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(54) **Ultrasonic probe of radial scan type, ultrasonic observation apparatus and ultrasonic diagnosing system**

Ultraschallsonde mit radialer Abtastung, Ultraschall-Beobachtungssystem und Ultraschall-Diagnosesystem

Sonde ultrasonore à balayage radial, système d'observation par ultrasons et système de diagnostic par ultrasons

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(56) References cited:
US-A- 5 081 993
US-A- 5 279 301
US-A- 5 924 993
US-A1- 2005 126 292
US-B1- 6 174 286

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an ultrasonic diagnosing system.

2. Background Arts

[0002] Recently, in a field of medical care, a medical diagnosis using ultrasonic images is widely used. In an ultrasonic diagnosis, an ultrasonic is emitted to a required area of a living organism from an ultrasonic probe, and an echo reflected from within the living organism is received and converted into an electronic signal. The echo signal is analyzed and converted into an image. Further, an ultrasonic probe of an electronic scan type is also known, which is provided with plural ultrasonic transducers for transmitting and receiving the ultrasound. The ultrasonic probe of the electronic scan type selectively drives the ultrasonic transducers by using an electronic switch or the like.

[0003] As the ultrasonic probe of the electronic scan type, there are a convex scan type and a radial scan type (see Japanese Patent Laid-Open Publication No. 2-134142). The ultrasonic probe of the convex scan type has, plural (for instance, 94 to 128) ultrasonic transducers disposed in a sector shape on a tip of the probe. The ultrasonic probe of the radial scan type has a plurality of (for instance, 360) ultrasonic transducers all around an outer periphery of a tip of the probe.

[0004] Fig.9 shows a conventional ultrasonic diagnosing system 100 of a convex scan type. The ultrasonic diagnosing system 100 is constructed of an ultrasonic probe 101 and an ultrasonic observation apparatus 102 to which the ultrasonic probe 101 is connected. It is possible to design an ultrasonic observation apparatus of a radial scan type by using a structure of the ultrasonic observation apparatus of the convex scan type. However, since the ultrasonic transducers of the radial scan type has more number of ultrasonic transducers, it is necessary to increase the number of input/output lines in each circuit. For instance, terminals of a second connector 105, input lines of a multiplexer (MP) 108, control lines of a scan controller 107 and the like should be increased in number. Likewise, a beamformer (BF) 111 should be modified according to the increase in the number of sound rays forming the ultrasonic image. In the modification, it becomes necessary to newly design the multiplexer 108, the scan controller 107 and the BF 111 in accordance with the number of the ultrasonic transducers, which result in a long-term development and an increasing cost.

[0005] Further, an ultrasonic observation apparatus, which is capable of applying both the ultrasonic probes of the convex scan type and the radial scan type, is desired. In particular, it is preferable that the ultrasonic observation apparatus of the convex scan type can be easily modified so as to connect the ultrasonic probe of the radial scan type.

[0006] In accordance with the preamble of claim 1, US-A-5 924 993 discloses a system which includes 72 transducers subdivided into four groups, each group including a multiplexer and 18 transducers. Each multiplexer is used for multiplexing the signals to or from four transducers.

SUMMARY OF THE INVENTION

[0007] A main object of the present invention is to provide an ultrasonic diagnosing system, which can be easily manufactured at a low cost, by utilizing a structure of the ultrasonic observation apparatus of the convex scan type.

[0008] Further another object of the present invention is to provide a compatible ultrasonic observation system which is manufactured by modifying the ultrasonic observation apparatus of the convex scan type with ease at low cost.

[0009] Further another object of the present invention is to provide an ultrasonic probe of a radial scan type which is compatible with the ultrasonic probe of the convex scan type.

[0010] In order to achieve the above and other objects, the ultrasonic diagnosing system of the radial scan type according to the present invention includes the features of claim 1.

[0011] Preferred embodiments are defined by the dependent claims.

[0012] Since the ultrasonic probe of the radial scan type uses the same number of output lines as the ultrasonic probe of the convex scan type by the function of the multiplexer, the ultrasonic probe of the radial scan type has become compatible with the ultrasonic probe of the convex scan type. Further, the ultrasonic probe of the radial scan type can be manufactured at the low cost by only incorporating the multiplexer.

[0013] Since the ultrasonic observation system of the present invention has a function to switch the multiplexer when the ultrasonic probe of the radial scan type incorporated with the multiplexer is connected, so that both the ultrasonic probes of the radial scan type and the convex scan type can be applied. Further, since the ultrasonic observation apparatus of the present invention utilizes the fundamental structure of the ultrasonic observation apparatus of the convex scan type, the manufacturing or the modification thereof can be performed at low cost.

[0014] Since the ultrasonic observation apparatus of the preferable embodiment has at least one multiplexer and divides the signals from the ultrasonic probe of the radial scan type, the configuration of the conventional ultrasonic observation apparatus of the convex scan type can be utilized. Accordingly, the ultrasonic observation

apparatus can be easily designed and manufactured at low cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The above objects and advantages of the present invention will become apparent from the following detailed descriptions of a preferred embodiment when read in association with the accompanying drawings, which are given by way of illustration only and thus do not limit the present invention. In the drawings, the same reference numerals designate like or corresponding parts throughout the several views, and wherein:

Fig. 1 is a schematic view showing an embodiment of an ultrasonic diagnosing system;
Fig. 2 is an explanatory view showing a method for dividing ultrasonic transducers into plural sensor element groups;
Fig. 3 is a schematic view showing a multiplexer;
Fig. 4 is a flow chart showing operational steps of the ultrasonic diagnosing system when an ultrasonic probe of a convex scan type is connected;
Fig. 5 is a flow chart showing the operational steps of the ultrasonic diagnosing system when an ultrasonic probe of a radial scan type is connected;
Fig. 6 is a schematic view showing an example of an ultrasonic diagnosing system not covered by the claims;
Fig. 7 is a schematic view showing a further example of an ultrasonic diagnosing system not covered by the claims;
Fig. 8 is a schematic view showing a multiplexer; and
Fig. 9 is a schematic view showing a conventional ultrasonic diagnosing system.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0016] In Fig. 1, an ultrasonic diagnosing system 2 as an embodiment of the present invention is constructed of an ultrasonic probe 10 and an ultrasonic observation apparatus 11. The ultrasonic probe 10 is of a radial scan type which is incorporated with a cylindrical substrate 13 with 360 ultrasonic transducers 12 disposed at regular intervals on an outer periphery on a tip of a sheath (not shown) formed of a flexible member. The ultrasonic probe 10 is connected to the ultrasonic observation apparatus 11 by inserting a first connector 14, which is provided at a trailing end of a code (not shown) extended from the sheath, into a second connector 15 provided in the ultrasonic observation apparatus 11.

[0017] The 360 ultrasonic transducers 12 are respectively connected to ends of 360 first signal lines 16 which transmit drive signals from a transmitter 23 (which will be described later) of the ultrasonic observation apparatus 11 and echo signals reflected from within a living organism. The other ends of the first signal lines 16 are respectively connected to a multiplexer (MPa) 17.

[0018] As shown in Fig. 2, the 360 ultrasonic transducers 12 are divided into four sensor element groups 40a (a first sensor element group which includes the ultrasonic transducers Nos.1-47 and 314-360), 40b (a second sensor element group which includes the ultrasonic transducers Nos. 44-137), 40c (a third sensor element group which includes the ultrasonic transducers Nos. 134-227) and 40d (a fourth sensor element group which includes the ultrasonic transducers Nos. 224-317). The four sensor element groups 40a-40d divide the outer periphery of the cylindrical substrate 13 into four approximately equal portions.

[0019] There are 94 ultrasonic transducers 12 in each sensor element group. At the boundary of the first sensor element group 40a and the second sensor element group 40b, the ultrasonic transducers 12 Nos. 44-47 are contained in both element groups. At the boundary of the second sensor element group 40b and the third sensor element group 40c, the ultrasonic transducers Nos. 134-137 are contained in both sensor element groups. At the boundary of the third sensor element group 40c and the fourth sensor element group 40d, the ultrasonic transducers Nos.224-227 are contained in both element groups. At the boundary of the fourth sensor element group 40d and the first sensor element group 40a, the ultrasonic transducers Nos.314-317 are contained in both element groups. Note that Nos. 1-360 are the numbers assigned to each of the ultrasonic transducers in a clockwise direction for the sake of convenience.

[0020] In Fig.1, a control line 19 is connected to the MPa 17. The control line 19 receives an element group selection signal from a CPU 20 (which will be described later) of the ultrasonic observation apparatus 11. According to the sensor element group selection signal, the MPa 17 switches the signal of 360 channels, which is transmitted from the first to fourth sensor element groups 40a-40d through the first signal lines 16, to that of 94 channels in the selected sensor element group. One end of each of 94 second signal lines 18 is connected to the MPa 17. The other end of each of the 94 second signal lines 18 is connected to the ultrasonic observation apparatus 11 through the second connector 15.

[0021] As shown in Fig. 3, the MPa 17 is constructed of a decoder 50, and first to fourth switches (SWa-SWd) 51a-51d which are constituted of FET and the like. The decoder 50 receives and decodes the sensor element group selection signal of two-bit sent from the CPU 20 of the ultrasonic observation apparatus 11 through the control line 19.

[0022] The signals from the ultrasonic transducers 12 of the first to fourth sensor element groups 40a-40d are respectively input to the corresponding switches (SWa-SWd) 51a-51d through the first signal lines 16. The overlapping transducers 12 at the boundaries between the first to the fourth sensor element groups 40a-40d are connected to each of the corresponding switches (SWa-SWd) 51a-51d.

[0023] The first to the fourth switches (SWa-SWd) 51a-

51d are switched between on and off according to the sensor element group selection signals decoded in the decoder 50. To be more specific, for instance, when the sensor element group selection signal is "00", the first sensor element group 40a is selected. At that time, the SWa 51a is turned on while the SWb-SWd 51b-51d are turned off. When the sensor element group selection signal is "01", the second sensor element group 40b is selected. At that time, the SWb 51b is turned on while the SWa 51a, SWc 51c and SWd 51d are turned off. Further, when the sensor element group selection signal is "10", the third sensor element group 40c is selected. At that time, the SWc 51c is turned on while the SWa 51a, SWb 51b and SWd 51d are turned off. When the sensor element group selection signal is "11", the fourth sensor element group 40d is selected. At that time, the SWd 51d is turned on while the SWa-SWc 51a-51c are turned off.

[0024] In Fig. 1, the ultrasonic observation apparatus 11 is thoroughly controlled by the CPU 20. A scan controller 21 is connected to the CPU 20. The scan controller 21 is connected to a multiplexer (MPb) 22, the transmitter 23 and a receiver 24, and transmits a reference pulse to each of the above sections to control the operation. An ultrasonic probe of a convex scan type with 94 channels has 94 ultrasonic transducers disposed in a sector shape on its tip (not shown). In a connector section of the ultrasonic probe of the convex scan type, an insertion detector/ probe type identifier, which has the same function as an insertion detector/ probe type identifier 31, is provided, which will be described later.

[0025] The MPb 22 selectively switches the signals of five channels out of 94 channels which are input and output through the second connector section 15. The drive signal of five channels is input from the transmitter 23 to the MPb 22, and the MPb 22 outputs the echo signal of five channels to the receiver 24.

[0026] The MPb 22 simultaneously drives the five selected ultrasonic transducers 12 as one block, out of one of the sensor element group selected by the MPa 17, under the control of the scan controller 21. Further, as shown in Fig. 2, the MPb 22 selectively switches the ultrasonic transducer 12, which receives and transmits the drive signal and the echo signal, by shifting at least one ultrasonic transducer 12 to be driven in the clockwise direction every time the drive signal and the echo signal are transmitted and received.

[0027] Under the control of the scan controller 21, the transmitter 23 transmits the drive signal (a voltage pulse with five channels for driving the ultrasonic transducer 12) to the ultrasonic transducer 12 selected by the MPb 22.

[0028] Under the control of the scan controller 21, the receiver 24 receives the echo signal (five channels) reflected from within the living organism, which is obtained by the ultrasonic transducers 12 selected by the MPb 22, and performs Sensitivity Time Control (STC) process to the received echo signal. In the STC, the sensitivity is adjusted according to the time which corresponds to a propagation distance (depth) of the ultrasound. The respective timings of the transmission and the reception of the transmitter 23 and the receiver 24 are switched by the scan controller 21.

[0029] The echo signal received by the receiver 24 is input to a beamformer (BF) 25. The echo signal of five channels is delayed by the BF 25 for a predetermined time to be co-phased, and added.

[0030] The echo signal, which is added in the BF 25, is digitalized and then stored in a memory 26. A digital scan converter (DSC) 27 reads the digital signal from the memory 26 under the control of the CPU 20, and converts the read digital signal into a television signal of a NTSC format. A D/A converter 28 converts the signal, which has been converted into the NTSC format by the DSC 27, into the analog signal again. A monitor 29 displays the analog signal converted by the D/A converter 28 as an ultrasonic image.

[0031] In addition to the above mentioned scan controller 21 and the DSC 27, an operation unit 30 and a serial signal line 32, through which a notification signal from the insertion detector/probe type identifier 31 provided in the first connector 14 of the ultrasonic probe 12 is transmitted, are connected to the CPU 20. The operation unit 30 is constructed of an operation panel in which various operation buttons are disposed, for instance. The CPU 20 controls the operation of each section according to the signals input from the operation unit 30.

[0032] An identification code, which indicates that the ultrasonic probe 12 is of the radial scan type, is stored in the insertion detector/ probe type identifier 31. The insertion detector/ probe type identifier 31 transmits the identification code to the CPU 20 by a serial communication through the serial signal line 32. Further, the CPU 20 detects the insertion of the ultrasonic probe by receiving the identification code.

[0033] When the CPU 20 receives the insertion detection signal and the identification signal from the insertion detector/ probe type identifier 31, and identifies that the ultrasonic probe of the convex scan type with the 94 channels is connected, the CPU 20 controls the operation of the MPb 22 through the scan controller 21 without transmitting the sensor element group selection signal to the MPa 17 (a first mode). When the CPU 20 identifies that the ultrasonic probe 10 of the radial scan type with the 360 channels is connected, the CPU 20 transmits the sensor element group selection signal to MPa 17 through the control line 19 and controls the operation of the MPb 22 through the scan controller 21 (a second mode).

[0034] Next, the operation of the ultrasonic diagnosing system 2 of the above configuration is described with reference to flowcharts in Figs.4 and 5. In Fig . 4 , when the CPU 20 identifies that the ultrasonic probe of the convex scan type with the 94 channels is connected to the ultrasonic observation apparatus 11 , the freeze is released by operating the operation unit 30. Thereafter, the drive signal of five channels is transmitted from the transmitter 23 under the control of the scan controller 21.

[0035] The drive signal is transmitted from the transmitter 23 to the desired block of the ultrasonic transducers selected by the MPb 22, through the first and second connectors 14 and 15. The ultrasonic transducers are driven by the drive signal so that the ultrasound is emitted to the living organism.

[0036] After the drive signal has been transmitted, the scan controller 21 switches from the transmission of the transmitter 23 to the reception of the receiver 24. Thereby, the echo signal reflected from within the living organism, which is obtained by the ultrasonic transducers, is input to the receiver 24 through the first and second connectors 14, 15 and the MPb 22.

[0037] The receiver 24 performs the STC (Sensitivity Time Control) process to the input echo signal. Then, the echo signal is added by the BF 25, and digitalized. The digital signal is stored in the memory 26. Thereafter, the above process is repeated through the last block while the MPb 22 shifts the ultrasonic transducer, which is to be driven, one by one under the control of the scan controller 21.

[0038] When the scanning by the 94 ultrasonic transducers is completed, the DSC 27 reads the digital echo signal stored in the memory 26 and converts into the NTSC format. The signal converted into the NTSC format is re-converted into the analog signal by the D/A converter 28 and displayed as the ultrasound image on the monitor 29. The above sequential process is continued until the operation unit 30 is operated to issue a command to freeze.

[0039] When the CPU 20 identifies that the ultrasonic probe 12 of the radial scan type with the 360 channels is connected to the ultrasonic observation apparatus 11, as shown in Fig.5, after the freeze is released by operating the operation unit 30, the transmitter 23 transmits the drive signal of five channels under the control of the scan controller 21.

[0040] The drive signal from the transmitter 23 is transmitted to the desired block of the ultrasonic transducers 12 selected by the MPb 22 from one of the sensor element groups 40a-40d selected by the MPa 17 according to the sensor element group selection signal sent from the CPU 20 through the control line 19. The ultrasonic transducer 12 is driven by the drive signal and thereby the ultrasound is emitted to the living organism.

[0041] After the drive signal has been transmitted, the scan controller 21 switches from the transmission of the transmitter 23 to the reception of the receiver 24. The echo signal reflected from within the living organism, which is obtained by the ultrasonic transducers, is input to the receiver 24 through the first and second connectors 14 and 15, and the MPb 22.

[0042] In the receiver 24, the STC process is performed to the input echo signal. Then, the signal is added by the BF 25, digitalized, and stored in the memory 26. Thereafter, under the control of the scan controller 21, the above process is repeated through the last block, while the MPb 22 shifts the ultrasonic transducer to be driven one by one.

[0043] In the MPa 17, the sensor element group selection signal transmitted from the CPU 20 is decoded by the decoder 50. The sensor element group selection signal "00" is sent to turn on the SWa 51a and turn off the SWb-SWd 51b-51d in the MPa 17. Thereby, the first sensor element group 40a is selected. In that state, the above process is performed through the last block of the first sensor element group 40a. Thereafter, the sensor element group selection signal "01" is transmitted to turn on the SWb 51b and turn off the SWa 51a, SWc 51c and SWd 51d in the MPa 17. Thereby, the second sensor element group 40b is selected and the above process is performed in the second sensor element group 40b. Thereafter, the sensor element group selection signal "10" and "11" are transmitted in this order so that the third and the fourth sensor element groups 40c and 40d are selected sequentially and the above process is respectively performed in the third and fourth sensor element groups 40c and 40d.

[0044] When the scanning by the 360 ultrasonic transducers 12 is completed, the digital echo signal stored in the memory 26 is read by the DSC 27 and converted into the NTSC format in the same manner as to when the ultrasonic transducer of the convex scan type is connected. Thereafter, the signal is reconverted into the analog signal in the D/A converter 28, and displayed on the monitor 29 as the ultrasonic image. The above process is repeated until the operation unit 30 is operated to issue the command to freeze.

[0045] As described above, since the 360 ultrasonic transducers are divided into four sensor element groups 40a-40d, and the MPa 17, which selectively connects the 94 first signal lines 16 out of the 360 first signal lines 16 to the second signal lines 18 according to the selected sensor element group, is disposed, the ultrasonic probe 10 of the radial scan type which can be connected to the ultrasonic observation apparatus 11 for the conventional ultrasonic probe of the convex scan type, and the ultrasonic diagnosing system 2 using the ultrasonic probe 10 are provided at a low cost.

[0046] Further, since the MPa 17 is provided in the first connector 14, it is relatively easy to manufacture the ultrasonic probe, which is connectable to the ultrasonic observation apparatus 11 of the convex scan type, by utilizing the structure of the conventional ultrasonic probe of the radial scan type.

[0047] In Fig.6, an ultrasonic diagnosing system 60 is constructed of an ultrasonic probe 61 of the radial scan type and an ultrasonic observation apparatus 62. The ultrasonic probe 61 has the same configuration as the ultrasonic probe 10 in Fig. 1 except that the ultrasonic probe 61 does not have the MPa 17 so that 360 first signal lines 63 from the 360 ultrasonic transducers 12 are directly connected to a first connector 64.

[0048] A second connector 65 of the ultrasonic observation apparatus 62 is provided with a multiplexer (MPc) 66 which has the same configuration as the MPa 17 in

Fig.3. As with the MPa 17, the MPc 66 selectively switches the 94 first signal lines 63 of the first signal lines 63 connected through the first connector 64, and respectively connects to 94 second signal lines 67 according to the selected sensor element group among the sensor element groups 40a-40d.

[0049] The first connector 64 is formed with 360 pins which respectively correspond to 360 channels, for instance. To be compatible with both the 360 channels and 94 channels, the second connector 65 is formed with 360 pins holes, for instance. When the ultrasonic probe of the convex scan type with the 94 channels is inserted into the second connector 65, 94 pins are inserted into the pin holes which correspond to the first sensor element group 40a.

[0050] Upon receiving the insertion detection signal and the identification code from the insertion detector/probe type identifier 31, and identifying that the ultrasonic probe of the convex scan type with the 94 channels is connected, the CPU 20 controls the MPc 66 to fix the sensor element group selection signal to "00" to constantly select the first sensor element group 40a, and also controls the action of MPb 22 through the scan controller 21 (a first mode) . When the CPU 20 identifies that the ultrasonic probe 10 of the radial scan type with the 360 channels is connected, the CPU 20 transmits the sensor element group selection signal to the MPc 66 through the control line 19 and also controls the action of the MPb 22 through the scan controller 21 (a second mode). Further, other configuration and the operation of the ultrasonic diagnosing system 60 are similar to the ultrasonic diagnosing system 2 shown in Fig.1, so that the same numeral is assigned to the similar component, and the descriptions and illustrations are omitted.

[0051] As shown above in the above example, since the MPc 66, which divides the 360 ultrasonic transducers 12 into four sensor element groups 40a-40d and selectively switches and connects 94 first signal lines 63 out of 360 first signal lines 63 to the second signal lines 67 according to the first to fourth sensor element groups 40a-40d, is disposed in the ultrasonic observation apparatus 62, the ultrasonic observation apparatus 62 of the convex scan type, to which the ultrasonic probe 61 of the radial scan type can also be applicable, and the ultrasonic diagnosing system 60 using the ultrasonic observation apparatus 62 are provided at the low cost.

[0052] Further, since the MPc 66 is provided in the second connector 65, the ultrasonic observation apparatus, which is capable of connecting the ultrasonic probe of the radial scan type, can be manufactured with relative ease by modifying the conventional ultrasonic observation apparatus of the convex scan type.

[0053] In Fig.7, an ultrasonic diagnosing system 70 is constructed of an ultrasonic probe 71 of the radial scan type and an ultrasonic observation apparatus 72. The ultrasonic probe 71 has the similar configuration as the ultrasonic probe 61 in Fig.6, and 360 first signal lines 73 from the 360 ultrasonic transducers 12 are directly connected to a first connector 74.

[0054] A multiplexer (MPd) 75 is disposed in the ultrasonic observation apparatus 72. The MPd 75 selectively switches five first signal lines 73 connected through the first and second connectors 74 and 76 according to the first to fourth sensor element groups 40a-40d and connects the five first signal lines 73 to the transmitter 23 and the receiver 24 through five second signal lines 77.

[0055] As shown in Fig.8, the MPd 75 is constructed of a decoder 80, which receives and decodes the sensor element group selection signal of two-bit sent from the CPU 20 through the control line 19, and first to fourth switches (SWa-SWd) 81a-81d.

[0056] The SWa-SWd 81a-81d selectively switch the first to fourth sensor element groups 40a-40d according to the sensor element group selection signal decoded in the decoder 80, and simultaneously drive the five ultrasonic transducers 12 as one block in the selected sensor element group under the control of the scan controller 21. Further, the MPd 75 selectively switches the ultrasonic transducer 12, which transmits and receives the drive signal and the echo signal, by shifting at least one ultrasonic transducer 12 (see Fig.2) to be driven in the clockwise direction every time the drive signal and the echo signal are transmitted and received. That is, the MPd 75 integrates the functions of the MPa 17 and MPb 22.

[0057] The MPd 75 is constituted of a programmable logic circuit, which is capable of reprogramming an arbitrary program, such as FPGA (Field Programmable Gate Array) and the like. The CPU 20 detects the number of channels being used in the ultrasonic probe according to the identification code from the insertion detector/probe type identifier 31, and reprograms the logic circuit of the MPd 75 based on the detected results.

[0058] Similar to the above example, for instance, 360 pins corresponding to 360 channels are formed in the first connector 74. The second connector 74 has 360 pin holes, for instance, to be compatible with 360 channels and 94 channels. When the ultrasonic probe of the convex scan type with 94 channels is inserted, 94 pins are inserted in the pin holes which correspond to the first sensor element group 40a.

[0059] Upon receiving the insertion detection signal and the identification code from the insertion detector/probe type identifier 31, and identifying that the ultrasonic probe of the convex scan type with the 94 channels is connected, the CPU 20, in the same manner as the above example, controls the MPd 75 to fix the sensor element group selection signal to "00" to constantly select the first sensor element group 40a, and also controls the action of MPd 75 through the scan controller 21 (a first mode). When the CPU 20 identifies that the ultrasonic probe 10 of the radial scan type with the 360 channels is connected, the CPU 20 transmits the sensor element group selection signal to the MPd 75 through the control line 19 and also controls the action of the MPd 75 through the scan controller 21 (a second mode). Further, other con-

figuration and the operation of the ultrasonic diagnosing system 70 are similar to the ultrasonic diagnosing system 2 shown in Fig.1, so that the same numeral is assigned to the similar component, and the descriptions and illustrations are omitted.

[0060] As shown above in the further example, since the MPd 75, which divides the 360 ultrasonic transducers 12 into four sensor element groups 40a-40d and selectively switches and connects five of 360 first signal lines 73 to the transmitter 23 and the receiver 24 through the five second signal lines 77 according to the first to fourth sensor element groups 40a-40d, is disposed in the ultrasonic observation apparatus 72, the ultrasonic observation apparatus 72, to which the ultrasonic probes of the convex scan type and the radial scan type are applicable, and the ultrasonic diagnosing system 70 using the ultrasonic observation apparatus 72 are provided at the low cost.

[0061] Since the MPd 75 is constituted of a programmable logic circuit, which is capable of reprogramming an arbitrary program, such as FPGA (Field Programmable Gate Array) and the like, the ultrasonic probe of the convex scan type with the number of channels other than 94 can also be connected.

[0062] Further, the number of ultrasonic transducers 12, the number of ultrasonic transducers 12 included in each of the first to fourth sensor element groups 40a-40d, the number of the drive signals transmitted from the transmitter 23 and the number of the echo signals received by the receiver 24 are not limited in those described in the above embodiments. Each number can be properly changed according to a specification of the ultrasonic diagnosing system.

[0063] In the above embodiment, the MPb 22 is disposed between the second connector 15, and the transmitter 23 and the receiver 24. In the above example, the MPb 22 is disposed between the second connector 65, and the transmitter 23 and the receiver 24. However, it is also possible to dispose the MPb 22 between the receiver 24 and the BF 25.

[0064] In the two examples described above, the second connectors 65 and 76, which are compatible with both 360 channels and 94 channels, are respectively disposed in the ultrasonic observation apparatuses 62 and 72. However, it is also possible to provide separate connectors for 360 channels and 94 channels.

[0065] In the above embodiment, the ultrasonic probe, which has the ultrasonic transducers on the outer periphery in one line, is described as an example. However, the present invention can be applied to the ultrasonic probe which has 360 ultrasonic transducers disposed on the outer periphery in plural lines. In that case, the ultrasonic transducers are divided into four sensor element groups along an axial direction of the sheath as in the same manner as the above embodiments.

[0066] In the above embodiment, only ultrasonic transducers are provided in the ultrasonic probe. However, it is also possible to integrally provide an endoscope in the ultrasonic probe.

[0067] Although the present invention has been described with respect to the preferred embodiment, the present invention is not to be limited to the above embodiment but, on the contrary, various modifications will be possible to those skilled in the art without departing from the scope of claims appended hereto.

Claims

1. An ultrasonic diagnosing system (2) comprising an ultrasonic probe (10) of a radial scan type and an ultrasonic observation apparatus (11) on which said ultrasonic probe of said radial scan type is mounted through a connector section thereof, said ultrasonic observation apparatus inputting and outputting M numbers of signals in parallel through said connector section, said ultrasonic diagnosing system including:

   A. said ultrasonic probe of said radial scan type including:

      N (N>M) numbers of ultrasonic transducers (12) disposed on an outer periphery of a tip of said probe, said N numbers of ultrasonic transducers being grouped into plural sensor element groups, which are activated in sequence, each of said sensor element groups having M numbers of said ultrasonic transducers:
      N numbers of first signal lines (16) respectively connected to said N numbers of ultrasonic transducers for transmitting drive signals for driving said ultrasonic transducers and echo signals from within a living organism;
      M numbers of second signal lines (18) connected to said ultrasonic observation apparatus through said connector section; and
      a first multiplexer (17) disposed between said first signal lines and said second signal lines, said first multiplexer selectively switching M numbers of said first signal lines for connecting to said second signal lines according to said sensor element group to be activated;

   B. said ultrasonic observation apparatus including:

      a second multiplexer (22) which selectively switches L numbers of said second signal lines to connect to a transmitter (23) for transmitting said drive signal or a receiver (24) for receiving said echo signal;
      a scan controller (21) for performing said switching operations of said first and sec-

ond multiplexers
wherein there are four of said sensor element groups (40a, 40b, 40c and 40d), and plural transducers disposed at a boundary between two adjacent sensor element groups are contained both in said two sensor element groups,
the further including a type identifier for identifying a type of an ultrasonic probe mounted through said connector section;
wherein according to said type identification of said type identifier, said scan controller selects a first mode for said ultrasonic probe of said radial scan type, and a second mode for an ultrasonic probe of a convex scan type which has M numbers of ultrasonic transducers on an outer periphery of a tip of said probe, said first multiplexer performs said switching operation in said first mode, and said switching operation not being performed in said second mode.

2. An ultrasonic diagnosing system according to claim 1 wherein said connector section includes a first connector (14) and a second connector (15) which are mutually connected, said first connector is disposed in said ultrasonic probe of said radial scan type, and said second connector is disposed in said ultrasonic observation apparatus.

3. An ultrasonic diagnosing system according to claim 2, wherein said first multiplexer is disposed in said first connector, and said second multiplexer is disposed in said second connector.

4. An ultrasonic diagnosing system according to claim 2, wherein said first multiplexer is disposed in said first connector, and said second multiplexer is disposed between said transmitter and said receiver, and said second connector.

5. An ultrasonic diagnosing system according to claim 1, wherein said multiplexer is a programmable logic circuit in which an arbitrary logic is reprogrammable.

6. An ultrasonic diagnosing system according to claim 1, wherein said N numbers of ultrasonic transducers are disposed throughout said outer periphery at a predetermined pitch.

7. An ultrasonic diagnosing system according to claim 1, wherein said ultrasonic transducer is disposed in an endoscope.

Patentansprüche

1. Ultraschalldiagnosesystem (2), umfassend eine Ultraschallsonde (10) vom Radialabtasttyp und eine Ultraschallbetrachtungsvorrichtung (11), an der die Ultraschallsonde des Radialabtasttyps über einen Verbindeabschnitt angebracht ist, wobei die Ultraschallbetrachtungsvorrichtung M Signale parallel über den Verbindeabschnitt eingibt und ausgibt, und das Ultraschalldiagnosesystem enthält:

A. die Ultraschallsonde des Radialabtasttyps enthält:

N (N>M) Ultraschallwandler (12), die an einer Außenperipherie einer Spitze der Sonde angeordnet sind, wobei die N Ultraschallwandler zu mehreren Sensorelementgruppen gruppiert sind, die sequentiell aktiviert werden, wobei jede der Sensorelementgruppen M Ultraschallwandler enthält;
N erste Signalleitungen (16), die an entsprechende N Ultraschallwandler angeschlossen sind, um Treibersignale zum Treiben der Ultraschallwandler zu senden und Echosignale vom Inneren eines lebenden Organismus zu empfangen;
M zweite Signalleitungen (18), die an die Ultraschallbetrachtungsvorrichtung über den Verbindeabschnitt angeschlossen sind; und
einen ersten Multiplexer (17), der zwischen den ersten Signalleitungen und den zweiten Signalleitungen angeordnet ist, wobei der erste Multiplexer selektiv M der ersten Signalleitungen umschaltet zur Verbindung mit den zweiten Signalleitungen nach Maßgabe der zu aktivierenden Sensorelementgruppe;

B. die Ultraschallbetrachtungsvorrichtung enthält:

einen zweiten Multiplexer (22), der selektiv L der zweiten Signalleitungen schaltet zur Verbindung mit einem Sender (23) zum Senden des Treibersignals oder mit einem Empfänger (24) zum Empfangen des Echosignals;
eine Abtaststeuerung (21) zum Ausführen der Schaltoperationen des ersten und des zweiten Multiplexers,
wobei es vier Sensorelementgruppen (40a, 40b, 40c, 40d) gibt und mehrere Wandler an einer Grenze zwischen zwei benachbarten Sensorelementgruppen in diesen beiden zwei Sensorelementgruppen enthalten sind,
weiterhin enthaltend einen Typidentifizierer zum Identifizieren eines Typs einer über

den Verbindeabschnitt angebrachten Ultraschallsonde;
wobei entsprechend der Typidentifizierung seitens des Typidentifizierers die Abtaststeuerung einen ersten Modus für die Ultraschallsonde des Radialabtasttyps und einen zweiten Modus für eine Ultraschallsonde eines Konvex-Abtasttyps, die M Ultraschallwandler an einer Außenperipherie einer Spitze der Sonde enthält, auswählt, wobei der erste Multiplexer den Schaltvorgang in dem ersten Modus ausführt, während der Schaltvorgang in dem zweiten Modus nicht ausgeführt wird.

2. Ultraschalldiagnosesystem nach Anspruch 1, bei dem der Verbindeabschnitt einen ersten Verbinder (14) und einen zweiten Verbinder (15), die untereinander verbunden sind, aufweist, wobei der erste Verbinder sich in der Ultraschallsonde des Radialabtasttyps befindet und der zweite Verbinder sich in der Ultraschallbetrachtungsvorrichtung befindet.

3. Ultraschalldiagnosesystem nach Anspruch 2, bei dem der erste Multiplexer sich in dem ersten Verbinder befindet und der zweite Multiplexer sich in dem zweiten Verbinder befindet.

4. Ultraschalldiagnosesystem nach Anspruch 2, bei dem der erste Multiplexer sich in dem ersten Verbinder befindet und der zweite Multiplexer sich zwischen dem Sender und dem Empfänger einerseits und dem zweiten Verbinder andererseits befindet.

5. Ultraschalldiagnosesystem nach Anspruch 1, bei dem der Multiplexer eine programmierbare Logikschaltung ist, in der eine Entscheidungslogik umprogrammierbar ist.

6. Ultraschalldiagnosesystem nach Anspruch 1, bei dem die N Ultraschallwandler über den gesamten Außenumfang mit einem vorbestimmten Mittenabstand angeordnet sind.

7. Ultraschalldiagnosesystem nach Anspruch 1, bei dem der Ultraschallwandler in einem Endoskop angeordnet ist.

Revendications

1. Système de diagnostic par ultrasons (2) comprenant une sonde ultrasonore (10) d'un type à balayage radial et un appareil d'observation par ultrasons (11) sur lequel ladite sonde ultrasonore dudit type à balayage radial est montée par l'intermédiaire d'une section de connecteur de celui-ci, ledit appareil d'observation par ultrasons entrant et sortant un nombre M de signaux en parallèle par l'intermédiaire de ladite section de connecteur, ledit système de diagnostic par ultrasons comprenant :

A. ladite sonde ultrasonore dudit type à balayage radial comprenant :

un nombre N (N > M) de transducteurs ultrasonores (12) disposés sur une périphérie extérieure d'une extrémité de ladite sonde, ledit nombre N de transducteurs ultrasonores étant groupés en plusieurs groupes d'éléments de capteur, qui sont activés en séquence, chacun desdits groupes d'éléments de capteur comportant un nombre M desdits transducteurs ultrasonores ;
un nombre N de premières lignes de signaux (16) respectivement connectées au dit nombre N de transducteurs ultrasonores pour transmettre des signaux de commande pour commander lesdits transducteurs ultrasonores et des signaux d'écho provenant d'un organisme vivant ;
un nombre M de deuxièmes lignes de signaux (18) connectées au dit appareil d'observation par ultrasons par l'intermédiaire de ladite section de connecteur ; et
un premier multiplexeur (17) disposé entre lesdites premières lignes de signaux et lesdites deuxièmes lignes de signaux, ledit premier multiplexeur commutant de manière sélective le nombre M desdites premières lignes de signaux pour une connexion aux dites deuxièmes lignes de signaux en fonction dudit groupe d'éléments de capteur à activer ;

B. ledit appareil d'observation par ultrasons comprenant :

un deuxième multiplexeur (22) qui commute de manière sélective un nombre L desdites deuxièmes lignes de signaux pour une connexion à un émetteur (23) pour transmettre ledit signal de commande ou à un récepteur (24) pour recevoir ledit signal d'écho ;
un contrôleur de balayage (21) pour effectuer lesdites opérations de commutation desdits premier et deuxième multiplexeurs, dans lequel lesdits groupes d'éléments de capteur (40a, 40b, 40c et 40d) sont au nombre de quatre, et plusieurs transducteurs disposés au niveau d'une frontière entre deux groupes d'éléments de capteur adjacents sont contenus à la fois dans lesdits deux groupes d'éléments de capteur,
le système comprenant en outre un identifiant de type pour identifier un type d'une

sonde ultrasonore montée par l'intermédiaire de ladite section de connecteur ;
dans lequel, conformément à ladite identification de type dudit identifiant de type, ledit contrôleur de balayage sélectionne un premier mode pour ladite sonde ultrasonore dudit type à balayage radial et un deuxième mode pour une sonde ultrasonore d'un type à balayage convexe qui comporte un nombre M de transducteurs ultrasonores sur une périphérie extérieure d'une extrémité de ladite sonde, ledit premier multiplexeur effectue ladite opération de commutation dans ledit premier mode, et ladite opération de commutation n'est pas effectuée dans ledit deuxième mode.

2. Système de diagnostic par ultrasons selon la revendication 1, dans lequel ladite section de connecteur comprend un premier connecteur (14) et un deuxième connecteur (15) qui sont connectés l'un à l'autre, ledit premier connecteur est disposé dans ladite sonde ultrasonore dudit type à balayage radial, et ledit deuxième connecteur est disposé dans ledit appareil d'observation par ultrasons.

3. Système de diagnostic par ultrasons selon la revendication 2, dans lequel ledit premier multiplexeur est disposé dans ledit premier connecteur, et ledit deuxième multiplexeur est disposé dans ledit deuxième connecteur.

4. Système de diagnostic par ultrasons selon la revendication 2, dans lequel ledit premier multiplexeur est disposé dans ledit premier connecteur, et ledit deuxième multiplexeur est disposé entre ledit émetteur et ledit récepteur, et ledit deuxième connecteur.

5. Système de diagnostic par ultrasons selon la revendication 1, dans lequel ledit multiplexeur est un circuit logique programmable dans lequel une logique arbitraire est reprogrammable.

6. Système de diagnostic par ultrasons selon la revendication 1, dans lequel ledit nombre N de transducteurs ultrasonores sont disposés tout le long de ladite périphérie extérieure avec un pas prédéterminé.

7. Système de diagnostic par ultrasons selon la revendication 1, dans lequel ledit transducteur ultrasonore est disposé dans un endoscope.

FIG. 1

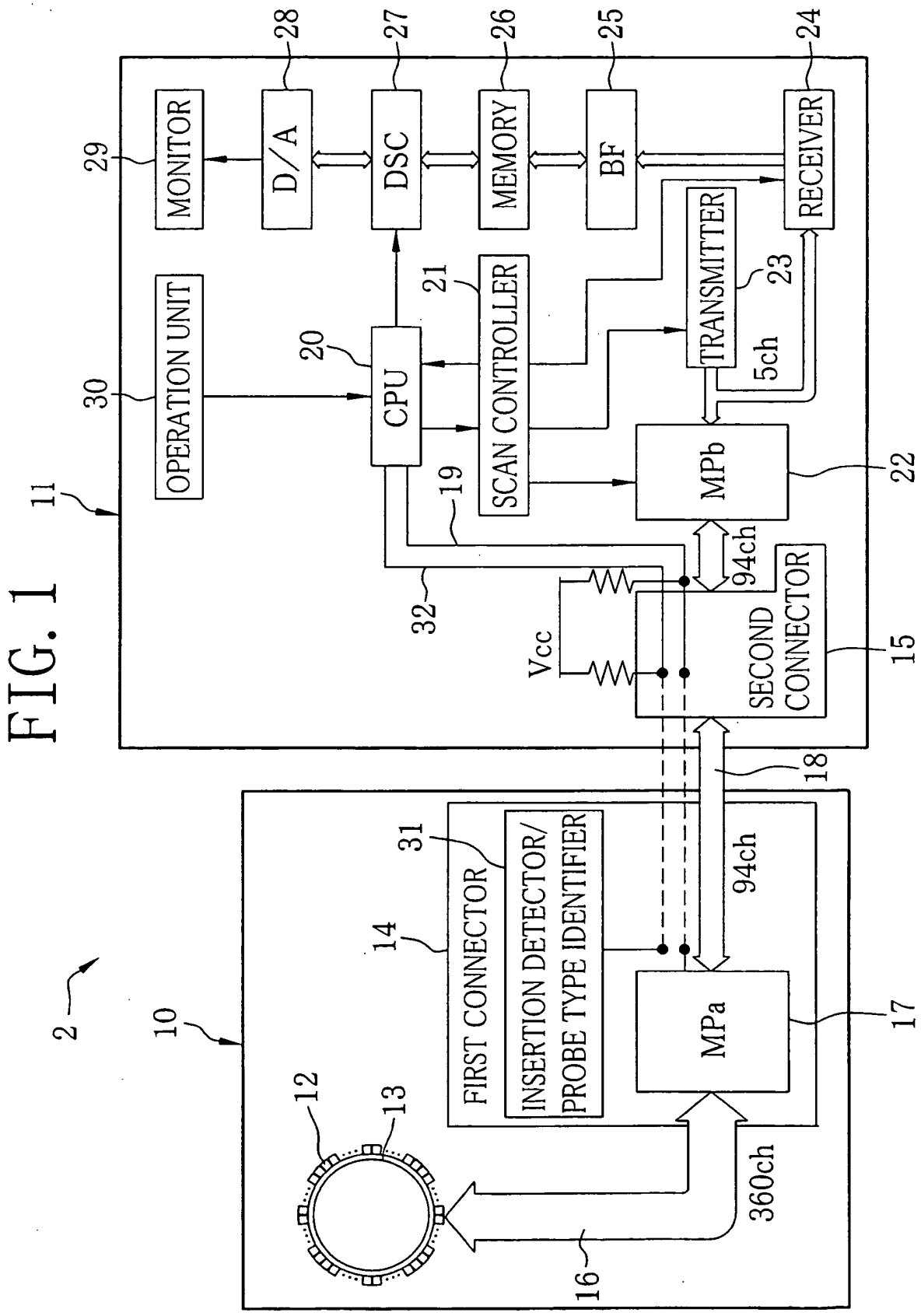

2
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
MONITOR
D/A
DSC
MEMORY
BF
RECEIVER
OPERATION UNIT
CPU
SCAN CONTROLLER
TRANSMITTER
5ch
MPb
94ch
Vcc
SECOND CONNECTOR
FIRST CONNECTOR
INSERTION DETECTOR/ PROBE TYPE IDENTIFIER
MPa
360ch

FIG. 2

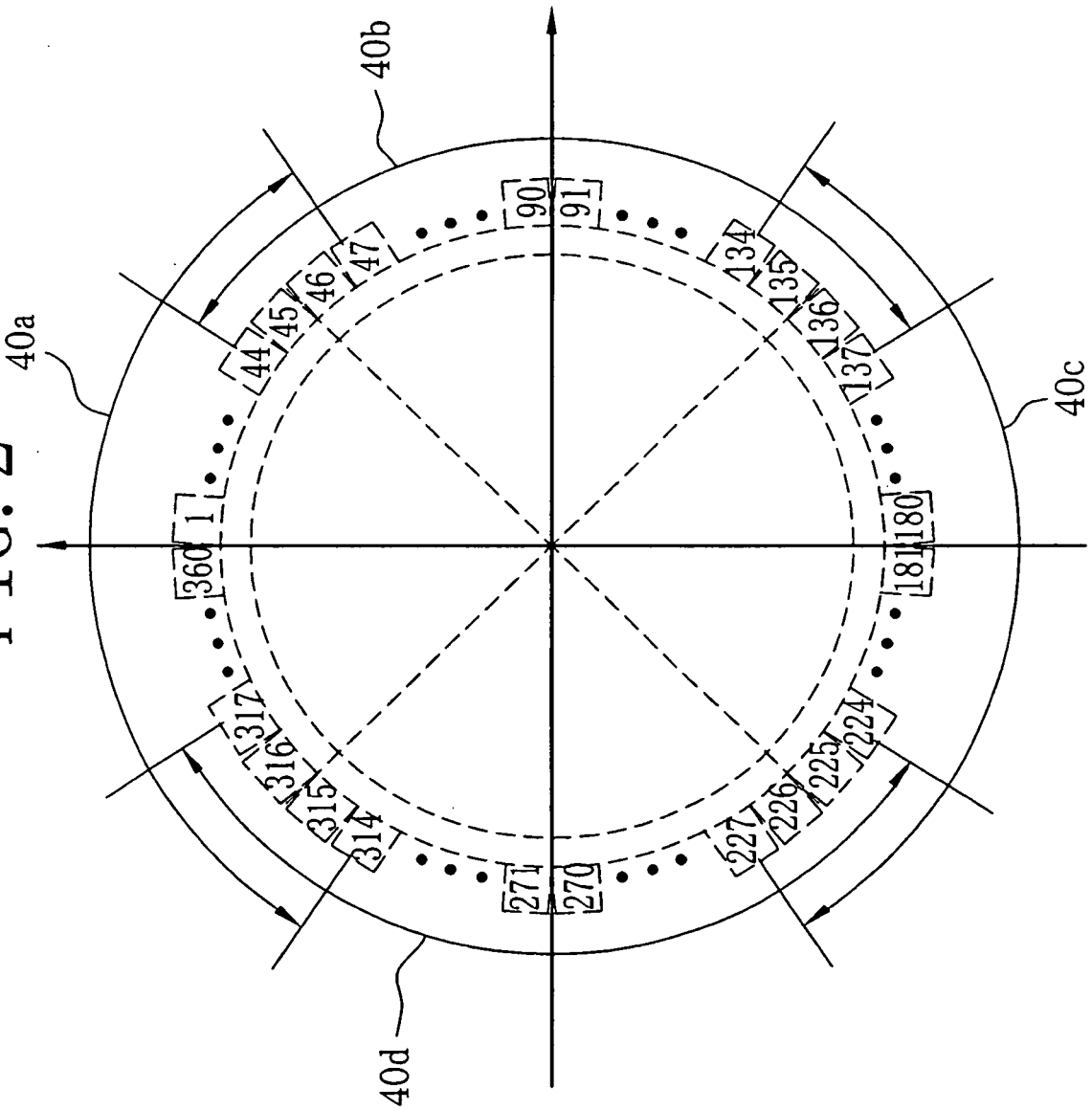

40a
40b
40c
40d
1
44
45
46
47
90
91
134
135
136
137
180
181
224
225
226
227
270
271
314
315
316
317
360

FIG. 3

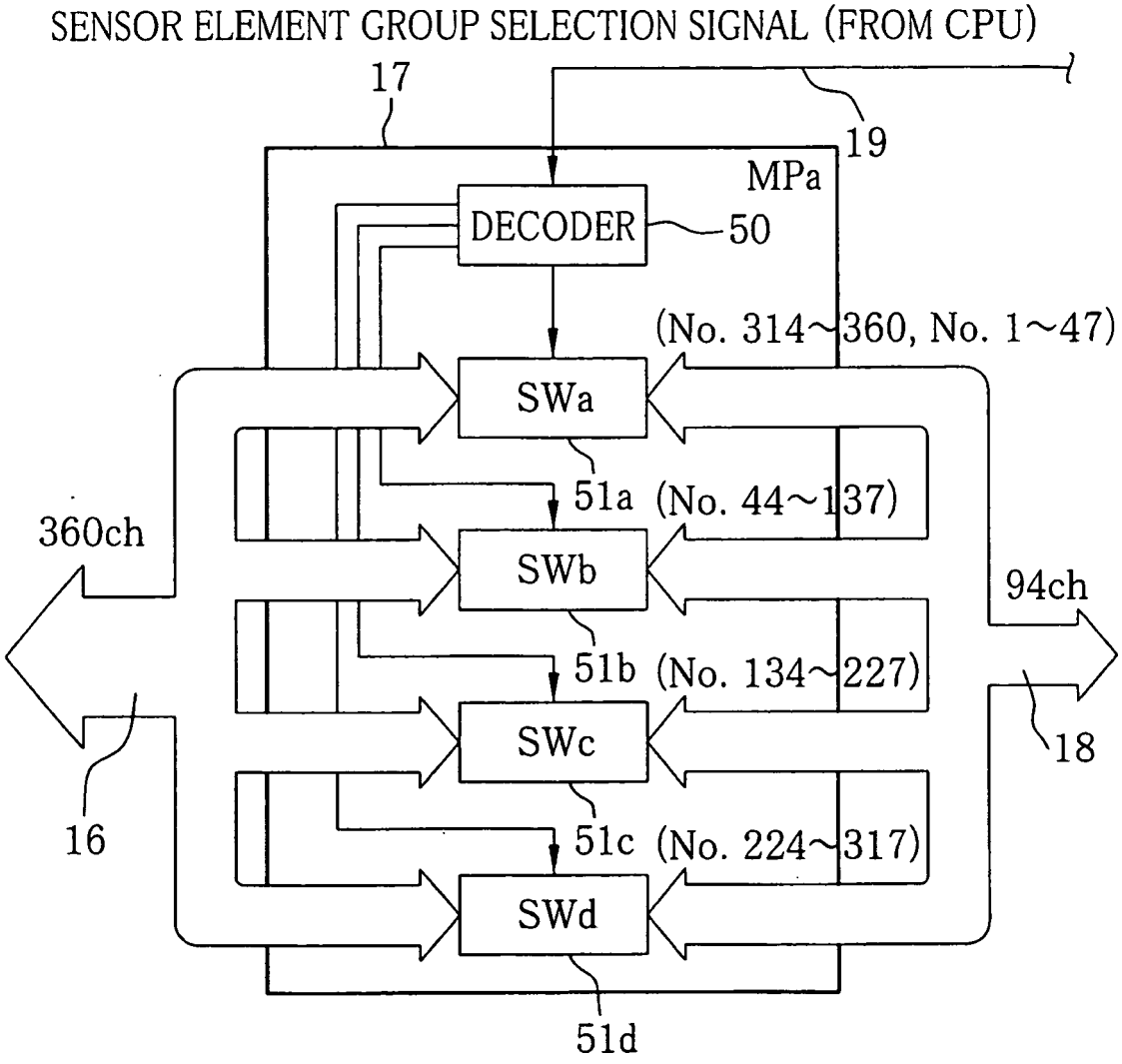

SENSOR ELEMENT GROUP SELECTION SIGNAL (FROM CPU)
17
19
MPa
DECODER
50
(No. 314~360, No. 1~47)
SWa
51a
(No. 44~137)
360ch
SWb
94ch
51b
(No. 134~227)
SWc
18
16
51c
(No. 224~317)
SWd
51d

FIG. 4

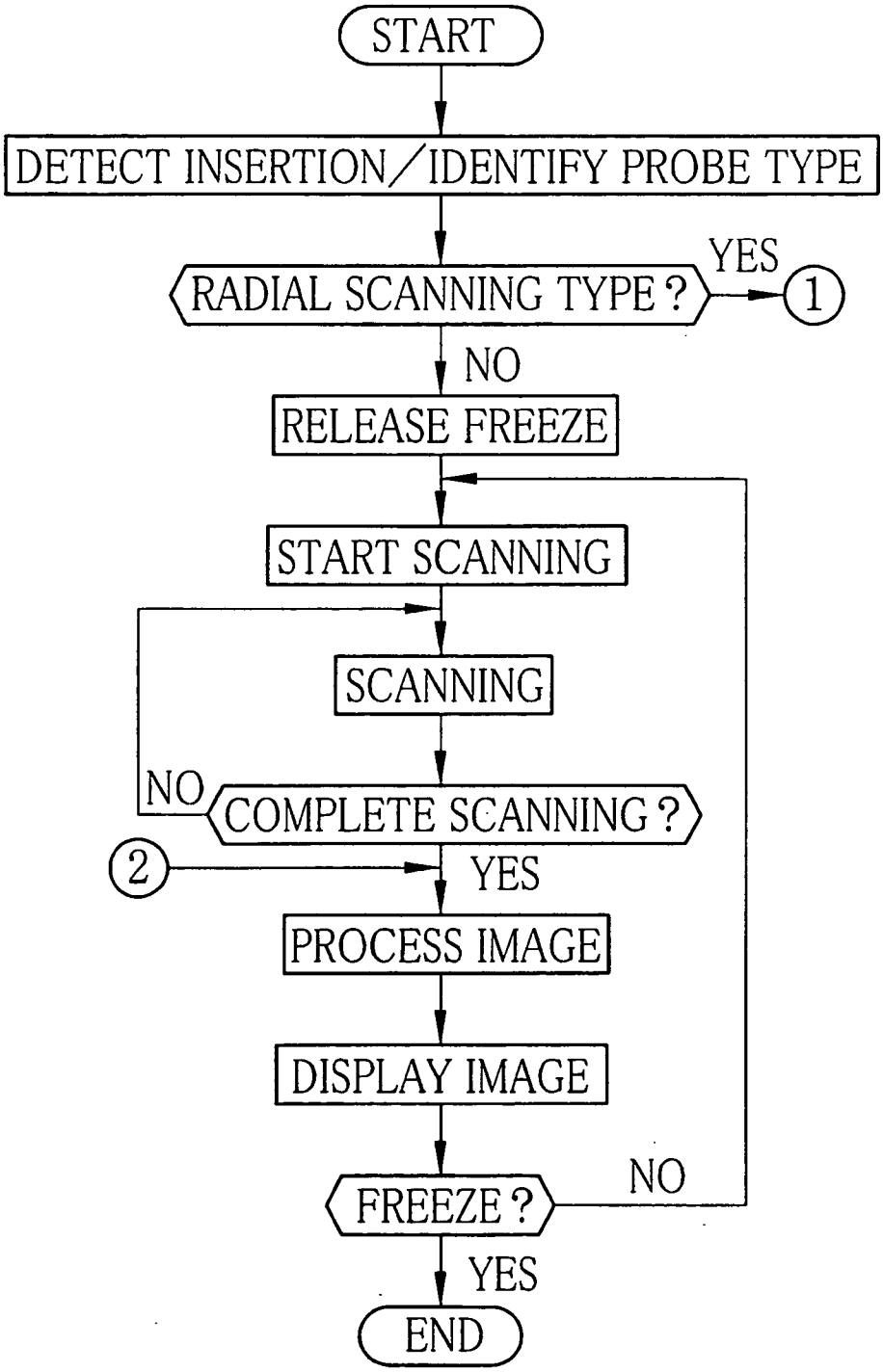

START
DETECT INSERTION/IDENTIFY PROBE TYPE
RADIAL SCANNING TYPE ?
YES
1
NO
RELEASE FREEZE
START SCANNING
SCANNING
NO
COMPLETE SCANNING ?
2
YES
PROCESS IMAGE
DISPLAY IMAGE
FREEZE ?
NO
YES
END

FIG. 5

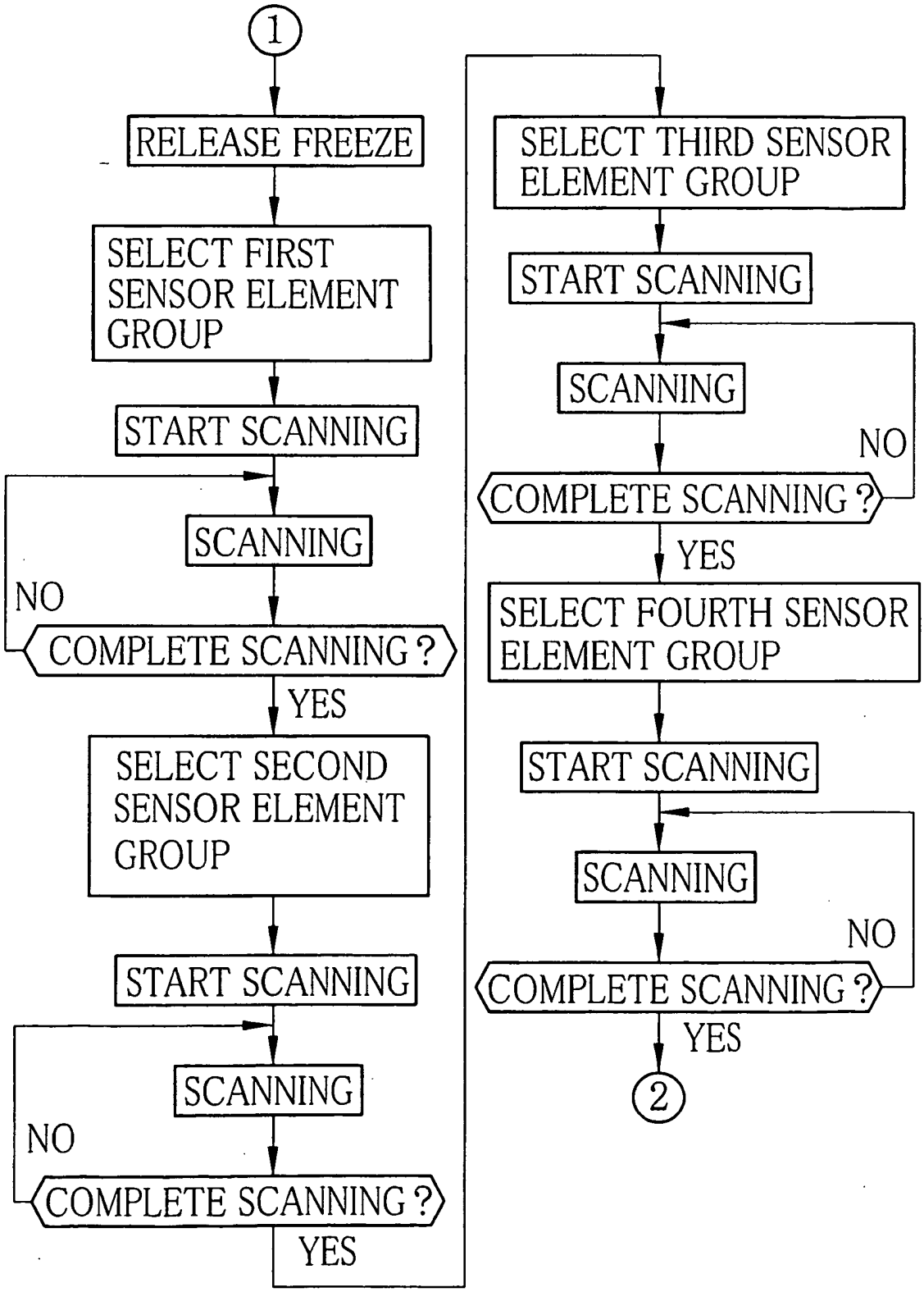

1
RELEASE FREEZE
SELECT FIRST SENSOR ELEMENT GROUP
START SCANNING
SCANNING
NO
COMPLETE SCANNING ?
YES
SELECT SECOND SENSOR ELEMENT GROUP
START SCANNING
SCANNING
NO
COMPLETE SCANNING ?
YES
SELECT THIRD SENSOR ELEMENT GROUP
START SCANNING
SCANNING
NO
COMPLETE SCANNING ?
YES
SELECT FOURTH SENSOR ELEMENT GROUP
START SCANNING
SCANNING
NO
COMPLETE SCANNING ?
YES
2

FIG. 6

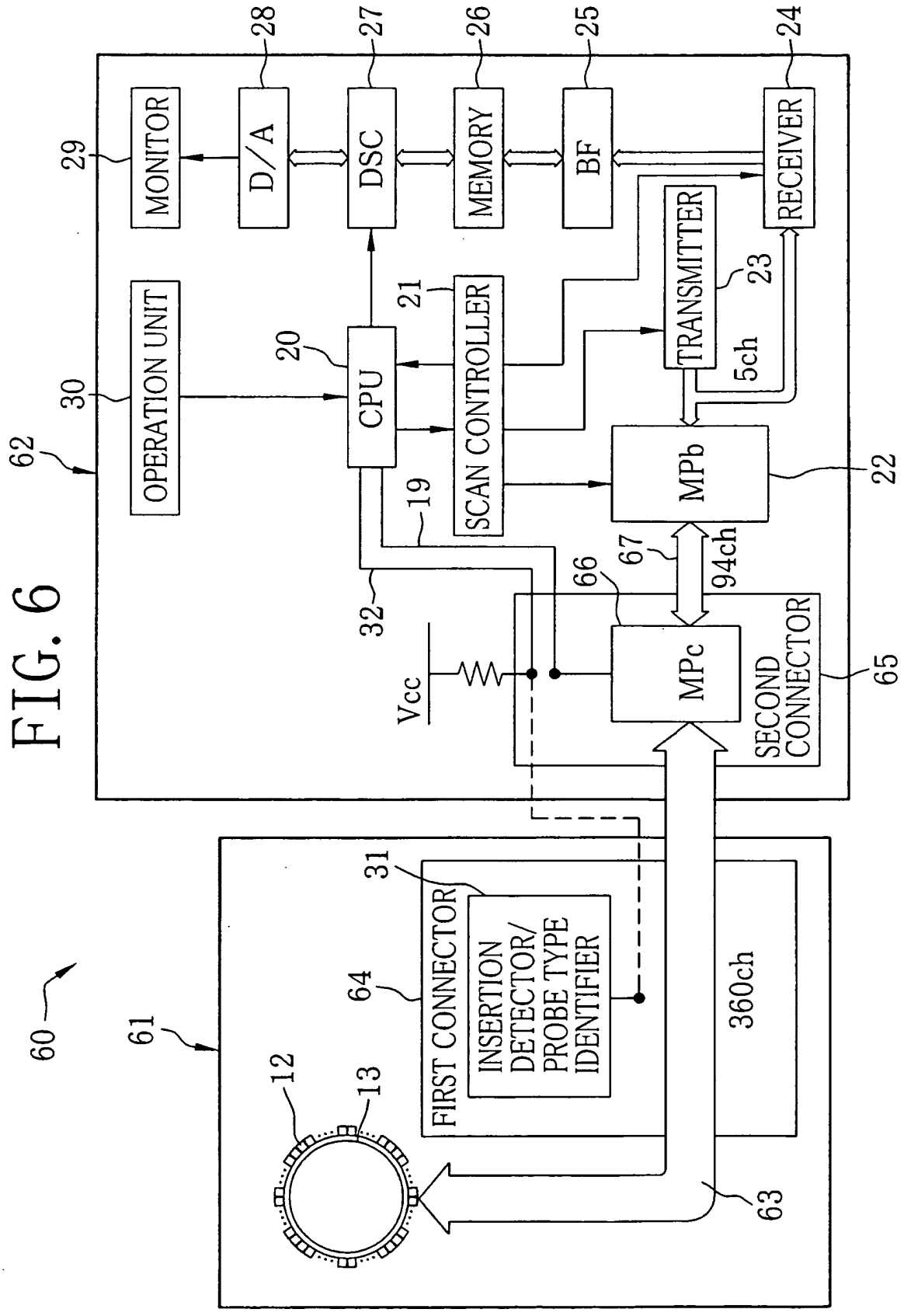

60
61
62
MONITOR
29
D/A
28
DSC
27
MEMORY
26
BF
25
RECEIVER
24
OPERATION UNIT
30
CPU
20
SCAN CONTROLLER
21
TRANSMITTER
23
5ch
MPb
22
19
67
94ch
66
32
Vcc
MPc
SECOND CONNECTOR
65
31
FIRST CONNECTOR
INSERTION DETECTOR/ PROBE TYPE IDENTIFIER
64
360ch
12
13
63

FIG. 7

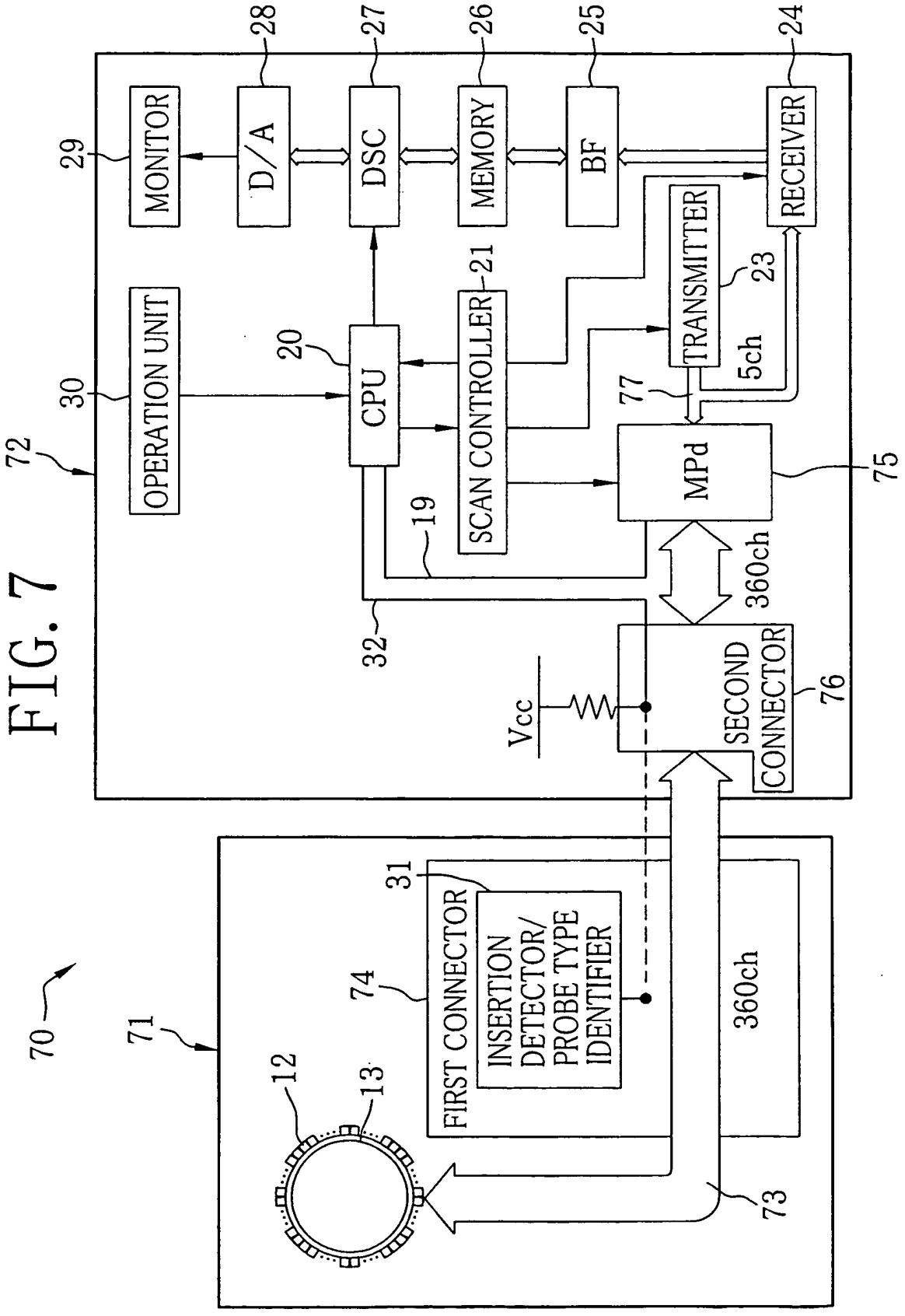

70
71
72
73
74
75
76
77
12
13
19
20
21
23
24
25
26
27
28
29
30
31
32
MONITOR
D/A
DSC
MEMORY
BF
RECEIVER
TRANSMITTER
5ch
OPERATION UNIT
CPU
SCAN CONTROLLER
MPd
360ch
SECOND CONNECTOR
Vcc
FIRST CONNECTOR
INSERTION DETECTOR/ PROBE TYPE IDENTIFIER
360ch

FIG. 8

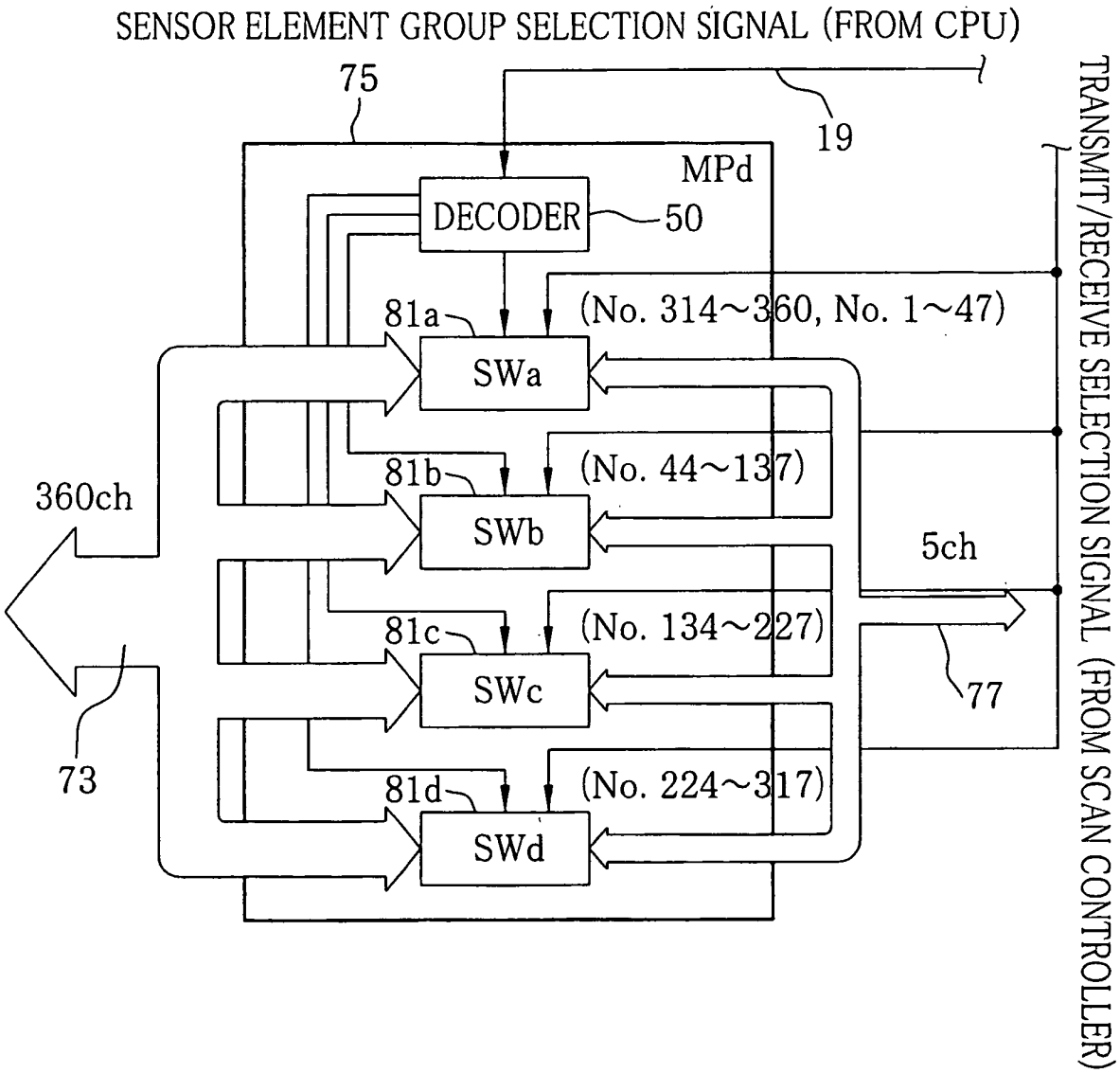
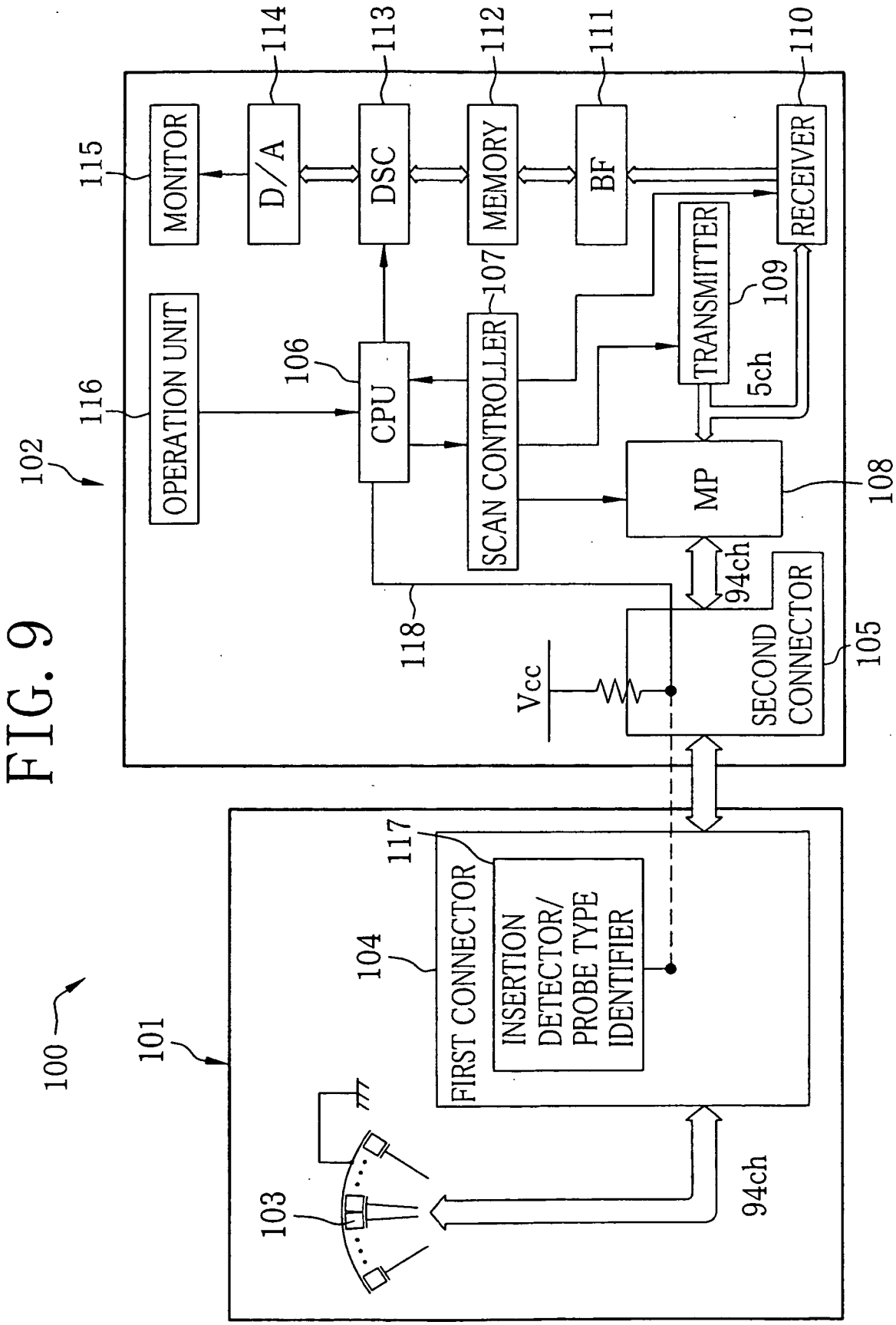

SENSOR ELEMENT GROUP SELECTION SIGNAL (FROM CPU)
75
19
TRANSMIT/RECEIVE SELECTION SIGNAL (FROM SCAN CONTROLLER)
MPd
DECODER
50
81a
(No. 314~360, No. 1~47)
SWa
81b
(No. 44~137)
SWb
360ch
5ch
81c
(No. 134~227)
SWc
77
73
81d
(No. 224~317)
SWd

FIG. 9


100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
MONITOR
D/A
DSC
MEMORY
BF
RECEIVER
OPERATION UNIT
CPU
SCAN CONTROLLER
TRANSMITTER
5ch
MP
94ch
SECOND CONNECTOR
Vcc
FIRST CONNECTOR
INSERTION DETECTOR/ PROBE TYPE IDENTIFIER
94ch

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2134142 A **[0003]**
- US 5924993 A **[0006]**

专利名称(译)	径向扫描型超声探头，超声波观察装置和超声诊断系统		
公开(公告)号	EP1645231B1	公开(公告)日	2014-01-01
申请号	EP2005021678	申请日	2005-10-04
[标]申请(专利权)人(译)	富士摄影胶片公司		
申请(专利权)人(译)	富士胶片有限公司.		
当前申请(专利权)人(译)	富士胶片株式会社		
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发明人	SATO, YOSHIAKI SATO, TOMOO KARASAWA, HIROYUKI TSUJITA, KAZUHIRO		
IPC分类号	A61B8/00 G10K11/34 B06B1/06		
CPC分类号	A61B8/4438 A61B8/12 A61B8/4411 A61B8/4488 B06B1/0633 G10K11/341		
优先权	2004293619 2004-10-06 JP		
其他公开文献	EP1645231A1		
外部链接	Espacenet		

摘要(译)

可安装在超声波观察装置（11）上的径向扫描型超声波探头（10），其并行输入和输出M个信号，包括：N（N> M）个超声波换能器（12）设置的数量在尖端的外周上，分组成多个依次激活的传感器元件组（40a，40b，40c和40d），每个传感器元件组具有M个超声换能器; N条第一信号线（16）分别连接到N个超声换能器，用于传输驱动信号和回波信号; M条连接到超声波观察装置的第二信号线（18）;多路复用器（17），设置在第一信号线和第二信号线之间，根据待激活的传感器元件组，选择性地切换M个第一信号线，分别连接到第二信号线。