the first switch SW1, and outputs the transmitting circuit control signal A1 for starting the operation of the transmitting circuit 14 according to the control signal A.

[0061] When the first switch SW1 is turned ON, the common interconnection G1 is grounded and the common electrodes of the ultrasonic transducers T_{1-1-1} to T_{1-15-5} that form the first two-dimensional ultrasonic transducer array TA1 are grounded.

[0062] The transmitting circuit 14 respectively generates drive signals to be applied to the individual electrodes of the ultrasonic transducers T_{1-1-1} to T_{1-15-5} via the signal interconnections EL_1 to EL_{15}. Simultaneously, the transmitting circuit 14 provides predetermined delay times as shown in Fig. 6 to the respective pulse signals in order to perform transmission beam forming with respect to the circumferential direction of the ultrasonic transducer, and changes with time the delay times of the drive pulse signals provided with the predetermined delay time such that the sector scan with viewing angle of about 60° is performed with respect to the circumferential direction of the ultrasonic transducer as shown in Fig. 4. Further, since the transmission beam forming is performed by the acoustic lens 330 (Fig. 11A) with respect to the width direction of the ultrasonic transducer, the transmitting circuit 14 does not provide the predetermined delay times as shown in Fig. 7 to the respective drive pulse signals.

[0063] In the case where the acoustic lens 330 is not used, the transmitting circuit 14 may provide the predetermined delay times as shown in Fig. 7 to the respective drive pulse signals in order to perform transmission beam forming with respect to the width direction of the ultrasonic transducer.

[0064] Thereby, ultrasonic waves are emitted from the ultrasonic transducers T_{1-1-1} to T_{1-15-5} that form the first two-dimensional ultrasonic transducer array TA1, and the sector scan with viewing angle of about 60° is performed with respect to the circumferential direction of the ultrasonic transducer as shown in Fig. 4 and the sector scan is also performed with respect to the width direction as shown in Fig. 8. The reception signals obtained by the sector scan are output to the receiving circuit 15 via the signal interconnections EL_1 to EL_{15}.

[0065] When the sector scan by the first two-dimensional ultrasonic transducer array TA1 is finished, the first switch control signal B1 for turning OFF the first switch SW1 is output to the first switch SW1 and the second switch control signal B2 for turning ON the second switch SW2 is output to the second switch SW2. Thereby, the common interconnection G2 is grounded and the common electrodes of the ultrasonic transducers T_{2-1-1} to T_{2-15-5} that form the second two-dimensional ultrasonic transducer array TA2 are grounded.

[0066] The transmitting circuit 14 respectively generates the drive pulse signals to be applied to the individual electrodes of the ultrasonic transducers T_{2-1-1} to T_{2-15-5} that form the second two-dimensional ultrasonic transducer array TA2 via the signal lines EL_1 to EL_{15} as described above.

[0067] Thereby, ultrasonic waves are emitted from the ultrasonic transducers T_{2-1-1} to T_{2-15-5} that form the second two-dimensional ultrasonic transducer array TA2, and the sector scan with viewing angle of about 60° is performed with respect to the circumferential direction of the ultrasonic transducer as shown in Fig. 4 and the sector scan is also performed with respect to the width direction as shown in Fig. 8. The plural reception signals obtained by the sector scan are output to the receiving circuit 15 via the signal interconnections EL_1 to EL_{15}.

[0068] The above operation is repeated, and thereby, sector scan is performed with respect to each of the first to twelfth two-dimensional ultrasonic transducer arrays TA1 to TA12 with respect to the circumferential direction of the ultrasonic transducer while performing sector scan with respect to the width direction of the ultrasonic transducer.

[0069] In the above description, in the ultrasonic endoscope 2, twelve sets of two-dimensional ultrasonic transducer arrays formed by 15 × 5 ultrasonic transducers are arranged in the semicircle form for performing three-dimensional scan with respect to each two-dimensional ultrasonic transducer array, however, these two-dimensional ultrasonic transducer arrays may be arranged in a dodecagonal form for performing three-dimensional scan with respect to each two-dimensional ultrasonic transducer array. Further, the number of ultrasonic transducers that form the two-dimensional ultrasonic transducer array may be not 15 × 5 (including the same number of ultrasonic transducers in the circumferential direction and the width direction).

[0070] Further, the first to twelfth switches SW1 and SW12 shown in Figs. 1 and 9 have been provided in the ultrasonic observation apparatus 3, however, they may be provided in the ultrasonic endoscope 2, or provided in an adapter and the ultrasonic endoscope 2 and the observation device 3 may be connected via the adapter.

[0071] Furthermore, the control signal A for controlling start/stop of ultrasonic imaging operation of the ultrasonic endoscope 2 has been output from the console 11, however, for example, a button for generating the control signal A may be provided in the operation part 22 of the ultrasonic endoscope 2 and the control signal A may be output from the operation part 22 to the CPU 12.

Claims

1. An ultrasonic endoscope comprising:

plural two-dimensional ultrasonic transducer arrays (TA1 to TA12) arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation;

a first group of interconnections (EL_{1-1} to EL_{15-5}) each for electrically connecting to one another first electrodes of the plural ultrasonic transduc-

ers located in a same row and a same column in said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit; and
a second group of interconnections (G1 to G12) each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit.

2. An ultrasonic endoscope comprising:

plural two-dimensional ultrasonic transducer arrays (TA1 to TA12) arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation;
a first group of interconnections (L_{1-1} to L_{15-5}) each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in a same row and a same column in said plural two-dimensional ultrasonic transducer arrays;
plural variable delay line units (DL_{1-1} to DL_{15-5}) having first terminals connected to said first group of interconnections, respectively;
a second group of interconnections (L1 to L15) each for electrically connecting to one another second terminals of the plural variable delay line units connected to the plural ultrasonic transducers located in a same row in said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit; and
a third group of interconnections (G1 to G12) each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit.

3. An ultrasonic endoscopic apparatus comprising:

an ultrasonic endoscope (2) including plural two-dimensional ultrasonic transducer arrays (TA1 to TA12) arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections (EL_{1-1} to EL_{15-5}) each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in a same row and a same column in said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a second group of interconnections (G1 to G12) each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit;
transmitting means (14) for generating drive signals and outputting the drive signals to said plural two-dimensional ultrasonic transducer arrays via said first group of interconnections;
plural pieces of switch means (SW1 to SW12) connected to said second group of interconnections and a fixedpotential ; and
control means (12) for controlling whether or not each of said second group of interconnections is connected to the fixed potential by supplying control signals to said plural pieces of switch means so as to select one to be used from among said plural two-dimensional ultrasonic transducer arrays, and controlling delay amounts of the drive signals in said transmitting means such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

4. An ultrasonic endoscopic apparatus comprising:

an ultrasonic endoscope (2) including plural two-dimensional ultrasonic transducer arrays (TA1 to TA12) arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections (L_{1-1} to L_{15-5}) each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in a same row and a same column in said plural two-dimensional ultrasonic transducer arrays, plural variable delay line units (DL_{1-1} to DL_{15-5}) having first terminals connected to said first group of interconnections, respectively, a second group of interconnections (L1 to L15) each for electrically connecting to one another second terminals of the plural variable delay line units connected to the plural ultrasonic transducers located in a same row in said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a third group of interconnections (G1 to G12) each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit;

transmitting means (14) for generating drive signals and outputting the drive signals to said plural two-dimensional ultrasonic transducer arrays via said second group of interconnections;

plural pieces of switch means (SW1 to SW12) connected to said third group of interconnections and a fixedpotential; and

control means (12) for controlling whether or not each of said third group of interconnections is connected to the fixed potential by supplying control signals to said plural pieces of switch means so as to select one to be used from among said plural two-dimensional ultrasonic transducer arrays, and supplying delay amount control signals for controlling delay amounts of the drive signals to said plural variable delay line units such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

5. An ultrasonic endoscopic apparatus according to claim 3, said control means (12) controls the delay amounts of the drive signals in said transmitting means so as to perform the three-dimensional scanning operation according to a sector method.

6. An ultrasonic endoscopic apparatus according to claim 4, said control means (12) supplying the delay amount control signals for controlling delay amounts of the drive signals to said plural variable delay line units so as to perform the three-dimensional scanning operation according to a sector method.

7. An ultrasonic endoscopic apparatus according to claim 3, saidplural pieces of switch means (SW1 to SW12) are provided within said ultrasonic endoscope.

8. An ultrasonic endoscopic apparatus according to claim 4 , said plural pieces of switch means (SW1 to SW12) are provided within said ultrasonic endoscope.

9. An ultrasonic endoscopic apparatus comprising:

an ultrasonic endoscope (2) including plural two-dimensional ultrasonic transducer arrays (TA1 to TA12) arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections (EL_{1-1} to EL_{15-5}) each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in a same row and a same column in said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a second group of interconnections (G1 to G12) each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit;

an adapter including plural pieces of switch means (SW1 to SW12) connected to said second group of interconnections and a fixed potential; and

an ultrasonic observation apparatus (3) including transmitting means (14) for generating drive signals and outputting the drive signals to said plural two-dimensional ultrasonic transducer arrays via said first group of interconnections, and control means (12) for controlling whether or not each of said second group of interconnections is connected to the fixed potential by supplying control signals to said plural pieces of switch means so as to select one to be used from among said plural two-dimensional ultrasonic transducer arrays, and controlling delay amounts of the drive signals in said transmitting means such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

10. An ultrasonic endoscopic apparatus comprising:

an ultrasonic endoscope (2) including plural two-dimensional ultrasonic transducer arrays (TA1 to TA12) arranged in a semicircle or polygonal form, each including plural ultrasonic transducers arranged in M rows and N columns where M and N are integers not less than 2, for performing three-dimensional scanning operation, a first group of interconnections (L_{1-1} to L_{15-5}) each for electrically connecting to one another first electrodes of the plural ultrasonic transducers located in a same row and a same column in said plural two-dimensional ultrasonic transducer arrays, plural variable delay line units (DL_{1-1} to DL_{15-5}) having first terminals connected to said first group of interconnections, respectively, a second group of interconnections (L1 to L15) each for electrically connecting to one another second terminals of the plural variable delay line units connected to the plural ultrasonic transducers located in a same row in said plural

two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit, and a third group of interconnections (G1 to G12) each for electrically connecting to one another second electrodes of the plural ultrasonic transducers included in respective one of said plural two-dimensional ultrasonic transducer arrays and electrically connecting a connection point thereof to an external circuit;
an adapter including plural pieces of switch means (SW1 to SW12) connected to said third group of interconnections and a fixed potential; and
an ultrasonic observation apparatus (3) including transmitting means (14) for generating drive signals and outputting the drive signals to said plural two-dimensional ultrasonic transducer arrays via said second group of interconnections, and control means (12) for controlling whether or not each of said third group of interconnections is connected to the fixed potential by supplying control signals to said plural pieces of switch means so as to select one to be used from among said plural two-dimensional ultrasonic transducer arrays, and supplying delay amount control signals for controlling delay amounts of the drive signals to said plural variable delay line units such that the selected two-dimensional ultrasonic transducer array performs the three-dimensional scanning operation within a respective area.

FIG.1

1 ULTRASONIC ENDOSCOPIC APPARATUS

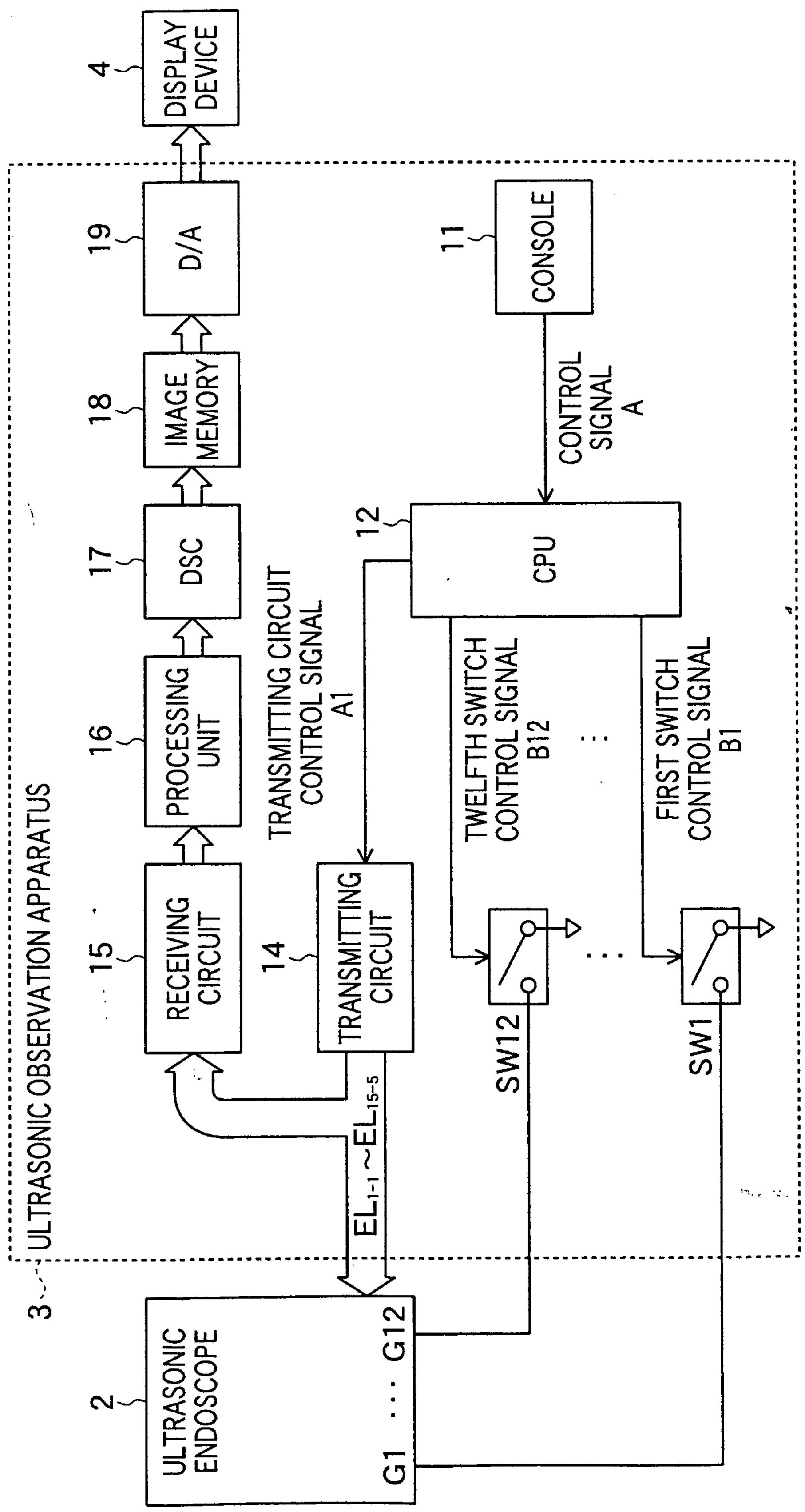


FIG.2

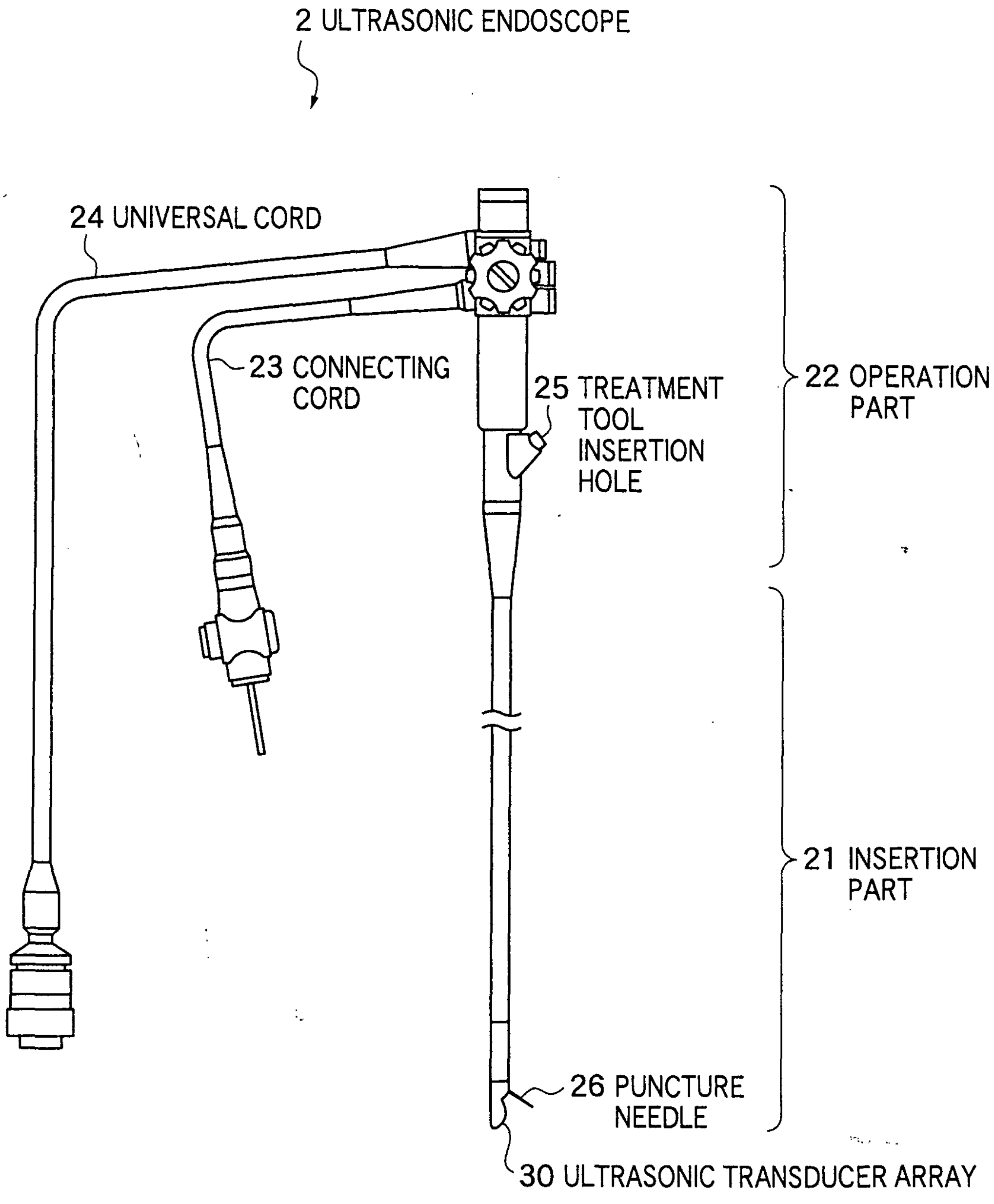

2 ULTRASONIC ENDOSCOPE
24 UNIVERSAL CORD
23 CONNECTING CORD
25 TREATMENT TOOL INSERTION HOLE
22 OPERATION PART
21 INSERTION PART
26 PUNCTURE NEEDLE
30 ULTRASONIC TRANSDUCER ARRAY

FIG.3A

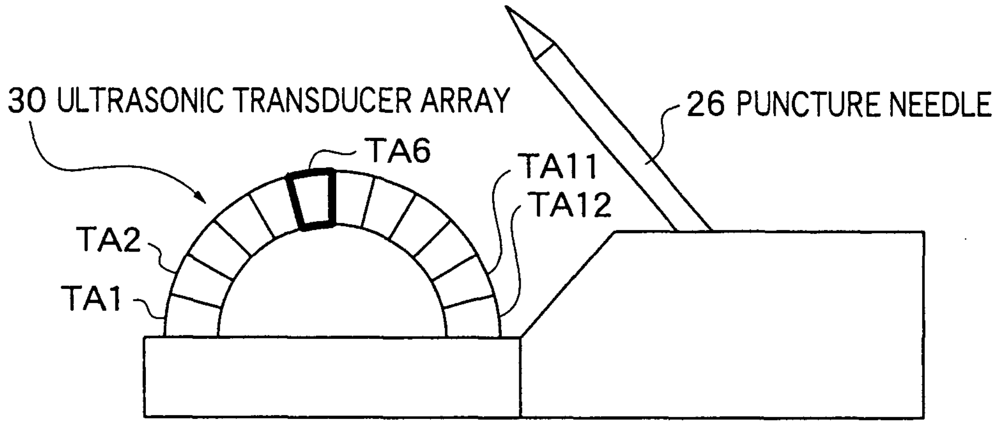

30 ULTRASONIC TRANSDUCER ARRAY
26 PUNCTURE NEEDLE
TA6
TA11
TA12
TA2
TA1

FIG.3B

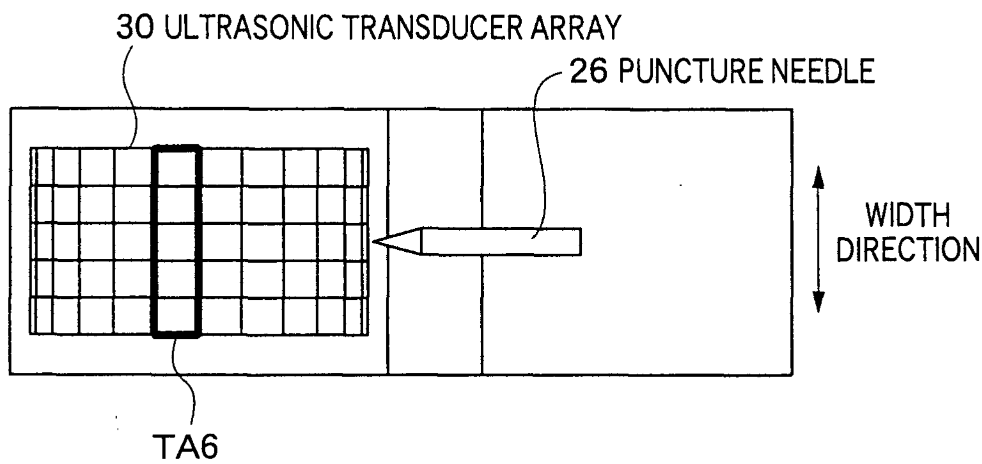

30 ULTRASONIC TRANSDUCER ARRAY
26 PUNCTURE NEEDLE
WIDTH DIRECTION
TA6

FIG.4

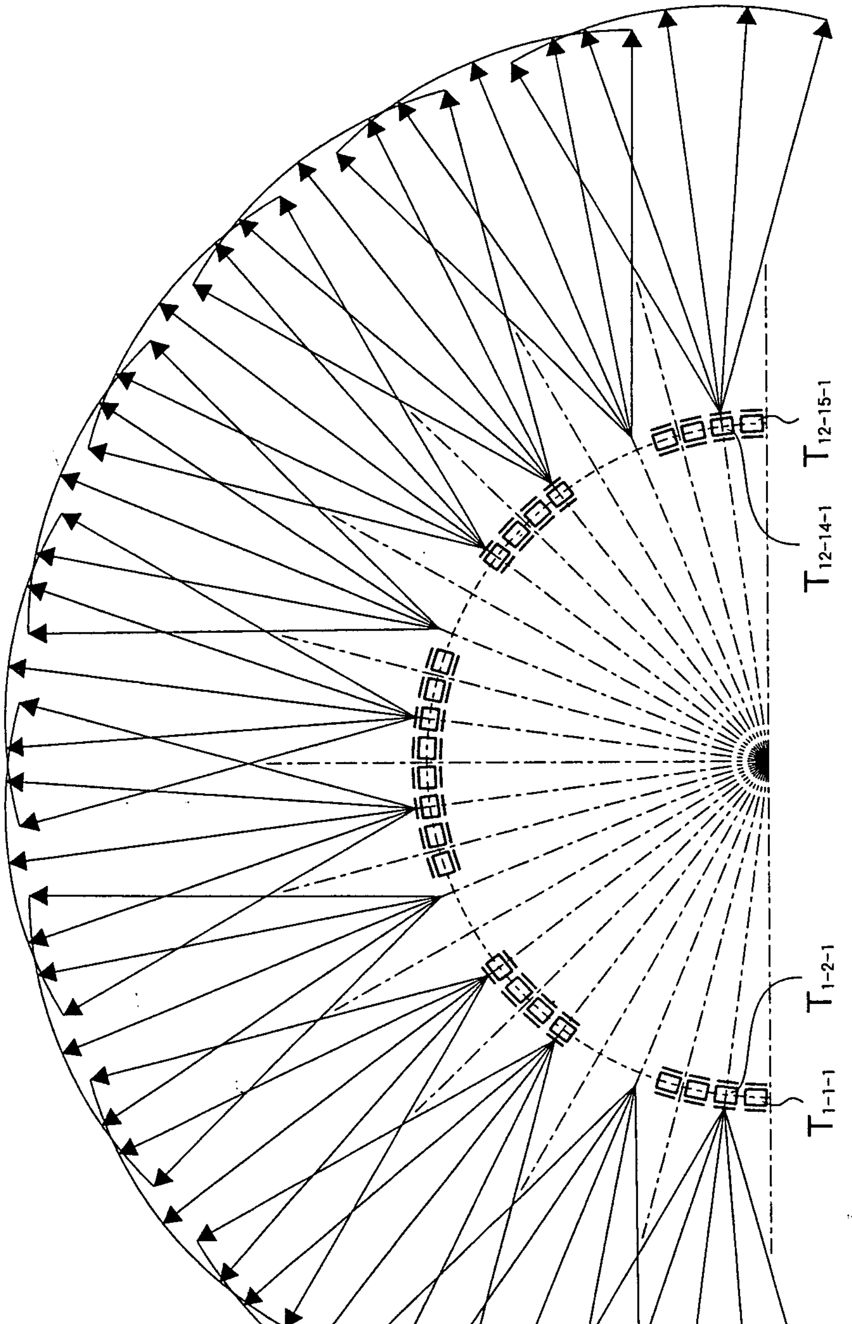
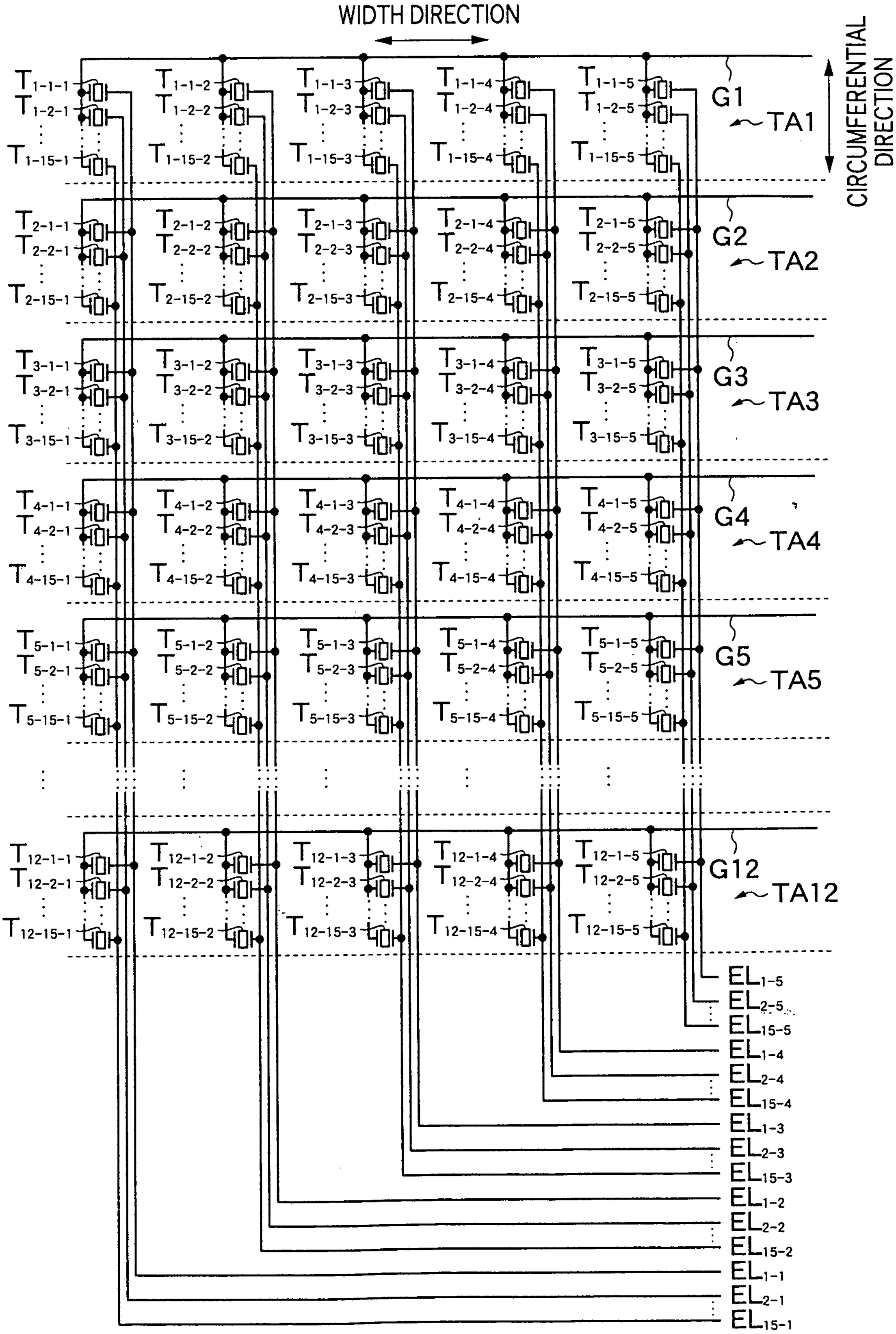


FIG.5


WIDTH DIRECTION
CIRCUMFERENTIAL DIRECTION
G1
TA1
G2
TA2
G3
TA3
G4
TA4
G5
TA5
G12
TA12
T1-1-1
T1-2-1
T1-15-1
T1-1-2
T1-2-2
T1-15-2
T1-1-3
T1-2-3
T1-15-3
T1-1-4
T1-2-4
T1-15-4
T1-1-5
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T2-15-2
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T4-15-2
T4-1-3
T4-2-3
T4-15-3
T4-1-4
T4-2-4
T4-15-4
T4-1-5
T4-2-5
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T5-1-2
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T12-2-3
T12-15-3
T12-1-4
T12-2-4
T12-15-4
T12-1-5
T12-2-5
T12-15-5
EL1-5
EL2-5
EL15-5
EL1-4
EL2-4
EL15-4
EL1-3
EL2-3
EL15-3
EL1-2
EL2-2
EL15-2
EL1-1
EL2-1
EL15-1

FIG.6

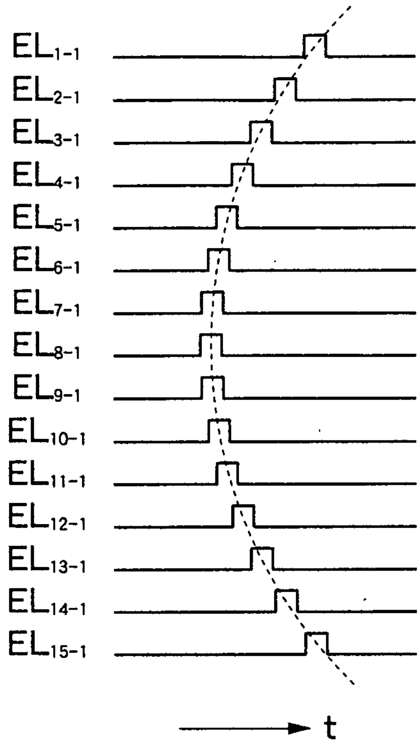

EL1-1
EL2-1
EL3-1
EL4-1
EL5-1
EL6-1
EL7-1
EL8-1
EL9-1
EL10-1
EL11-1
EL12-1
EL13-1
EL14-1
EL15-1
t

FIG.7

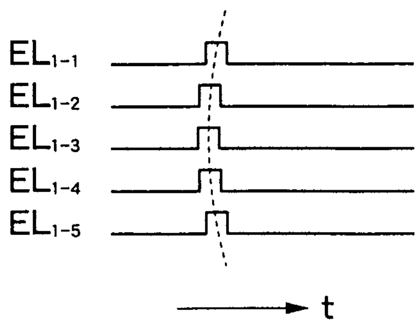

EL1-1
EL1-2
EL1-3
EL1-4
EL1-5
t

FIG.8

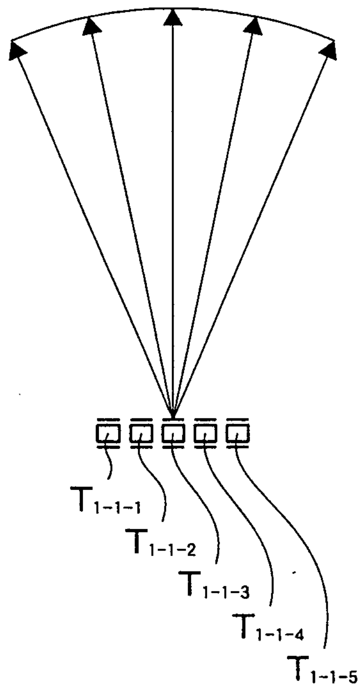


FIG.9

200 ULTRASONIC ENDOSCOPIC APPARATUS

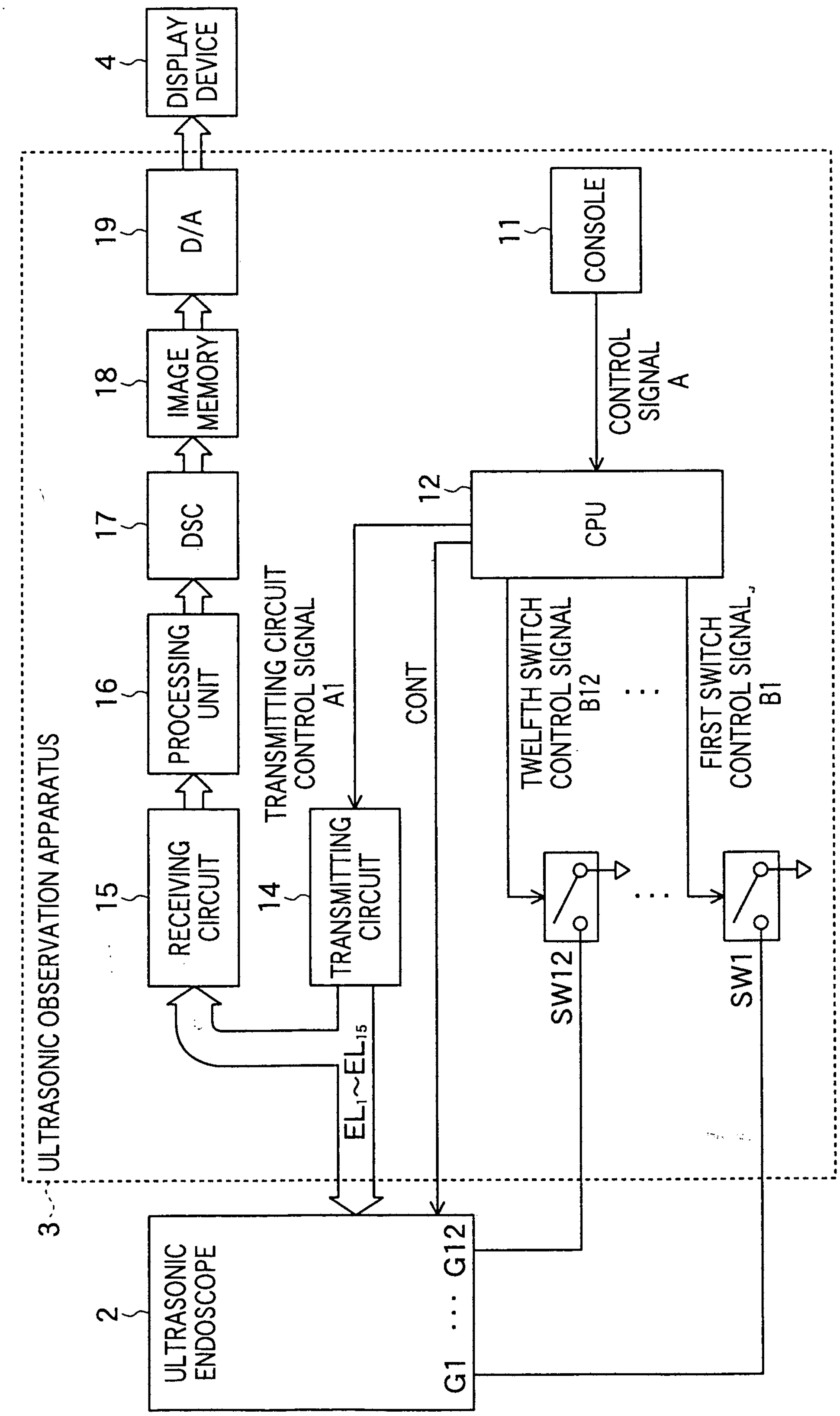
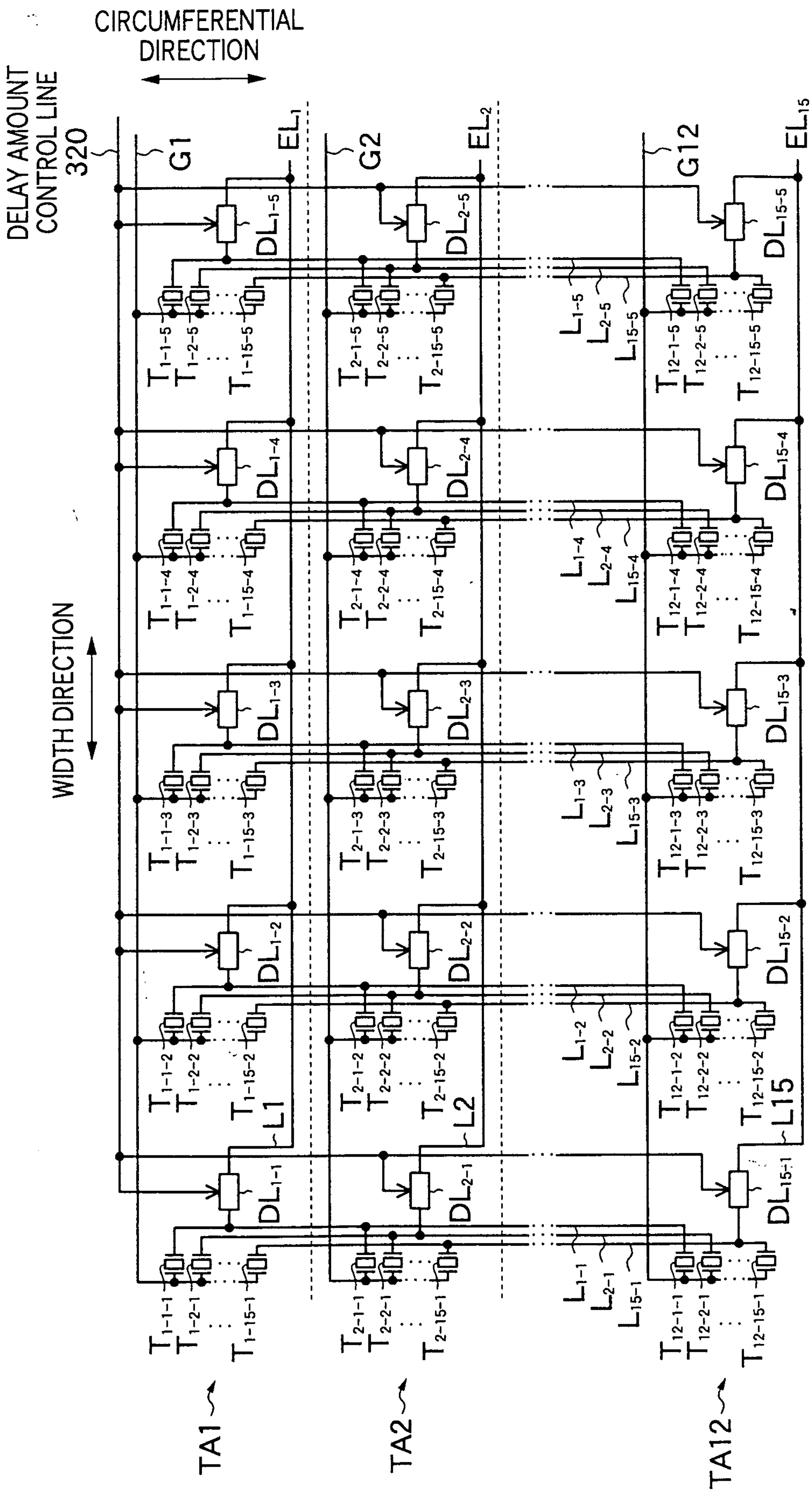


FIG.10


CIRCUMFERENTIAL DIRECTION
WIDTH DIRECTION
DELAY AMOUNT CONTROL LINE 320
G1
G2
G12
EL1
EL2
EL15
DL1-1
DL1-2
DL1-3
DL1-4
DL1-5
DL2-1
DL2-2
DL2-3
DL2-4
DL2-5
DL15-1
DL15-2
DL15-3
DL15-4
DL15-5
L1
L2
L15
L1-1
L2-1
L15-1
L1-2
L2-2
L15-2
L1-3
L2-3
L15-3
L1-4
L2-4
L15-4
L1-5
L2-5
L15-5
T1-1-1
T1-2-1
T1-15-1
T2-1-1
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T12-1-1
T12-2-1
T12-15-1
TA1
TA2
TA12

FIG.11A

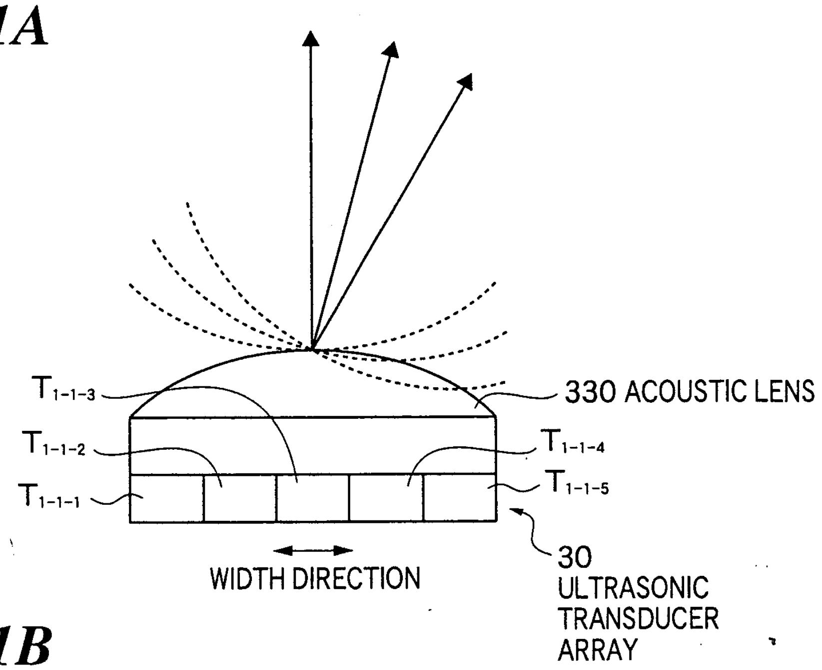


FIG.11B

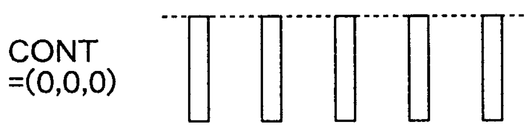


FIG.11C

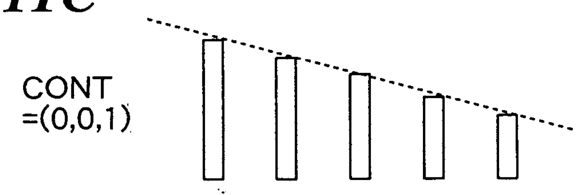


FIG.11D

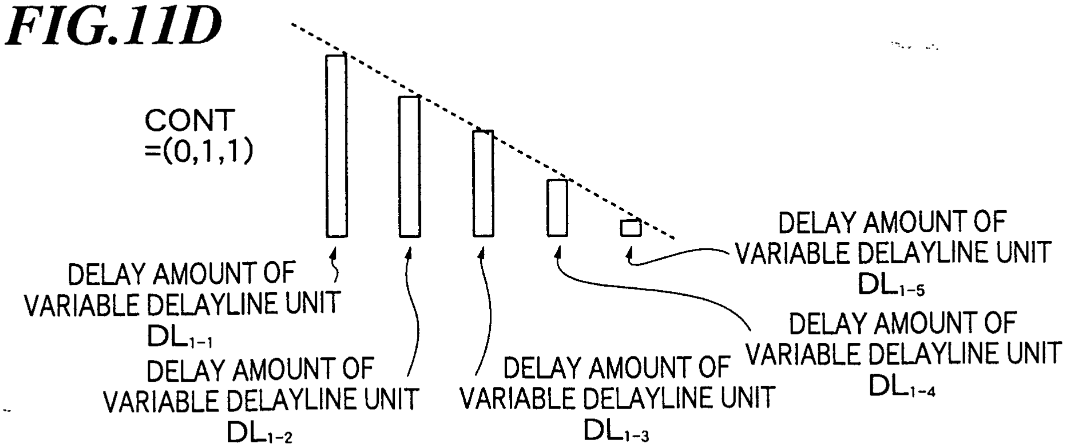


FIG.12A
PRIOR ART

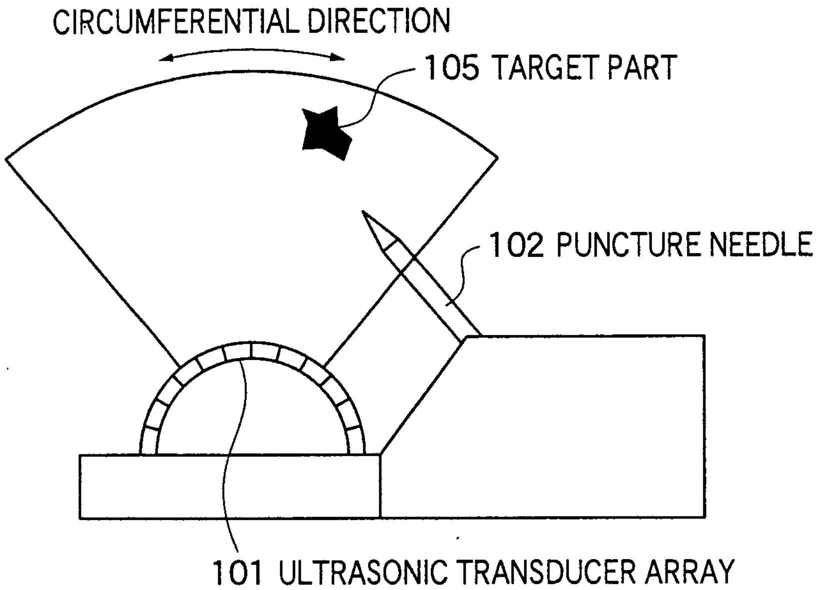
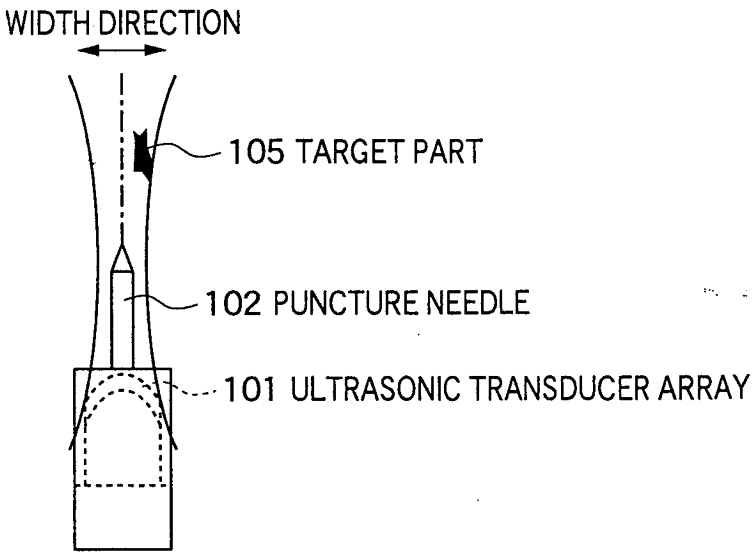


FIG.12B
PRIOR ART



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 01 8095

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	US 6 059 731 A (SEWARD ET AL) 9 May 2000 (2000-05-09) * column 6, line 47 - column 7, line 23; claim 1; figure 1 *	1,3,4	A61B8/12 A61B8/00 A61B8/14
Y	US 6 419 633 B1 (ROBINSON ANDREW L ET AL) 16 July 2002 (2002-07-16) * column 2, line 60 - column 4, line 55; claim 1 *	1,3,4	
Y	US 5 320 104 A (FEARNSIDE ET AL) 14 June 1994 (1994-06-14) * column 3, line 14 - line 65; figures 11,3 *	1,3,4	
A	US 5 685 311 A (HARA ET AL) 11 November 1997 (1997-11-11) * the whole document *	1-10	
A	US 6 461 304 B1 (TANAKA TOSHIZUMI ET AL) 8 October 2002 (2002-10-08) * claim 1; figures 2,3,13 *	1-10	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A61B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	26 September 2005	Chopinaud, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 01 8095

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26-09-2005

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

专利名称(译)	超声波内窥镜		
公开(公告)号	EP1629778A1	公开(公告)日	2006-03-01
申请号	EP2005018095	申请日	2005-08-19
[标]申请(专利权)人(译)	富士摄影胶片公司		
申请(专利权)人(译)	富士胶片CO.LTD.		
当前申请(专利权)人(译)	富士胶片株式会社		
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IPC分类号	A61B8/12 A61B8/00 A61B8/14		
CPC分类号	A61B8/14 A61B1/042 A61B8/06 A61B8/0833 A61B8/0841 A61B8/12 A61B8/13 A61B8/4483 A61B8/4488 A61B8/483 G01S7/52079 G01S15/8927 G01S15/8929 G01S15/8993		
优先权	2004244908 2004-08-25 JP		
其他公开文献	EP1629778B1		
外部链接	Espacenet		

摘要(译)

一种超声波内窥镜，即使在超声波换能器的宽度方向上也能够掌握位置关系。超声波内窥镜通过使用具有以半圆形等布置的多个二维超声波换能器阵列（TA1至TA12）的超声波换能器阵列来执行三维扫描操作，并且包括多个信号互连（EL1-1至EL15-5）。）每个用于将相同的驱动信号输入到位于多个二维超声换能器阵列中的相同行和列中的超声换能器的各个电极，以及多个用于连接多个公共电极的多个公共互连（G1到G12）。包括在多个二维超声换能器阵列中的相应一个中的超声换能器到固定电位。

FIG.1