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Takagi

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(54) **MAGNETIC RESONANCE IMAGING APPARATUS AND MAGNETIC RESONANCE IMAGING METHOD**

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Feb. 14, 2008 (JP) 2008-033422

(51) **Int. Cl.**
G01V 3/00 (2006.01)

(52) **U.S. Cl.** **324/318**; 324/322

(58) **Field of Classification Search** 324/300–322; 600/407–422; 333/101–103; 340/825.79; 128/623.5, 899
See application file for complete search history.

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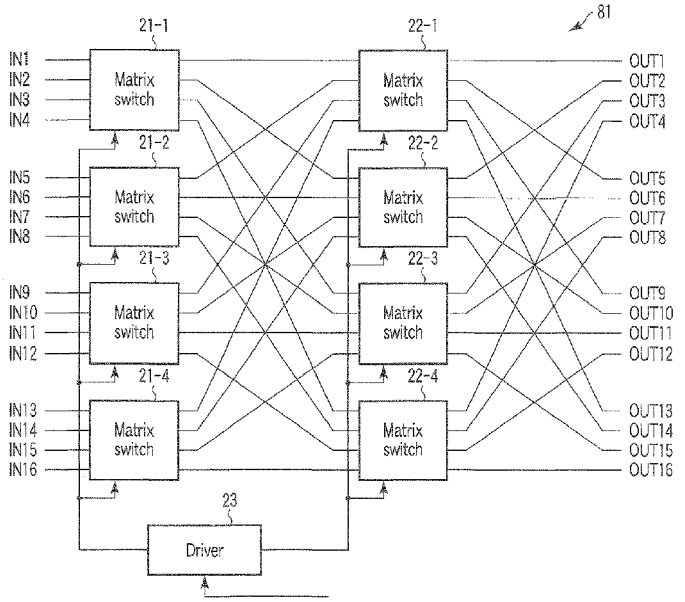
(57) **ABSTRACT**

A magnetic resonance imaging apparatus includes a applying unit which applies a gradient magnetic field and a radio-frequency pulse to a subject placed in a static magnetic field, a radio-frequency coil unit which includes element coils to respectively detect magnetic resonance signals emitted from the subject, and outputs signals of a plurality of channels based on the magnetic resonance signals, receiving circuits each of which receives one of the signals of the plurality of channels, and whose number is smaller than the channels, a selecting circuit which includes matrix switches connected in multiple stages, selects some of magnetic resonance signals from the signals of the channels, and inputs the selected magnetic resonance signals to the receiving circuits, a setting unit which sets diagnostic conditions, and a determining unit which determines a connection state of the matrix switches in accordance with the set diagnostic conditions.

9 Claims, 14 Drawing Sheets



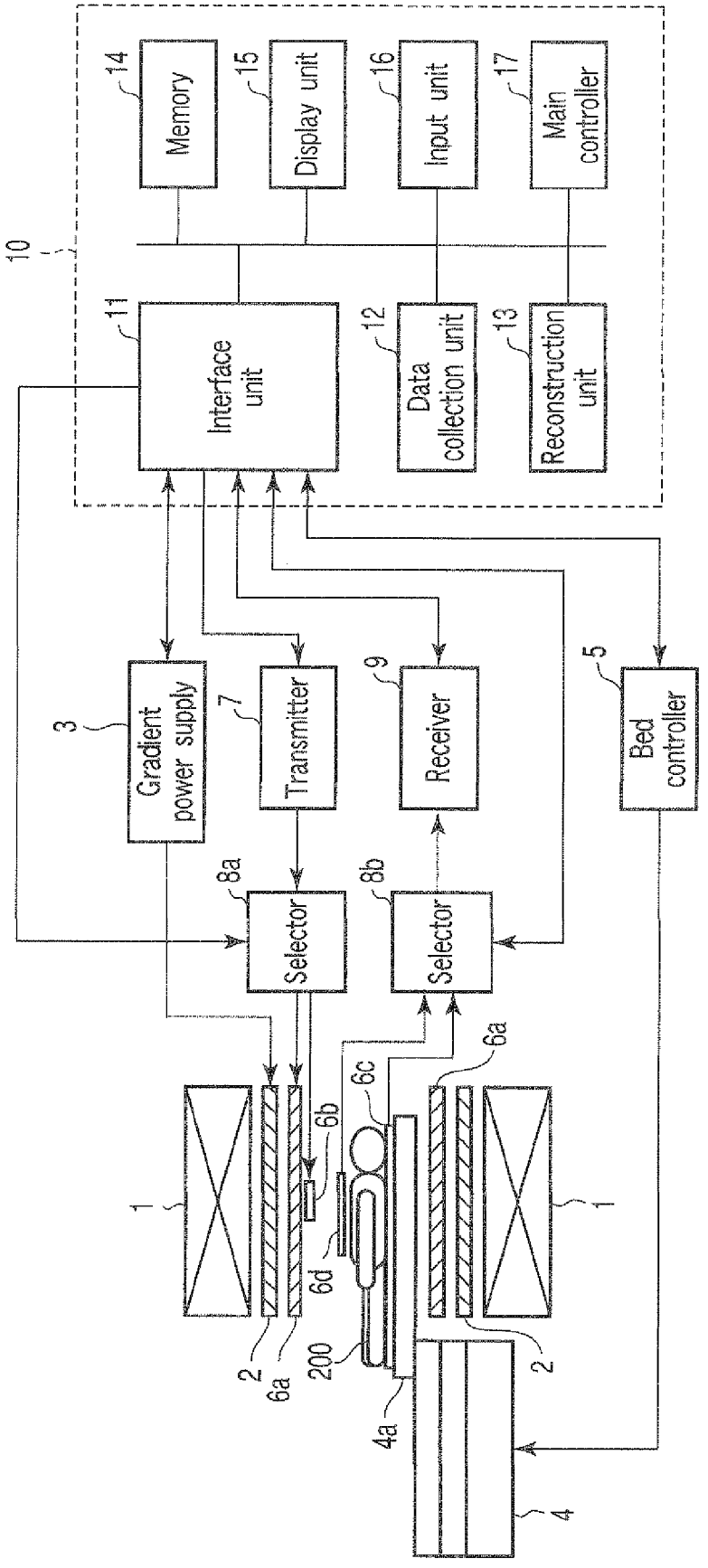

10
14
Memory
15
Display unit
16
Input unit
17
Main controller
11
Interface unit
12
Data collection unit
13
Reconstruction unit
3
Gradient power supply
7
Transmitter
9
Receiver
5
Bed controller
8a
Selector
8b
Selector
1
2
6a
6b
6c
6d
200
4a
4

FIG. 1

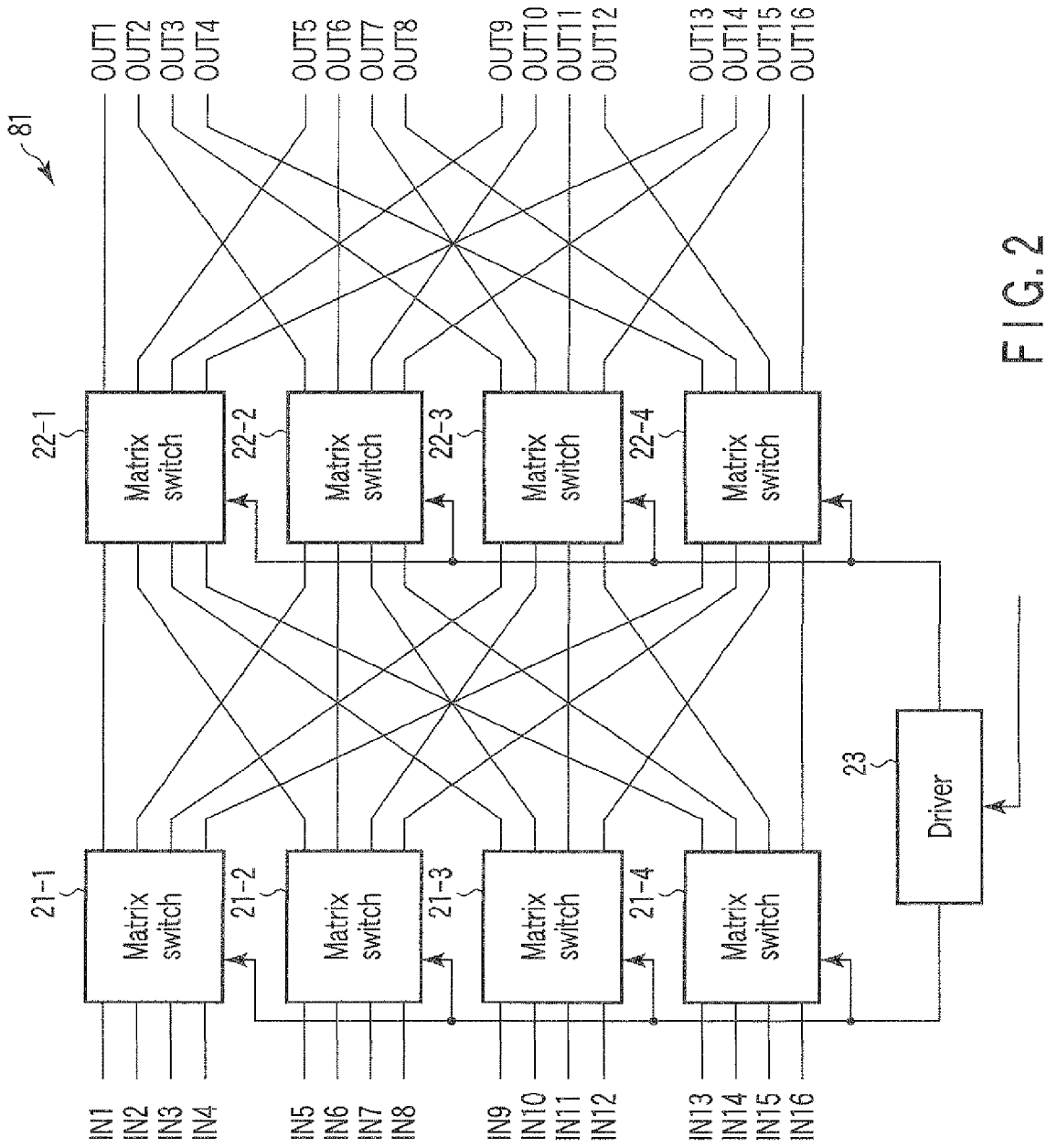

81
OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
OUT7
OUT8
OUT9
OUT10
OUT11
OUT12
OUT13
OUT14
OUT15
OUT16
22-1
22-2
22-3
22-4
Matrix switch
21-1
21-2
21-3
21-4
23
Driver
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
IN9
IN10
IN11
IN12
IN13
IN14
IN15
IN16

FIG. 2

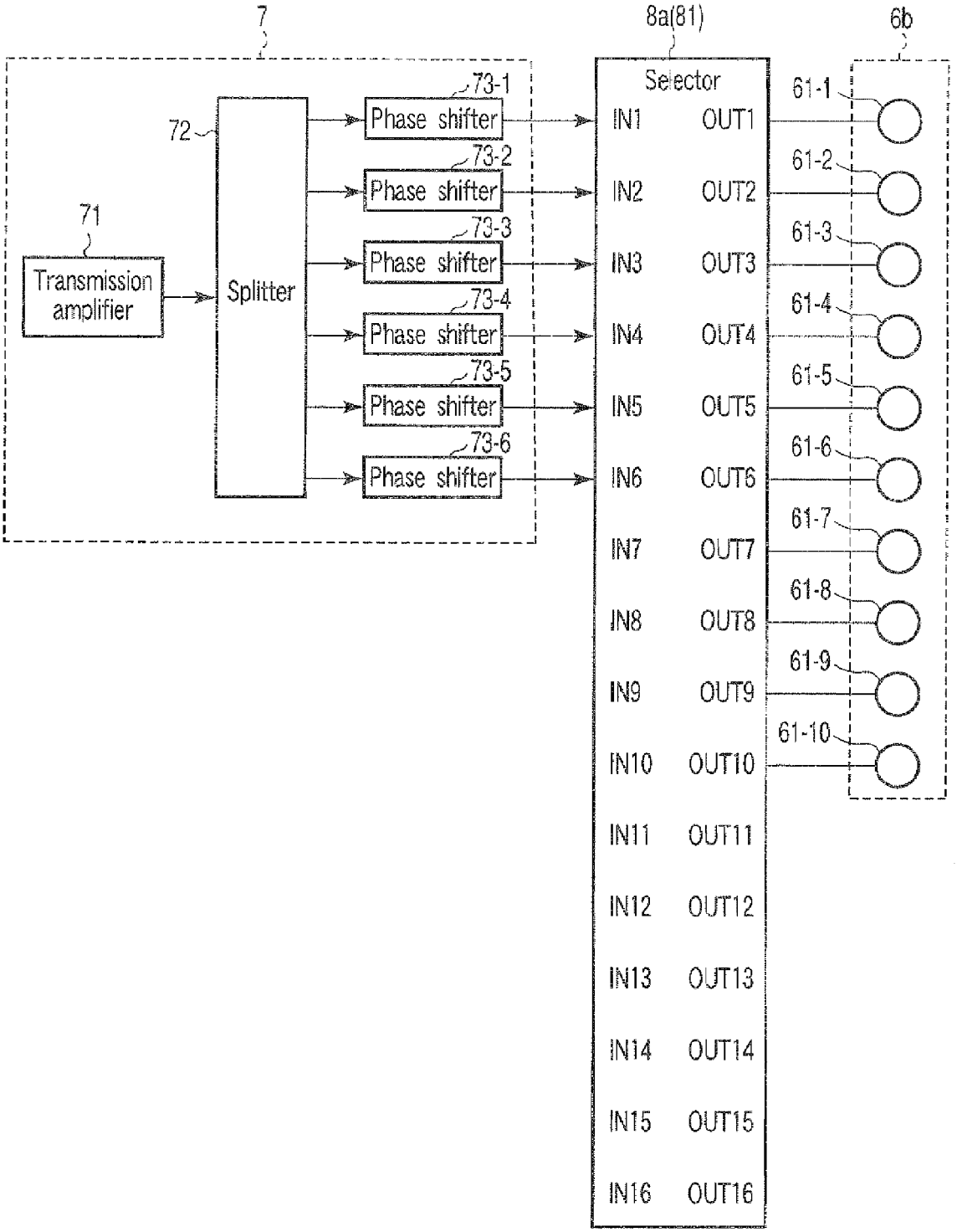

7
8a(81)
6b
Selector
71
Transmission amplifier
72
Splitter
73-1
Phase shifter
73-2
Phase shifter
73-3
Phase shifter
73-4
Phase shifter
73-5
Phase shifter
73-6
Phase shifter
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
IN9
IN10
IN11
IN12
IN13
IN14
IN15
IN16
OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
OUT7
OUT8
OUT9
OUT10
OUT11
OUT12
OUT13
OUT14
OUT15
OUT16
61-1
61-2
61-3
61-4
61-5
61-6
61-7
61-8
61-9
61-10

FIG. 3

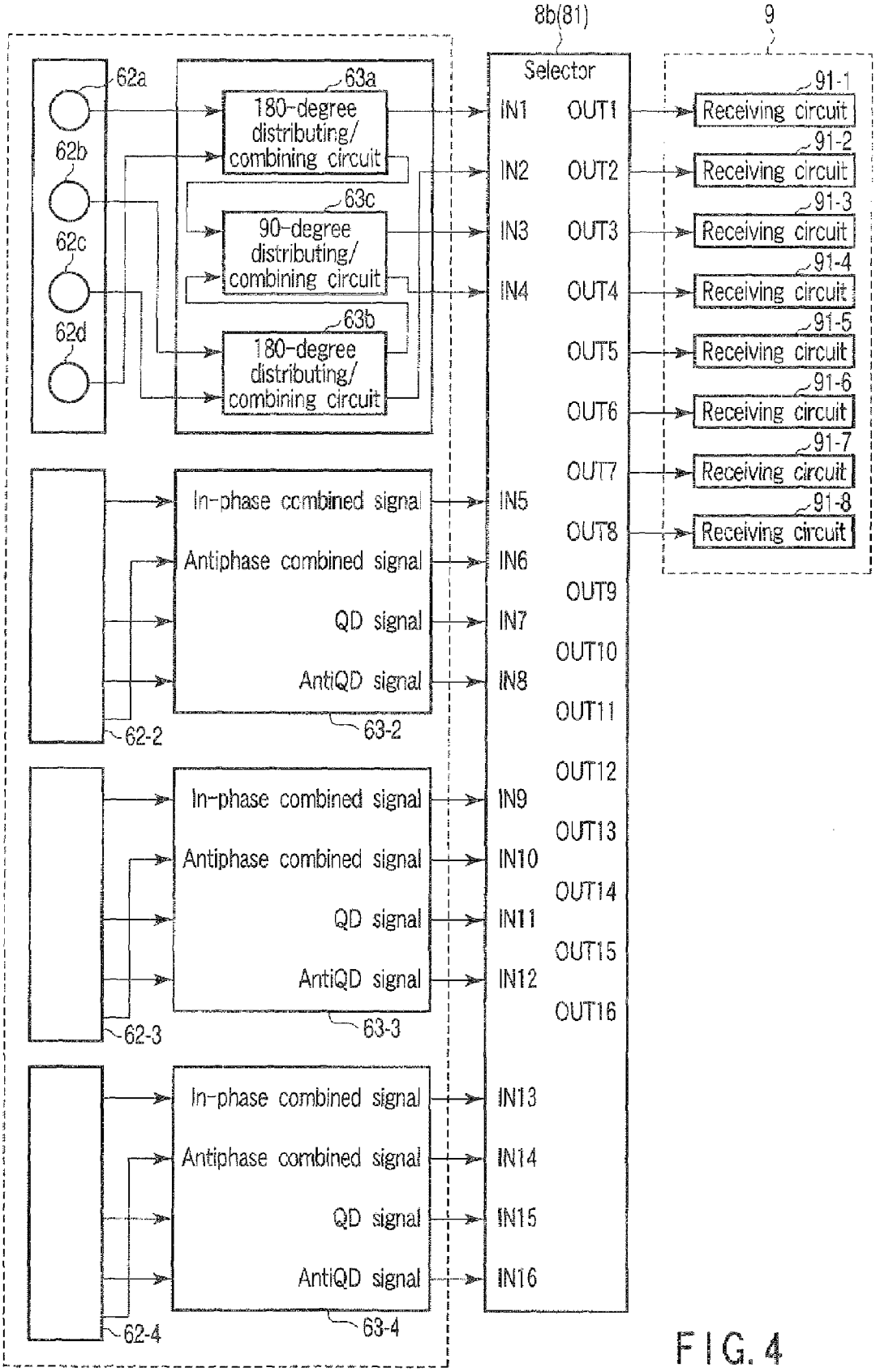

8b(81)
9
Selector
62a
62b
62c
62d
63a
180-degree distributing/ combining circuit
63c
90-degree distributing/ combining circuit
63b
180-degree distributing/ combining circuit
IN1
IN2
IN3
IN4
OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
OUT7
OUT8
OUT9
OUT10
OUT11
OUT12
OUT13
OUT14
OUT15
OUT16
91-1 Receiving circuit
91-2 Receiving circuit
91-3 Receiving circuit
91-4 Receiving circuit
91-5 Receiving circuit
91-6 Receiving circuit
91-7 Receiving circuit
91-8 Receiving circuit
In-phase combined signal
Antiphase combined signal
QD signal
AntiQD signal
IN5
IN6
IN7
IN8
62-2
63-2
In-phase combined signal
Antiphase combined signal
QD signal
AntiQD signal
IN9
IN10
IN11
IN12
62-3
63-3
In-phase combined signal
Antiphase combined signal
QD signal
AntiQD signal
IN13
IN14
IN15
IN16
62-4
63-4

FIG. 4

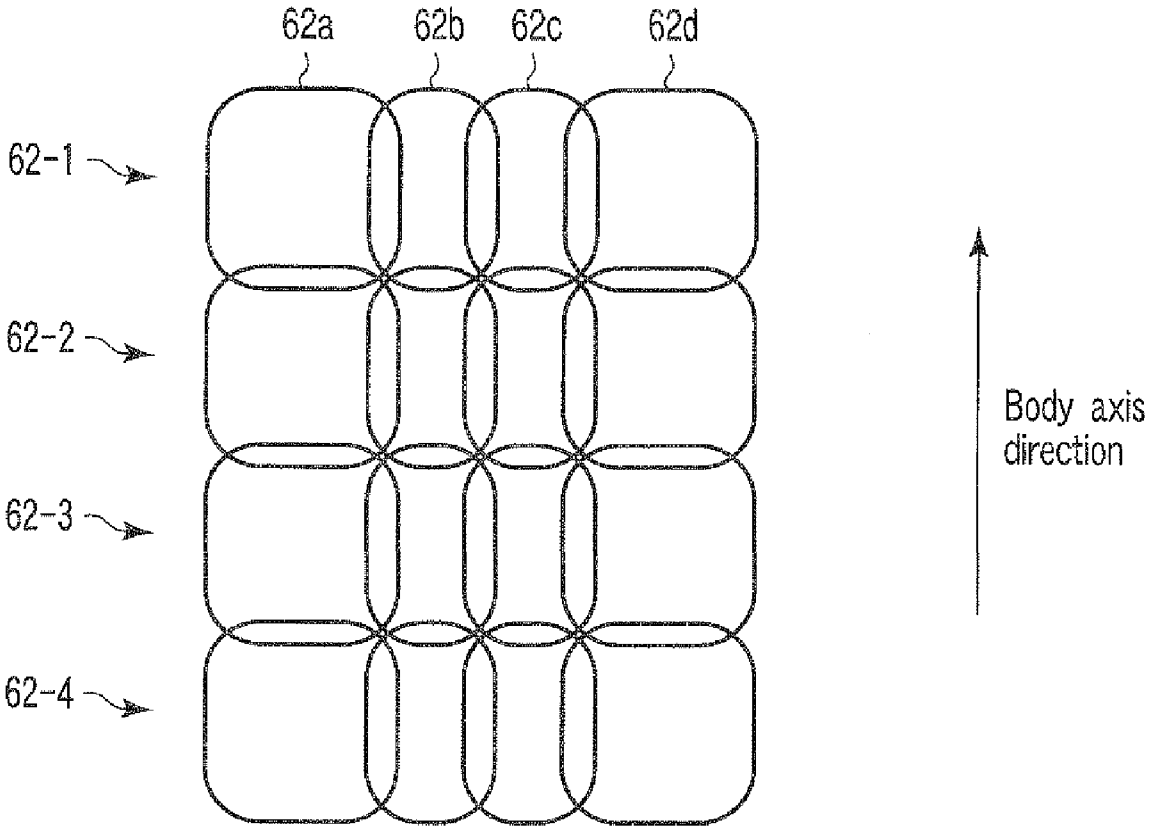


FIG. 5

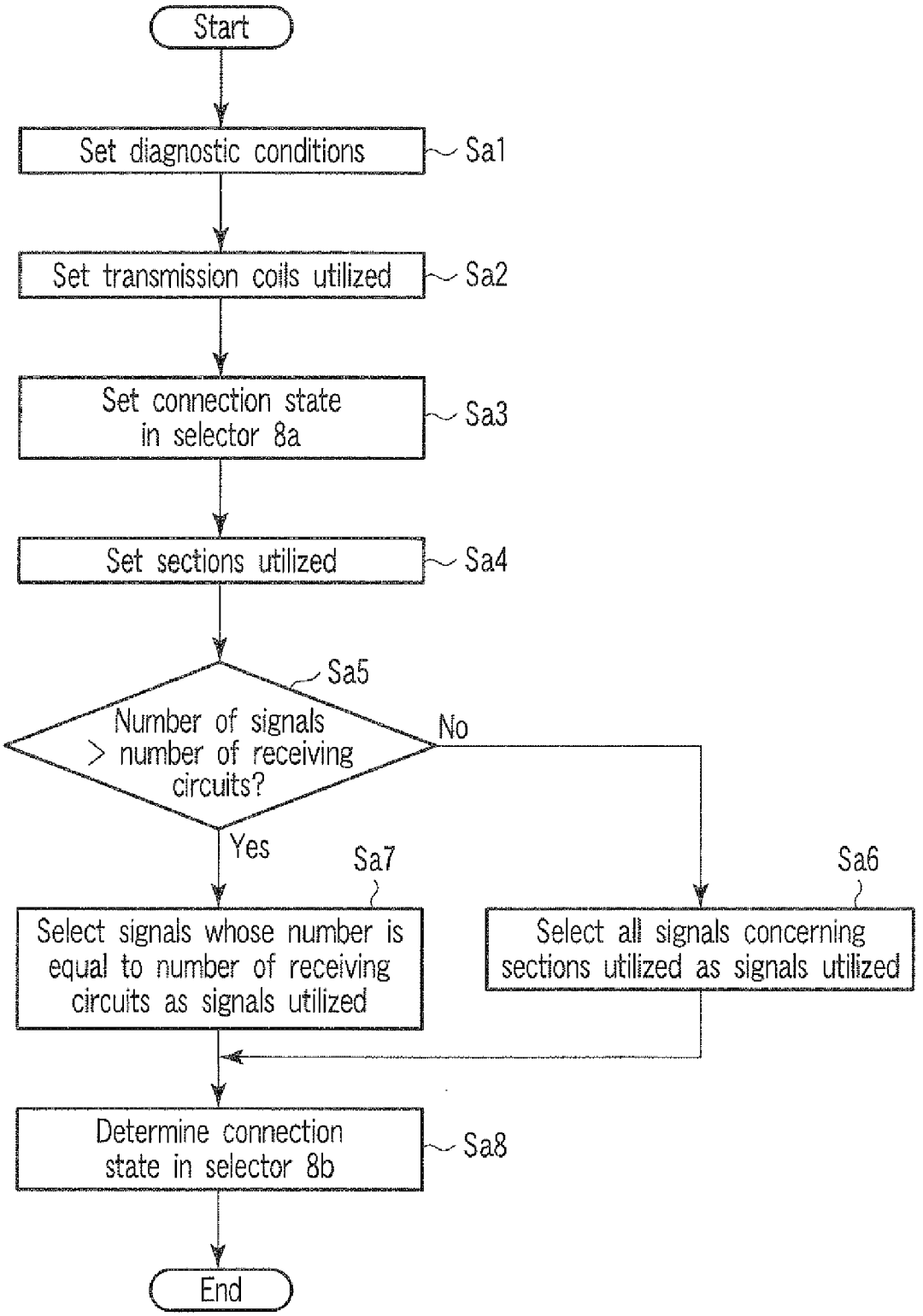

Start
Set diagnostic conditions
Sa1
Set transmission coils utilized
Sa2
Set connection state in selector 8a
Sa3
Set sections utilized
Sa4
Sa5
Number of signals > number of receiving circuits?
No
Yes
Sa7
Sa6
Select signals whose number is equal to number of receiving circuits as signals utilized
Select all signals concerning sections utilized as signals utilized
Determine connection state in selector 8b
Sa8
End

FIG. 6

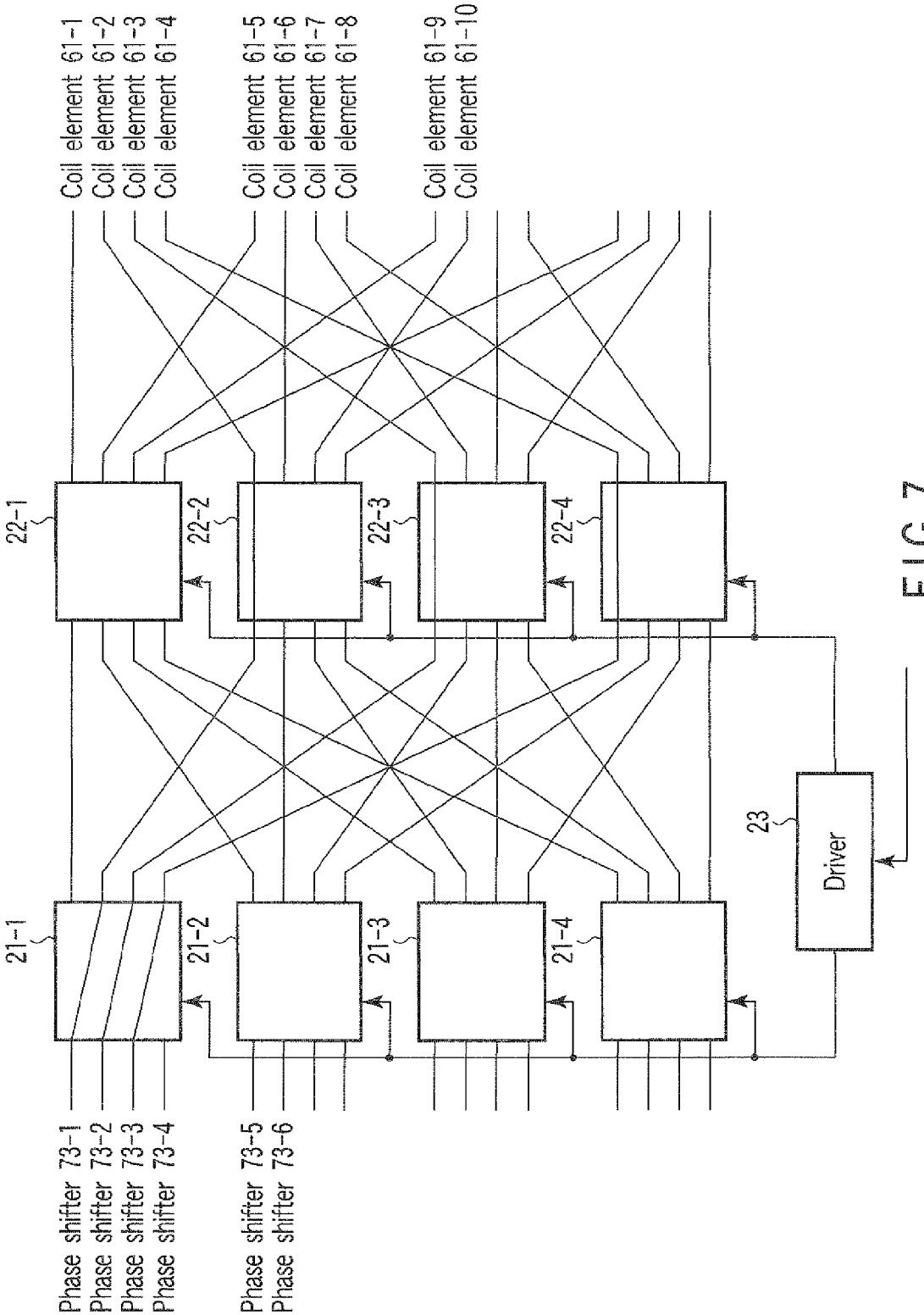

Coil element 61-1
Coil element 61-2
Coil element 61-3
Coil element 61-4
Coil element 61-5
Coil element 61-6
Coil element 61-7
Coil element 61-8
Coil element 61-9
Coil element 61-10
22-1
22-2
22-3
22-4
21-1
21-2
21-3
21-4
23
Driver
Phase shifter 73-1
Phase shifter 73-2
Phase shifter 73-3
Phase shifter 73-4
Phase shifter 73-5
Phase shifter 73-6

FIG. 7

		Section priorities			
		1	2	3	4
Sections utilized	63-1, 63-2	63-1	63-2	-	-
	63-2, 63-3	63-2	63-3	-	-
	63-3, 63-4	63-3	63-4	-	-
	63-1, 63-2, 63-3	63-2	63-1	63-3	-
	63-2, 63-3, 63-4	63-3	63-2	63-4	-
	63-1, 63-2, 63-3, 63-4	63-2	63-3	63-1	63-4

FIG. 8

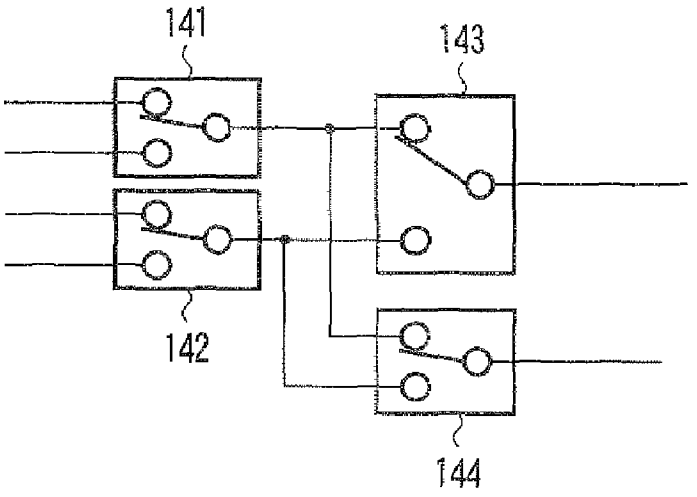


FIG. 14

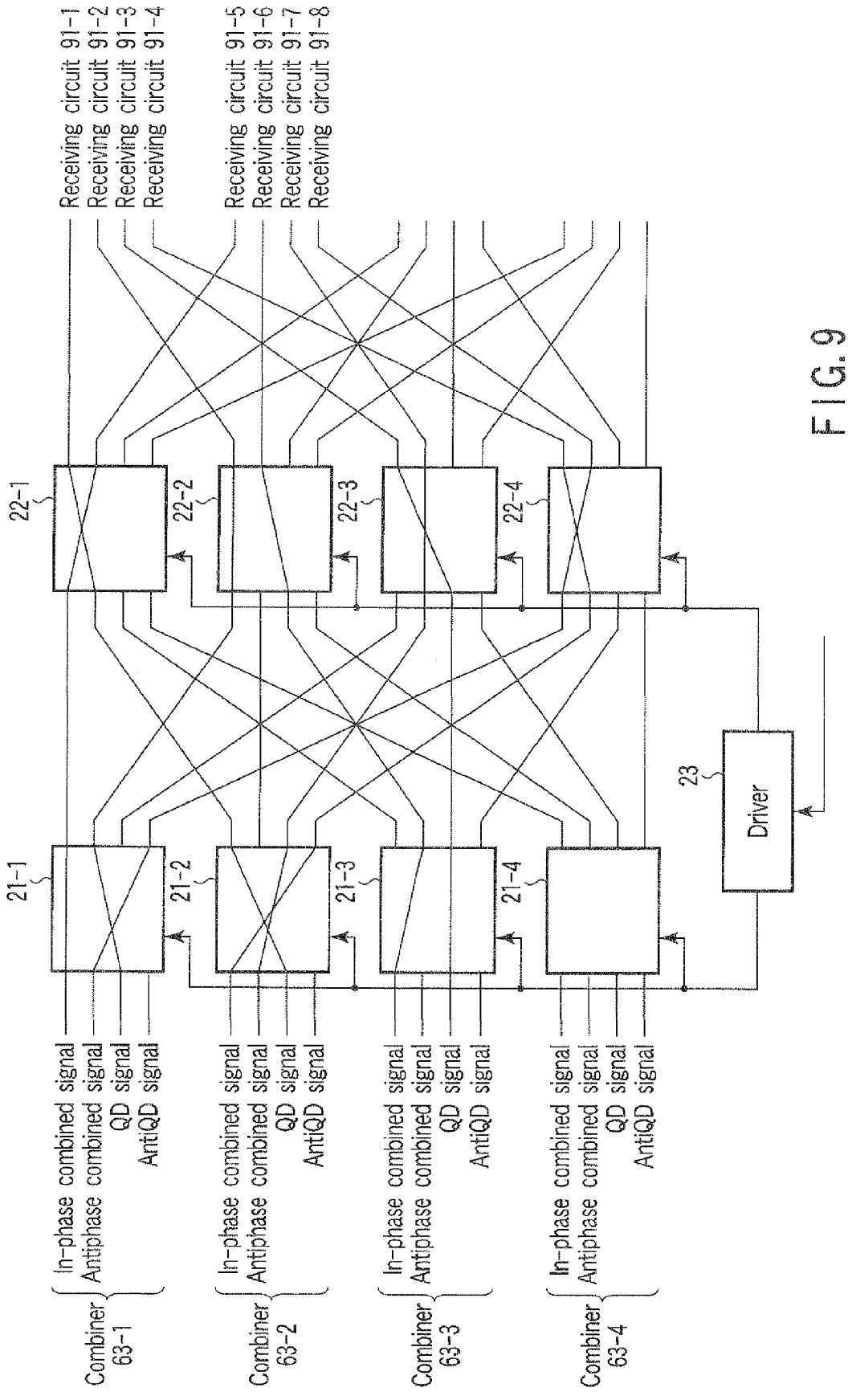

Receiving circuit 91-1
Receiving circuit 91-2
Receiving circuit 91-3
Receiving circuit 91-4
Receiving circuit 91-5
Receiving circuit 91-6
Receiving circuit 91-7
Receiving circuit 91-8
22-1
22-2
22-3
22-4
21-1
21-2
21-3
21-4
23
Driver
In-phase combined signal
Antiphase combined signal
QD signal
AntiQD signal
Combiner 63-1
Combiner 63-2
Combiner 63-3
Combiner 63-4

FIG. 9

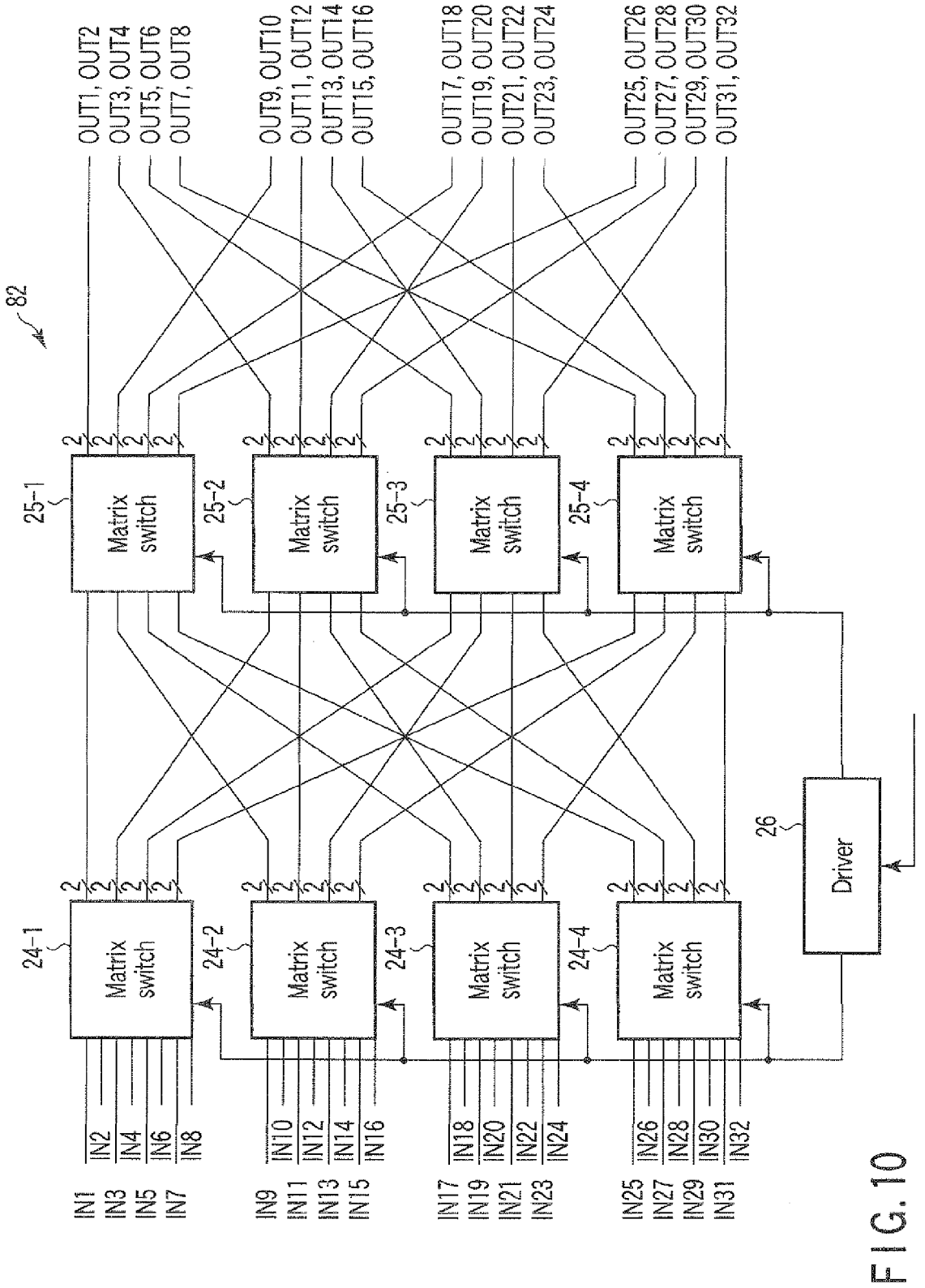

82
OUT1, OUT2
OUT3, OUT4
OUT5, OUT6
OUT7, OUT8
OUT9, OUT10
OUT11, OUT12
OUT13, OUT14
OUT15, OUT16
OUT17, OUT18
OUT19, OUT20
OUT21, OUT22
OUT23, OUT24
OUT25, OUT26
OUT27, OUT28
OUT29, OUT30
OUT31, OUT32
25-1
25-2
25-3
25-4
Matrix switch
24-1
24-2
24-3
24-4
26
Driver
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
IN9
IN10
IN11
IN12
IN13
IN14
IN15
IN16
IN17
IN18
IN19
IN20
IN21
IN22
IN23
IN24
IN25
IN26
IN27
IN28
IN29
IN30
IN31
IN32

FIG. 10

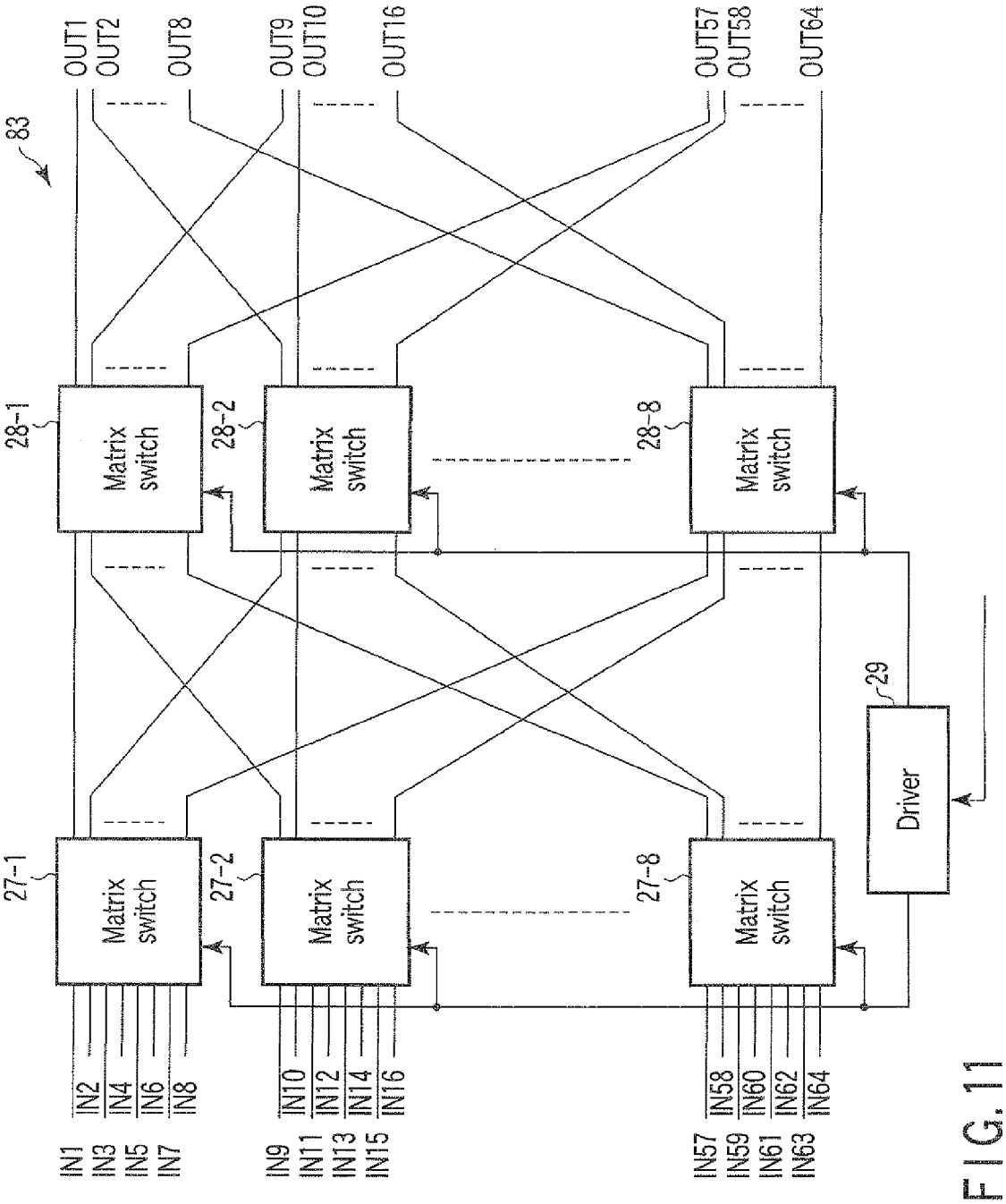

83
OUT1
OUT2
OUT8
OUT9
OUT10
OUT16
OUT57
OUT58
OUT64
28-1
28-2
28-8
Matrix switch
27-1
27-2
27-8
29
Driver
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
IN9
IN10
IN11
IN12
IN13
IN14
IN15
IN16
IN57
IN58
IN59
IN60
IN61
IN62
IN63
IN64

FIG. 11

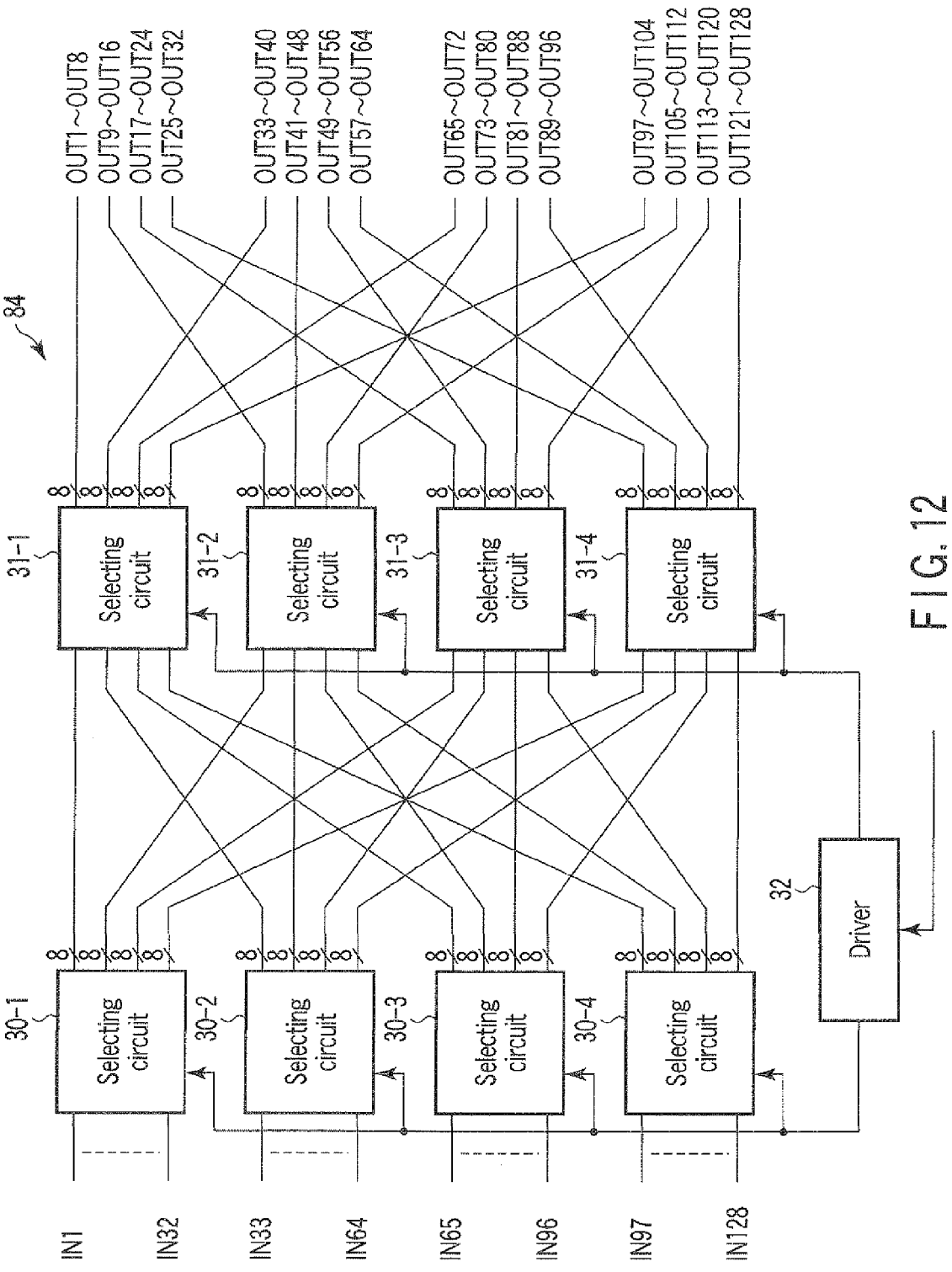

84
OUT1~OUT8
OUT9~OUT16
OUT17~OUT24
OUT25~OUT32
OUT33~OUT40
OUT41~OUT48
OUT49~OUT56
OUT57~OUT64
OUT65~OUT72
OUT73~OUT80
OUT81~OUT88
OUT89~OUT96
OUT97~OUT104
OUT105~OUT112
OUT113~OUT120
OUT121~OUT128
31-1
31-2
31-3
31-4
Selecting circuit
30-1
30-2
30-3
30-4
32
Driver
IN1
IN32
IN33
IN64
IN65
IN96
IN97
IN128

FIG. 12

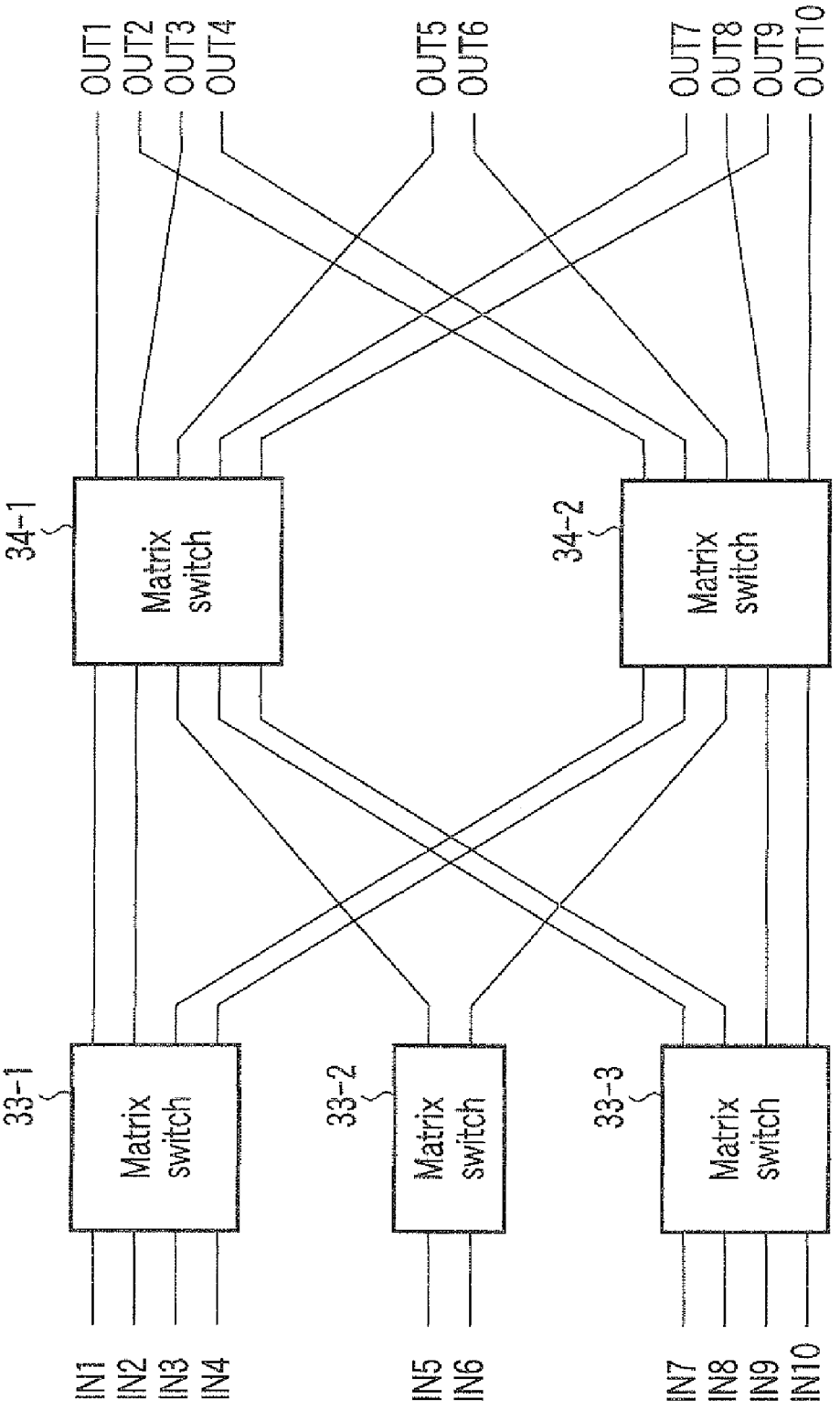

OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
OUT7
OUT8
OUT9
OUT10
34-1
Matrix switch
34-2
Matrix switch
33-1
Matrix switch
33-2
Matrix switch
33-3
Matrix switch
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
IN9
IN10

FIG. 13

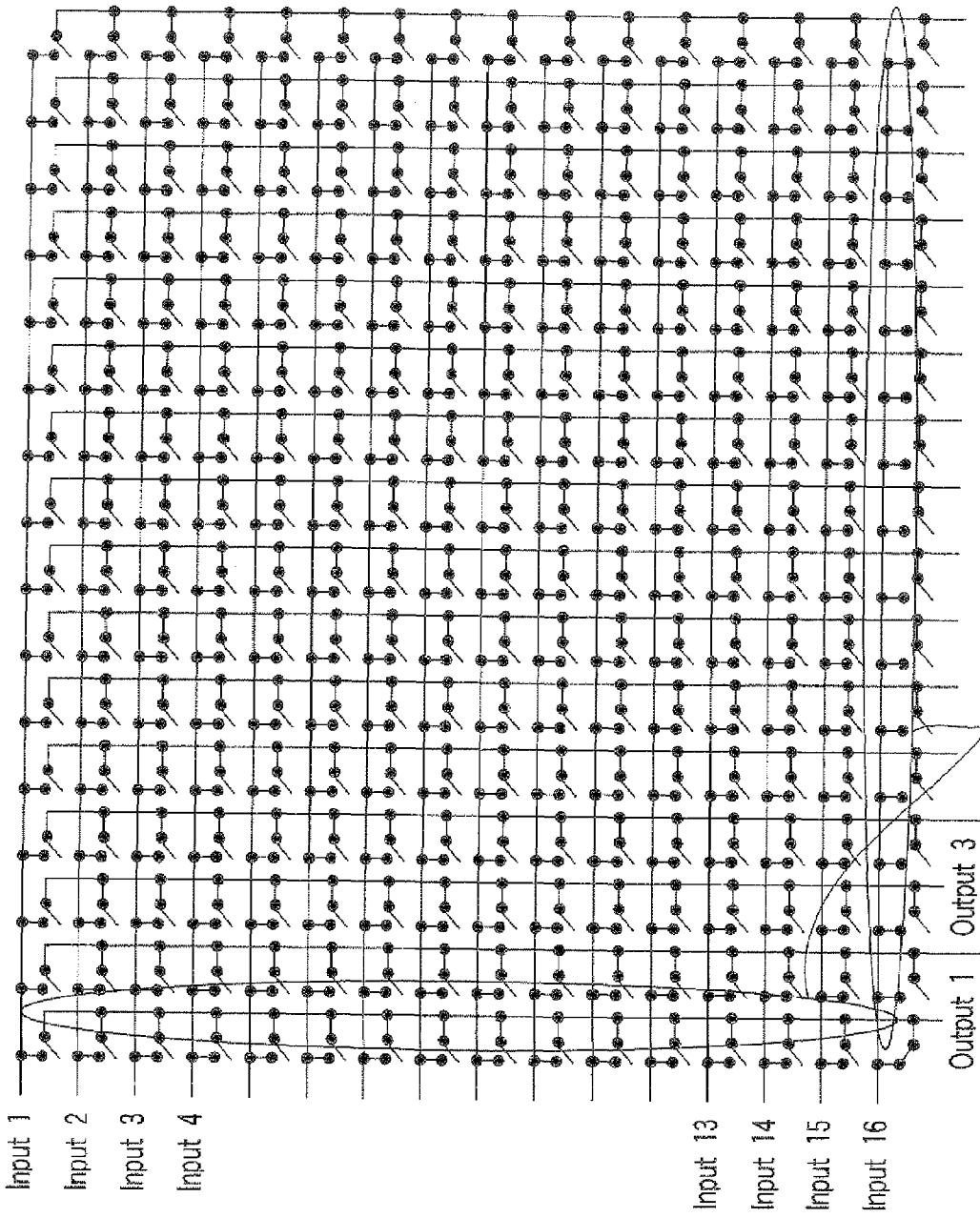

Input 1
Input 2
Input 3
Input 4
Input 13
Input 14
Input 15
Input 16
Output 1
Output 2
Output 3
Output 4
Stab
Input 16 → Output 1

FIG. 15

MAGNETIC RESONANCE IMAGING APPARATUS AND MAGNETIC RESONANCE IMAGING METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from prior Japanese Patent Applications No. 2007-058901, filed Mar. 8, 2007; and No. 2008-033422, filed Feb. 14, 2008, the entire contents of both of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a magnetic resonance imaging apparatus and magnetic resonance imaging method that uses a plurality of element coils to transmit an RF (radio frequency) pulse or receive a magnetic resonance signal.

2. Description of the Related Art

A magnetic resonance imaging apparatus in recent years can utilize various kinds of radio-frequency coils meeting the purposes. As such radio-frequency coils, there is one in which a plurality of element coils are arranged. Further, a plurality of types of radio-frequency coils may be simultaneously disposed in some cases.

Thus, in the magnetic resonance imaging apparatus, a plurality of element coils arranged in a radio-frequency coil or a plurality of types of radio-frequency coils can be connected in parallel, and the number of these coils is increasing.

On the other hand, all element coils connected in parallel in this manner are not simultaneously used. Therefore, the number of receiving circuits that receive magnetic resonance signals through element coils or the number of transmitting circuits that transmit RF pulses is smaller than the number of connectable element coils.

In such a case, element coils which should be used must be selectively connected with the receiving circuit or the transmitting circuit. However, the number of combinations of connection states is large, and hence a selecting circuit becomes very complicated. As the selecting circuit, a transfer type switch or a matrix switch is typically applied.

FIG. **14** is a view showing a structural example of a transfer type switch. In this example, four two-input/one-output selectors **141**, **142**, **143**, and **144** constitute a four-input/two-output signal selecting circuit.

FIG. **15** is a view showing a structure of a 16-input/16-output matrix switch.

In the transfer type switch, a degree of flexibility in selection is small, and realization of multichannel is difficult.

In the matrix switch, a degree of flexibility in selection is higher than that in the transfer type, and realization of multichannel is relatively easy. However, in a multichannel type matrix switch, such an unconnected line called a stab as shown in FIG. **15** becomes long depending on a signal selection state. In case of a radio-frequency signal like a magnetic resonance signal, the signal may be degraded when a stab becomes long. Further, when the stab is long at the time of selecting an RF transmission signal, unnecessary radiation may be disadvantageously increased.

It is to be noted that, as a related technology, a technology disclosed in, e.g., JP-A 2001-46356 (KOKAI) is known.

BRIEF SUMMARY OF THE INVENTION

Under the circumstances, there has been demanded freely enabling multichannel signal selection while shortening a stab as much as possible to suppress degradation in a radio-frequency signal or unnecessary radiation.

According to a first aspect of the present invention, there is provided a magnetic resonance imaging apparatus comprising: a applying unit which applies a gradient magnetic field and a radio-frequency pulse to a subject placed in a static magnetic field; a radio-frequency coil unit which includes a plurality of element coils to respectively detect magnetic resonance signals emitted from the subject in accordance with the application of the gradient magnetic field and the radio-frequency pulse, and outputs signals of a plurality of channels based on the plurality of magnetic resonance signals detected by the plurality of element coils; a plurality of receiving circuits each of which receives one of the signals of the plurality of channels, and whose number is smaller than the plurality of channels; a selecting circuit which includes a plurality of matrix switches connected in multiple stages, selects some of magnetic resonance signals from the signals of the plurality of channels, and inputs the selected magnetic resonance signals to the plurality of receiving circuits; a setting unit which sets diagnostic conditions; and a determining unit which determines a connection state of the plurality of matrix switches in accordance with the set diagnostic conditions.

According to a second aspect of the present invention, there is provided a magnetic resonance imaging apparatus comprising: a transmission coil having a plurality of element coils; transmitting circuits which transmit a radio-frequency pulse applied to a subject placed in a static magnetic field through the element coils, and whose number is smaller than the plurality of element coils; a selecting circuit which includes a plurality of matrix switches connected in multiple stages, selects some of the plurality of element coils, and connects the selected element coils with the plurality of transmitters; a determining unit determines a connection state of the plurality of matrix switches in accordance with a size of the subject; and a receiving coil which detects an electromagnetic field emitted from the subject in accordance with the application of a radio-frequency magnetic field produced form the element coils in a state where a gradient magnetic field is applied in accordance with the radio-frequency pulse input based on the connection state.

According to a third aspect of the present invention, there is provided a magnetic resonance method for use in a magnetic resonance imaging apparatus comprising: a high-frequency coil unit including a plurality of element coils; and selecting circuit which includes a plurality of matrix switches connected in multiple stages, the method comprising: setting an imaging condition; determining a connection state of the matrix switches in accordance with the set imaging condition; applying a gradient magnetic field and a radio-frequency pulse to a subject placed in a static magnetic field; detecting magnetic resonance signals emitted from the subject in accordance with the application of the gradient magnetic field and the radio-frequency pulse, at each of the element coils; acquiring signals of a plurality of channels based on the magnetic resonance signals detected by the element coils; selecting part of the signals of the plurality of channels by means of the selecting circuit whose connection state of the matrix switches is the determined connection state; and receiving and processing signals selected by the selecting circuit.

According to a fourth aspect of the present invention, there is provided a magnetic resonance imaging method for use in a magnetic resonance imaging apparatus comprising: a transmission coil having a plurality of element coils; and a selection circuit including a plurality of matrix switches connected

in multiple stages, the method comprising: determining a connection state of the matrix switches in accordance with size of a subject; selecting part of the element coils by means of the selecting circuit whose connection state of the matrix switches is the determined connection state; transmitting radio-frequency pulses to be applied to the subject placed in a static magnetic field through the element coils, by supplying selected ones of the element coils with radio-frequency pulses which are smaller in number than the element coils; and detecting an electromagnetic field emitted from the subject in accordance with the application of a radio-frequency magnetic field produced form the selected ones of the element coils in a state where a gradient magnetic field is applied.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

FIG. **1** is a view showing a structure of a magnetic resonance imaging apparatus according to an embodiment of the present invention;

FIG. **2** is a view showing a structure of a signal selecting circuit according to a first embodiment which can be utilized as selectors depicted in FIG. **1**;

FIG. **3** is a view showing an example of a connection state of an RF coil unit and a transmitter to the selector in FIG. **1**;

FIG. **4** is a view showing an example of a connection state of an RF coil unit and a receiver to the selector in FIG. **1**;

FIG. **5** is a view showing an example of an arrangement of coil sections and element coils in the RF coil unit in FIG. **1**;

FIG. **6** is a flowchart showing a processing procedure of a main controller concerning control over the selectors in FIG. **1**;

FIG. **7** is a view showing an example of a connection state in the selector;

FIG. **8** is a view showing an example of section priorities;

FIG. **9** is a view showing an example of a connection state in the selector;

FIG. **10** is a view showing a structure of a signal selecting circuit according to a second embodiment which can be utilized as the selectors in FIG. **1**;

FIG. **11** is a view showing a structure of a signal selecting circuit according to a third embodiment which can be utilized as the selectors in FIG. **1**;

FIG. **12** is a view showing a structure of a signal selecting circuit according to a fourth embodiment which can be utilized as the selectors in FIG. **1**;

FIG. **13** is a view showing a structural example of a modification of the present invention;

FIG. **14** is a view showing a structural example of a transfer type switch; and

FIG. **15** is a view showing a structure of a 16-input/16-output matrix switch.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, embodiments according to the present invention will be described with reference to drawings.

FIG. **1** is a diagram illustrating a configuration of a magnetic resonance imaging apparatus **100** related to the present embodiment. The magnetic resonance imaging apparatus **100** shown in FIG. **1** comprises a static field magnet **1**, a gradient coil unit **2**, a gradient power supply **3**, a bed **4**, a bed controller **5**, RE coil units **6***a*, **6***b*, **6***c* and **6***d*, a transmitter **7**, a selector **8***b*, a receiver **9** and a computer system **10**.

The static field magnet **1** is a hollow cylindrical member, which generates a uniform static magnetic field inside the hollow space. For instance, a permanent magnet or a superconducting magnet is used as the static field magnet **1**.

The gradient coil unit **2** is also a hollow cylindrical member located inside the static field magnet **1**. The gradient coil unit **2** is formed by a combination or three coils corresponding to three axes X, Y and Z which are perpendicular to each other. In the gradient coil unit **2**, the three coils are individually supplied with a current from the gradient power supply **3**, thereby generating gradient magnetic fields having their magnetic field intensities varied along the X, Y and Z axes. Assume here that the Z-axis corresponds to, for example, the magnetization direction of the static magnetic field. The gradient magnetic fields along the X, Y and Z axes correspond to, for example, a slice-selecting gradient magnetic field Gs, a phase-encoding gradient magnetic field Ge and a readout gradient magnetic field Gr, respectively. The slice-selecting gradient magnetic field Gs is used to determine an arbitrary imaging section. The phase-encoding gradient magnetic field Ge is used to change the phase of a magnetic resonance signal in accordance with its spatial position. The readout gradient magnetic field Gr is used to change the frequency of a magnetic resonance signal in accordance with its spatial position.

A subject **200** placed on a top board **4***a* of the bed **4** is inserted into the cavity (imaging space) of the gradient coil unit **2**. The bed **4** is driven by the bed controller **5** to move the top board **4***a* longitudinally (horizontally in FIG. **1**) and vertically. Normally, the bed **4** is positioned, with its longitudinal axis being set parallel to the central axis of the static field magnet **1**.

The RF coil unit **6***a* is made by arranging one or a plurality of element coils in a cylindrical case. The RF coil unit **6***a* is located inside the gradient coil unit **2**, and is used to generate a radio-frequency magnetic field upon receiving a radio-frequency pulse (an RF pulse) from the transmitter **7**.

The RF coil units **6***b*, **6***c* and **6***d* are mounted on the top board **4***a*, built in the top board **4***a*, or attached to the subject **200**. When imaging is performed, the RF coil units **6***b*, **6***c* and **6***d* are inserted together with the subject **200** into the imaging space of the gradient coil unit **2**. Array coils are used as the RF coil units **6***b*, **6***c* and **6***d*. In other words, each of the RF coil units **6***b*, **6***c* and **6***d* includes a plurality of element coils. Each of the element coils included in the RF coil unit **6***b* receives an RE pulse from a transmitter **7** to generate a radio-frequency magnetic field. Each of the element coils included in the RF coil units **6***c* and **6***d* receives magnetic resonance signals emitting from the subject **200**. Output signals from the element coils are input to the selector **8***b*, individually. The RF coil units for signal transmission or signal reception are not limited to the RF coil units **6***b*, **6***c* and **6***d*, and various types of RF coil units may be arbitrarily attached. In addition, one or three or more of the RF coil units for signal transmission or signal reception may be attached thereto.

The transmitter **7** outputs an RF pulse corresponding to the Larmor frequency. Furthermore, The transmitter **7** can output in parallel the plurality of RE pulses having different phases thereto, respectively.

A selector **8***a* arbitrarily supplies one RF pulse or the plurality of RF pulses output from the transmitter **7** to the plurality of element coils included in the RF coil unit **6***a* or **6***b*. It is indicated by the computer system **10** that a certain RF pulse is supplied to a certain element coil.

The selector **8***b* selects some signals from a plurality of magnetic resonance signals output from the RF coil units **6***c* and **6***d*. The selector **8***b* supplies the selected magnetic resonance signals to the receiver **9**. The computer system **10** designates which channel to select.

The receiver **9** includes processing systems corresponding to a plurality of channels, and each processing system includes a preamplifier, a phase detection unit and an analog-to-digital converter. Magnetic resonance signals selected by the selector **8***b* are input to these plural-channel processing systems, respectively. The preamplifier amplifies magnetic resonance signals. The phase detection unit detects the phase of the magnetic resonance signals output from the preamplifier. The analog-to-digital converter digitizes the signals output from the phase detection unit. The receiver **9** outputs digital signals produced from each processing system.

The computer system **10** includes an interface **11**, a data collection unit **12**, a reconstruction unit **13**, a memory **14**, a display unit **15**, an input unit **16** and a main controller **17**.

The interface **11** is connected to the gradient power supply **3**, bed controller **5**, transmitter **7**, receiver **9**, selecting circuit **8**, etc. The interface **11** permits signals to be interfaced between each of these connected units and the computer system **10**.

The data collection unit **12** collects digital signals output from the receiver **9**. The data collection unit **12** stores the collected digital signals, i.e., magnetic resonance signal data, in the memory **14**.

The reconstruction unit **13** performs post-processing such as Fourier transform on the magnetic resonance signal data stored in the memory **14**, thereby acquiring spectrum data or image data corresponding to a desired nuclear spin in the subject **200**.

The memory **14** stores the magnetic resonance signal data and spectrum data or image data of each subject.

The display unit **15** displays various information items, such as spectrum data or image data, etc., under the control of the controller **17**. The display unit **15** may be a liquid crystal display, for example.

The input unit **16** receives various instructions or information items input by an operator. The input unit **16** may be a pointing device, such as a mouse or a track ball, a selective device, such as a mode switch, or an input device, such as a keyboard.

The main controller **17** includes a CPU, a memory, etc., and controls the entire magnetic resonance imaging apparatus **100** of the present embodiment.

FIRST EMBODIMENT

FIG. **2** is a view showing a structure of a signal selecting circuit **8***a* according to a first embodiment which can be utilized as a selector **8***a* or a selector **8***b*. Both a maximum number of input signals and a maximum number of output signals of this signal selecting circuit **81** are "16".

The signal selecting circuit **81** includes matrix switches **21-1** to **21-4**, matrix switches **22-1** to **22-4**, and a driver **23**.

All of the matrix switches **21-1** to **21-4** and the matrix switches **22-1** to **22-4** are matrix switches having a known four-input/four-output (4×4) structure.

Signals respectively output from element coils provided in the RF coil units **6***c* and **6***d* are input to a total of 16 input terminals provided to the matrix switches **21-1** to **21-4**. It is to be noted that signals input to the matrix switch **21-1** are referred to as input signals IN**1** to IN**4**, signals input to the matrix switch **21-2** are referred to as input signals IN**5** to IN**8**, signals input to the matrix switch **21-3** are referred to as input signals IN**9** to IN**12**, and signals input to the matrix switch **21-4** are referred to as input signals IN**13** to IN**16** in this example.

Four output terminals of each of the matrix switches **21-1** to **21-4** are connected with input terminals provided to each of the matrix switches **22-1** to **22-4**, respectively. Signals output from first output terminals provided to the matrix switches **22-1** to **22-4** are output from the signal selecting circuit **81** as output signals OUT**1** to OUT**4**, respectively. Signals output from second output terminals provided to the matrix switches **22-1** to **22-4** are output from the signal selecting circuit **81** as output signals OUT**5** to OUT**8**, respectively. Signals output from third output terminals provided to the matrix switches **22-1** to **22-4** are output from the signal selecting circuit **81** as output signals OUT**9** to OUT**12**, respectively. Signals output from fourth output terminals provided to the matrix switches **22-1** to **22-4** are output from the signal selecting circuit **81** as output signals OUT**13** to OUT**16**, respectively.

The driver **23** receives a command from a main controller **17** through an interface unit **11**. The driver **23** drives the matrix switches **21-1** to **21-4** and the matrix switches **22-1** to **22-4** so that appropriate signal selection can be carried out in accordance with this command.

When applying the thus configured signal selecting circuit **81** to the selector **8***b*, up to 16 element coils can be connected with the total of 16 input terminals provided to the matrix switches **21-1** to **21-4**, respectively. It is to be noted that, when the number of the element coils is 15 or below, the input terminals to which these element coils are to be connected can be arbitrarily selected.

On the other hand, a plurality of channel processing systems of a receiver **9** are connected with the output terminals of the matrix switches **22-1** to **22-4**, respectively. Usually, the number of the channels of the processing systems provided to the receiver **9** is smaller than the number of the element coils which can be connected with the selector **8***b*. That is, when using the signal selecting circuit **81**, the number of the channels of the processing systems provided to the receiver **9** is usually 15 or below. In this case, the processing systems whose numbers are close to each other are connected with the matrix channels **22-1** to **22-4**, respectively. For example, when the receiver **9** has eight channel processing systems, two channel processing systems are connected with each of the matrix switches **22-1** to **22-4**. It is to be noted that achieving connection so that output signals having continuous numbers can be input to the receiver **9** enables attaining connection in the above-explained state in this embodiment. Specifically, when connection is achieved so that the output signals OUT**1** to OUT**8** can be input the eight channel processing systems of the receiver **9**, connection in the above-explained state can be attained. When connection is formed so that the output signals OUT**5** to OUT**12** or the output signals OUT**7** to OUT**14** are input to the eight channel processing systems of the receiver **9**, connection can be likewise attained in the above-explained state.

Meanwhile, the driver **23** drives the matrix switches **21-1** to **21-4** so that close number of selected input signals can be

input to each of the matrix switches **22-1** to **22-4**. Further, the driver **23** drives the matrix switches **22-1** to **22-4** so that signals input from the matrix switches **21-1** to **21-4** can be output from the output terminals connected with the processing systems of the receiver **9**. Specifically, when eight input signals are selected, the driver **23** drives the matrix switches **21-1** to **21-4** so that two signals can be input to each of the matrix switches **22-1** to **22-4**. Since two channel processing systems are connected with each of the matrix switches **22-1** to **22-4** in this manner, the driver **23** drives the matrix switches **22-1** to **22-4** so that input two signals are output to these connected processing systems. This can be realized by associating selected input signals with output signals input to the processing systems of the receiver **9** in an ascending order of numbers of these signals, for example.

Specifically, when the input signals IN**1** to IN**8** are selected and the output signals OUT**1** to OUT**8** are input to the processing systems of the receiver **9**, the input signals IN**1** to IN**8** are associated with the output signals OUT**1** to OUT**8**, respectively. Furthermore, the driver **23** controls the matrix switches **21-1**, **21-2**, and **22-1** to **22-4** to achieve the following connection states.

(1) The input signal IN**1** is output as the output signal OUT**1** through the matrix switch **21-1** and the matrix switch **22-1**.

(2) The input signal IN**2** is output as the output signal OUT**2** through the matrix switch **21-1** and the matrix switch **22-2**.

(3) The input signal IN**3** is output as the output signal OUT**3** through the matrix switch **21-1** and the matrix switch **22-3**.

(4) The input signal IN**4** is output as the output signal OUT**4** through the matrix switch **21-1** and the matrix switch **22-4**.

(5) The input signal IN**5** is output as the output signal OUT**5** through the matrix switch **21-2** and the matrix switch **22-1**.

(6) The input signal IN**5** is output as the output signal OUT**6** through the matrix switch **21-1** and the matrix switch **22-2**.

(7) The input signal IN**7** is output as the output signal OUT**7** through the matrix switch **21-2** and the matrix switch **22-3**.

(8) The input signal IN**8** is output as the output signal OUT**8** through the matrix switch **21-2** and the matrix switch **22-4**.

As explained above, since the eight routes are all independent, a desired selection state can be achieved.

That is, the output signal OUT**1** and the output signal OUT**5** are output from the same matrix switch **22-1**, and this matrix switch **22-1** is connected with the matrix switch **21-1** through one signal line alone. Therefore, two of the input signals IN**1** to IN**4** of the matrix switch **21-1** cannot be output as the output signal OUT**1** and the output signal OUT**5**. However, when the output signal OUT**5** is enabled, five or more input signals are selected, and the output signal OUT**5** is associated with any one of the input signals IN**5** to IN**16**. Therefore, two of the input signals IN**1** to IN**4** of the matrix switch **21-1** are not associated with the output signal OUT**1** and the output signal OUT**5**, and a desired selection status can be attained as explained above.

When any input signal is selected, or when any output signal is input to the processing system of the receiver **9**, a desired selection status can be likewise achieved.

On the other hand, when applying the thus configured signal selecting circuit **81** to the selector **8***a*, up to 16 RF signals can be input to a total of 16 input terminals provided to the matrix switches **21-1** to **21-4**. It is to be noted that, when the number of the RF signals output from a transmitter **7** is 15 or below, the input terminals to which these RF signals are to be input can be arbitrarily selected.

A plurality of element coils provided to an RF coil unit **6***a* or an RF coil unit **6***b* are connected with output terminals of the matrix switches **22-1** to **22-4**, respectively. Usually, the number of the RF signals output from the transmitter **7** is smaller than the number of the element coils which can be connected with the selector **8***a*. That is, when using the signal selecting circuit **81**, the number of the RF signals is usually 15 or below. In this case, sets of the RF signals whose numbers are as close to each other as possible are input to the matrix switches **21-1** to **21-1**, respectively. For example, when the number of the RF signals is eight, two RF signals are input to each of the matrix switches **21-1** to **21-4**, respectively.

Meanwhile, the driver **23** drives the matrix switches **21-1** to **21-4** so that sets of the RF signals whose numbers are as close as possible to each other are input to the respective switches **22-1** to **22-4**, and also drives the matrix switches **22-1** to **22-4** so that the signals input from the matrix switches **21-1** to **21-4** can be output to the enabled element coils. It is to be noted that an element coil to be enabled is determined while considering a size of a diagnostic region, a direction of a slice, a sensitivity region of each element coil, a region where RF is excited, and others.

FIG. **3** is a view showing an example of a connection state of the RF coil unit **6***b* and the transmitter **7** with respect to the selector **8***a*. However, the signal selecting circuit **81** is used as the selector **8***a*.

In the example depicted in FIG. **3**, the RF coil unit **6***b* includes 10 element coils **61-1** to **61-10**. These element coils **61-1** to **61-10** are connected with the selector **8***a* so that the output signals OUT**1** to OUT**10** are respectively input.

The transmitter **7** includes a transmission amplifier **71**, a splitter **72**, and six phase shifters **73-1** to **73-6**. The transmission amplifier **71** amplifies an RF pulse. The splitter **72** divides the RF pulse output from the transmission amplifier **71** into six, and provides them to the phase shifters **73-1** to **73-6**, respectively. The phase shifters **73-1** to **73-6** individually change phases of the RF pulses. The phase shifters **73-1** to **73-6** are connected with the selector **8***a* so that their output signals serve as the input signals IN**1** to IN**6**.

FIG. **4** is a view showing an example of a connection state of the RF coil unit **6***d* and the receiver **9** with respect to the selector **8***b*. However, it is determined that the signal selecting circuit **81** is used as the selector **8***b*.

In the example in FIG. **4**, the receiver **9** includes eight receiving circuits **91-1** to **91-8**. These receiving circuits **91-1** to **91-8** are connected with the selector **8***b* so that the output signals OUT**1** to OUT**5** are respectively input.

The RF coil unit **6***d* includes four coil sections **62-1** to **62-4** and four combiners **63-1** to **63-4**.

Each of the coil sections **62-1** to **62-4** includes four element coils **62***a*, **62***b*, **62***c*, and **62***d*. The element coils **62***a*, **62***b*, **62***c*, and **62***d* are linearly aligned so that coils adjacent to each other partially overlap each other. As shown in FIG. **5**, the coil sections **61-1** to **62-4** are aligned to cross the alignment axis of the element coils **62***a*, **62***b*, **62***c*, and **62***d*. Neighboring ones of the coil sections **62-1** to **62-4** partially overlap each other.

This RF coil unit **6***d* is generally used in a state where the alignment axis of the element coils **62***a*, **62***b*, **62***c*, and **62***d* substantially matches the X-axis and the alignment axis of the coil sections **62-1** to **62-4** substantially matches the longitudinal axis of a top board **41**, i.e., the body axis (Z-axis) of a subject P.

Each of the combiners **63-1** to **63-4** includes 180-degree distributing/combining circuits **63***a* and **63***b* and a 90-degree distributing/combining circuit **63***c*.

Signals output from the element coils **62***a* and **62***d* are input to the 180-degree distributing/combining circuit **63***a*. The 180-degree distributing/combining circuit **63***a* combines these signals in phase or antiphase. The 180-degree distributing/combining circuit **63***a* outputs a signal obtained as a result of combination in phase to the 90-degree distributing/combining circuit **63***c*. The 180-degree distributing/combining circuit **63***a* outputs a signal obtained as a result of combination in antiphase as an antiphase combined signal.

Signals output from the element coils **62***b* and **62***c* are respectively input to the 180-degree distributing/combining circuit **63***b*. The 180-degree distributing/combining circuit **63***b* combines these signal in phase and antiphase. The 180-degree distributing/combining circuit **63***a* outputs a signal obtained as a result of combination in phase as an in-phase combined signal. The 180-degree distributing/combining circuit **63***a* outputs a signal obtained as a result of combination in antiphase to the 90-degree distributing/combining circuit **63***c*.

The 90-degree distributing/combining circuit **63***c* shifts a phase of the signal supplied from the 180-degree distributing/combining circuit **63***a* 90 degrees, and combines this signal to the signal supplied from the 180-degree distributing/combining circuit **63***b*. The 90-degree distributing/combining circuit **63***c* outputs a signal obtained as a result of this combination as a QD signal. Moreover, the 90-degree distributing/combining circuit **63***c* outputs a signal which is in antiphase with the QD signal as an AntiQD signal.

The RF coil unit **6***d* is connected with the selector **8***b* in such a manner that the in-phase combined signal, the antiphase combined signal, the QD signal, and the AntiQD signal output from the combiner **63-1** serve as the input signals IN**1** to IN**4**, the in-phase combined signal, the antiphase combined signal, the QD signal, and the AntiQD signal output from the combiner **63-2** serve as the input signals IN**5** to IN**8**, the in-phase combined signal, the antiphase combined signal, the QD signal, and the AntiQD signal output from the combiner **63-3** serve as the input signals IN**9** to IN**12**, and the in-phase combined signal, the antiphase combined signal, the QD signal, and the AntiQD signal output from the combiner **63-4** serve as the input signals IN**13** to IN**16**.

FIG. **6** is a flowchart showing a processing procedure of the main controller **17** concerning control over the selectors **8***a* and **8***b*.

In step Sa**1**, the main controller **17** sets diagnostic conditions in accordance with a command from an operator input at an input unit **16**.

In step Sa**2**, the main controller **17** sets some of the element coils **61-1** to **61-10** as transmission coils utilized in accordance with the set diagnostic conditions. This setting is automatically carried out as well known while considering an FOV (field of view), a slice position, a size of a subject, and others in the set diagnostic conditions. It is to be noted that the size of the subject **200** can be calculated based on image data obtained by imaging the entire subject **200**. The number of the transmission coils utilized is determined as the number of the phase shifter **73-1** to **73-6** or below. It is to be noted that selecting the minimum necessary number of element coils as the transmission coils utilized is preferable in order to reduce a magnetic resonance signal which becomes noise for image reconstruction, and the number of the transmission coils utilized is generally small.

In step Sa**3**, the main controller **17** determines a connection state in the selector **8***a* in such a manner that the RF signals output from the phase shifters, whose number is equal to that of the transmission coils utilized, in the phase shifters **73-1** to **73-6** are respectively input to the element coils selected as the transmission coils utilized. Further, the main controller **17** informs the selector **8***a* of this determined connection state.

FIG. **7** is a view showing an example of a connection state in the selector **8***a* when the element coils **61-2**, **61-3**, and **61-4** are set as the transmission coils utilized. The connection states are as follows.

(1) The RF pulse output from the phase shifter **73-1** is supplied to the element coil **61-1** through the matrix switch **21-1** and the matrix switch **22-2**.

(2) The RF pulse output from the phase shifter **73-2** is supplied to the element coil **61-2** through the matrix switch **21-1** and the matrix switch **22-3**.

(3) The RF pulse output from the phase shifter **73-3** is supplied to the element coil **61-1** through the matrix switch **21-1** and the matrix switch **22-3**.

In step Sa**4**, the main controller **17** sets one or some of the coil sections **62-1** to **62-4** as sections utilized. This setting may be performed in accordance with a command from an operator input at the input unit **16** or may be automatically carried out in accordance with the diagnostic conditions set in the step Sa**1**.

In step Sa**5**, the main controller **17** confirms whether the number of signals obtained in relation to the sections utilized is larger than the number of the receiving circuits **91-1** to **91-8**. If the number of signals is equal to or smaller than the number of the receiving circuits here, the main controller **17** advances to a step Sa**6** from the step Sa**5**. In the step Sa**6**, the main controller **17** selects all signals concerning the sections utilized as signals utilized. However, when the number of signals is larger than the number of the receiving circuits, the main controller **17** advances to a step Sa**7** from the step Sa**5**. In the step Sa**7**, the main controller **17** selects signals, whose number is equal to the number of the receiving circuits, from all the signals concerning the sections utilized as signals utilized. The signals utilized are selected based on, e.g., priorities determined in advance. For example, in case of parallel imaging, a priority sequence of the respective signals is the QD signal, the in-phase combined signal, the antiphase combined signal, and the AntiQD signal. Furthermore, when all of the same type of signals cannot be selected, a reference is made to section priorities determined as shown in FIG. **8**.

Specifically, if the coil sections **62-1**, **62-2**, and **62-3** are set as the sections utilized, a total number of the QD signals and the in-phase combined signals concerning these coil sections is six. Therefore, all of these signals can be selected as the signals utilized. However, since the number of the receiving circuits is eight, all of the three antiphase combined signals cannot be selected as the signals utilized. Thus, based on the selection priorities shown in FIG. **8**, the antiphase combined signals concerning the coil section **62-2** having a priority "1" and the coil section **63-1** having a priority "2" are selected as the signals utilized.

Upon completing selection of the signals utilized in the step Sa**6** or the step Sa**7**, the main controller **17** advances to a step Sa**8**. In the step Sa**8**, the main controller **17** determines a connection state in the selector **8***b* in such a manner that the respective signals selected as the signals utilized are input to the receiving circuits whose number is equal to the number of these signals. Furthermore, the main controller **17** informs the selector **8***b* of this determined connection state.

FIG. **9** is a view showing an example of a connection state in the selector **8***b* in the above specific example. The connection state is as follows.

(1) The QD signal output from the combiner **63-2** is input to the receiving circuit **91-1** through the matrix switch **21-2** and the matrix switch **22-1**.

(2) The QD signal output from the combiner **63-1** is input to the receiving circuit **91-2** through the matrix switch **21-1** and the matrix switch **22-2**.

(3) The QD signal output from the combiner **63-3** is input to the receiving circuit **91-3** through the matrix switch **21-3** and the matrix switch **22-3**.

(4) The in-phase combined signal output from the combiner **63-2** is input to the receiving circuit **91-4** through the matrix switch **21-2** and the matrix switch **22-4**.

(5) The in-phase combined signal output from the combiner **63-1** is input to the receiving circuit **91-5** through the matrix switch **21-1** and the matrix switch **22-2**.

(6) The in-phase combined signal output from the combiner **63-3** is input to the receiving circuit **91-6** through the matrix switch **21-3** and the matrix switch **22-2**.

(7) The antiphase combined signal output from the combiner **63-2** is input to the receiving circuit **91-7** through the matrix switch **21-2** and the matrix switch **22-3**.

(8) The antiphase combined signal output from the combiner **63-1** is input to the receiving circuit **91-8** through the matrix switch **21-1** and the matrix switch **22-4**.

As explained above, according to the signal selecting circuit **81**, arbitrary signals can be selected from the 16 input signals IN**1** to IN**16** and output as output signals which are input to the processing systems of the receiver **9**. Furthermore, although this signal selecting circuit **81** has a 16×16 structure, all of the matrix switches **21-1** to **21-4** and **22-1** to **22-4** may have a 4×4 structure. As a result, a stab can be reduced as compared with a 16×16 matrix switch, and a radio-frequency magnetic resonance signal can be excellently transmitted, or an RF signal can be transmitted while suppressing unnecessary radiation.

SECOND EMBODIMENT

FIG. **10** is a view showing a structure of a signal selecting circuit **82** according to a second embodiment which can be utilized as a selector **8***a* or a selector **8***b*. Both a maximum number of input signals and a maximum number of output signals of this signal selecting circuit **82** are "32".

The signal selecting circuit **82** includes matrix switches **24-1** to **24-4**, matrix switches **25-1** to **25-4**, and a driver **26**.

Each of the matrix switches **24-1** to **24-1** and the matrix switches **25-1** to **25-4** is a matrix switch having a known 8×8 structure.

Signals output from respective element coils provided in the RE coil units **6***c* and **6***d* are input to a total of 32 input terminals provided to the matrix switches **24-1** to **24-4**. It is to be noted that signals input to the matrix switch **24-1** are referred to as input signals IN**1** to IN**8**, signals input to the matrix switch **24-1** are referred to as IN**9** to IN**16**, signals input to the matrix switch **24-3** are referred to as IN**17** to IN**24**, and signals input to the matrix switch **24-4** are referred to as IN**25** to IN**32**.

In regard to eight output terminals of each of the matrix switches **24-1** to **24-4**, every two output terminals are connected with input terminals provided to each of the matrix switches **25-1** to **25-4**. Signals output from first and second output terminals respectively provided to the matrix switches **25-1** to **25-4** are output from the signal selecting circuit **82** as output signals OUT**1** to OUT**8**. Signals output from third and fourth output terminals respectively provided to the matrix switches **25-1** to **25-4** are output from the signal selecting circuit **82** as output signals OUT**9** to OUT**16**. Signals output from fifth and sixth output terminals respectively provided to the matrix switches **25-1** to **25-4** are output from the signal selecting circuit **82** as OUT**17** to OU**24**. Signals output from seventh and eighth output terminals respectively provided to the matrix switches **25-1** to **25-4** are output from the signal selecting circuit **82** as output signals OUT**25** to OUT**32**.

The driver **26** receives a command from a main controller **17** through an interface unit **11**. The driver **26** drives the matrix switches **24-1** to **24-4** and the matrix switches **25-1** to **25-4** so that appropriate signals can be selected in accordance with this command.

In the signal selecting circuit **82** having such a structure, when the driver **26** drives the matrix switches **24-1** to **24-4** and the matrix switches **25-1** to **25-4** under the same conditions as those in the first embodiment based on the same rule as that in the first embodiment, arbitrary signals can be likewise selected from the 32 input signals IN**1** to IN**32** and output as output signals which are input to processing systems of a receiver **9**. Moreover, although this signal selecting circuit **82** has a 32×32 structure, each of the matrix switches **24-1** to **24-4** and **25-1** to **25-4** can have an 8×8 structure. As a result, a stab can be reduced as compared with the matrix switch having a 32×32 structure, and a radio-frequency magnetic resonance signal can be excellently transmitted, or an RF signal can be transmitted while suppressing unnecessary radiation.

THIRD EMBODIMENT

FIG. **11** is a view showing a structure of a signal selecting circuit **83** according to a third embodiment which can be utilized as a selector **8***a* or a selector **8***b*. Both a maximum number of input signals and a maximum number of output signals of this signal selecting circuit **83** are "64".

The signal selecting circuit **83** includes matrix switches **27-1** to **27-8**, matrix switches **28-1** to **28-8**, and a driver **29**.

Each of the matrix switches **27-1** to **27-8** and the matrix switches **28-1** to **28**-B is a matrix switch having a known 8×8 structure.

Signals IN**1** to IN**64** output from element coils provided to RF coil units **6***c* and **6***d* are input to a total of 64 input terminals provided to the matrix switches **27-1** to **27-8**, respectively.

Eight output terminals of each of the matrix switches **27-1** to **27-8** are connected with input terminals provided to each of the matrix switches **28-1** to **28-8**, respectively. Signals output from first output terminals provided to the matrix switches **28-1** to **28-8** are output from the signal selecting circuit **83** as output signals OUT**1** to OUT**8**, respectively. Signals output from second output terminals provided to the matrix switches **28-1** to **28-8** are output from the signal selecting circuit **83** as output signals OUT**9** to OUT**16**, respectively. Likewise, signals output from third to eighth output terminals provided to the matrix switches **28-1** to **28-8** are output from the signal selecting circuit **83** as output signals OUT**17** to OUT**24**, output signals OUT**25** to OUT**32**, output signals OUT**33** to OUT**40**, output signals OUT**41** to OUT**48**, output signals OUT**49** to OUT**56**, and output signals OUT**57** to OUT**64**, respectively.

The driver **29** receives a command from a main controller **17** through an interface unit **11**. The driver **29** drives the matrix switches **27-1** to **27-8** and the matrix switches **28-1** to **28-8** so that appropriate signals can be selected in accordance with this command.

Even in the signal selecting circuit **83** having such a structure, when the driver **29** drives the matrix switches **27-1** to **27-8** and the matrix switches **28-1** to **28-8** under the same

conditions as those in the first embodiment based on the same rule as that in the first embodiment, arbitrary signals can be selected from the 64 input signals IN**1** to IN**64** and output as output signals which are input to processing systems of a receiver **9**. Additionally, although this signal selecting circuit **83** has a 64×64 structure, each of the matrix switches **27-1** to **27-8** and **28-1** to **28-8** can have an 8×8 structure. As a result, a stab can be reduced as compared with a matrix switch having a 64×64 structure, and a radio-frequency magnetic resonance signal can be excellently transmitted, or an RF signal can be transmitted while suppressing unnecessary radiation.

FOURTH EMBODIMENT

FIG. **12** is a view showing a structure of a signal selecting circuit **84** according to a fourth embodiment which can be utilized as a selector **8***a* or a selector **8***b*. Both a maximum number of input signals and a maximum number of output signals of this signal selecting circuit **84** are "128".

The signal selecting circuit **84** includes selecting circuits **30-1** to **30-4**, selecting circuits **31-1** to **31-4**, and a driver **32**.

As each of the selecting circuits **30-1** to **30-4** and the selecting circuits **31-1** to **31-4**, the signal selecting circuit **82** according to the second embodiment is used.

Signals IN**1** to IN**128** output from element coils provided to RF coil units **6***c* and **6***d* are input to a total of 128 input terminals provided to the selecting circuits **30-1** to **30-4**, respectively.

In regard to 32 output terminals of each of the selecting circuits **30-1** to **30-4**, every eight output terminals are connected with each input terminal provided to the selecting circuits **31-1** to **31-4**. Signals output from first to eighth output terminals provided to the selecting circuits **31-1** to **31-4** are output from the signal selecting circuit **84** as output signals OUT**1** to OUT**32**, respectively. Signals output from ninth to 16th output terminals provided to the selecting circuits **31-1** to **31-4** are output from the signal selecting circuit **84** as output signals OUT**33** to OUT**64**, respectively. Signals output from 17th to 24th output terminals provided to the selecting circuits **31-1** to **31-4** are output from the signal selecting circuit **84** as output signals OUT**65** to OUT**96**, respectively. Signals output from 24th to 32nd output terminals provided to the selecting circuits **31-1** to **31-4** are output from the signal selecting circuit **84** as output signals OUT**97** to OUT**128**, respectively.

The driver **32** receives a command from a main controller **17** through an interface unit **11**. The driver **32** drives the selecting circuits **30-1** to **30-4** and the selecting circuits **31-1** to **31-4** so that appropriate signals can be selected in accordance with this command.

Even in the signal selecting circuit **84** having such a structure, when the driver **32** drives the selecting circuits **30-1** to **30-4** and the selecting circuits **31-1** to **31-4** under the same conditions as those in the first embodiment based on the same rule as that in the first embodiment, arbitrary signals can be selected from the 128 input signals IN**1** to IN**128** and output as output signals which are input to processing systems of a receiver **9**. Further, although this signal selecting circuit **84** has a 128×128 structure, each of the matrix switches provided to the selecting circuits **30-1** to **30-4** and **31-1** to **31-4** can have an 8×8 structure. As a result, a stab can be reduced as compared with a matrix switch having a 128×128 structure, and a radio-frequency magnetic resonance signal can be excellently transmitted, or an RF signal can be transmitted while suppressing unnecessary radiation.

This embodiment can be modified in many ways as follows.

The number of the matrix switches on each of the front stage side and the rear stage side, the number of inputs and the number of outputs of each matrix switch on the front stage side, and the number of inputs and the number of outputs of each matrix switch on the rear stage side can be arbitrarily set as long as conditions of the present invention are satisfied. It is to be noted that each of the above-explained values can be set with a necessary maximum number of output signals being determined as a reference in the signal selecting circuit used as the selector **8***a*, and each of the above-explained numbers can be set with a necessary maximum number of input signals being determined as a reference in the signal selecting circuit used as the selector **8***b*.

As shown in FIG. **13**, both matrix switches **33-1** and **33-3** and a matrix switch **33-2** of different scales may be present as matrix switches on a front stage side. Likewise, a matrix switch of a different scale may be present as a matrix switch on a rear stages side. Furthermore, as shown in FIG. **13**, the scales of the matrix switches **33-1** to **33-3** on the front stages side may be different from the scale of the matrix switches **34-1** and **34-2** on the rear stage side.

In each matrix switch on the rear stage side, the number of outputs may be smaller than the number of inputs. For example, in case of the first embodiment, each of the matrix switches **22-1** to **22-4** may be substituted by a matrix switch having a 4×2 structure. Such a configuration is useful in the signal selecting circuit utilized as the selector **8***b*.

In each matrix switch on the front stage side, the number of inputs may be smaller than the number of outputs. For example, in case of the first embodiment, each of the matrix switches **21-1** to **21-4** may be substituted by a matrix switch having a 2×4 matrix switch. Such a configuration is useful in the signal selecting circuit utilized as the selector **8***a*.

It is possible to substitute r matrix switches on the rear stage side by one matrix switch having r-fold inputs. For example, in case of the first embodiment, the matrix switches **22-1** to **22-2** can be substituted by one matrix switch having an 8×8 structure.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A magnetic resonance imaging apparatus comprising:

a applying unit which applies a gradient magnetic field and a radio-frequency pulse to a subject placed in a static magnetic field;

a radio-frequency coil unit which includes a plurality of element coils to respectively detect magnetic resonance signals emitted from the subject in accordance with the application of the gradient magnetic field and the radio-frequency pulse, and outputs signals of a plurality of channels based on the plurality of magnetic resonance signals detected by the plurality of element coils;

a plurality of receiving circuits each of which receives one of the signals of the plurality of channels, and whose number is smaller than the plurality of channels;

a selecting circuit which includes a plurality of matrix switches connected in multiple stages, selects some of magnetic resonance signals from the signals of the plu-

rality of channels, and inputs the selected magnetic resonance signals to the plurality of receiving circuits;

a setting unit which sets diagnostic conditions; and

a determining unit which determines a connection state of the plurality of matrix switches in accordance with the set diagnostic conditions.

2. The magnetic resonance imaging apparatus according to claim **1**, wherein the radio-frequency coil has a structure where the plurality of element coils are arranged in two directions perpendicular to each other,

the setting unit sets element coils to be used from among the plurality of element coils, as the diagnostic conditions, and

the determining unit determines the connection state in accordance with the element coils to be used.

3. The magnetic resonance imaging apparatus according to claim **1**, wherein the radio-frequency coil has a structure where the plurality of element coils are arranged in two directions perpendicular to each other,

the setting unit sets priority utilization conditions of the plurality of element coils as the diagnostic conditions, and

the determining unit determines the connection state in accordance with the priority utilization conditions.

4. The magnetic resonance imaging apparatus according to claim **1**, wherein the selecting circuit includes matrix switch groups on a first stage and a second stages each of the matrix switch groups including a plurality of matrix switches each having m input terminals and n output terminals;

the input terminals of the plurality of matrix switches included in the matrix switch group on the first stage respectively connected with the plurality of element coils and the output terminals of the plurality of matrix switches included in the matrix switch group on the second stage respectively connected with input terminals of the matrix switches included in the matrix switch group on the second stage, and

some of output terminals of the plurality of matrix switches included in the matrix switch group on the second stage are respectively connected with the plurality of receiving circuits.

5. A magnetic resonance imaging apparatus comprising:

a transmission coil having a plurality of element coils;

transmitting circuits which transmit a radio-frequency pulse applied to a subject placed in a static magnetic field through the element coils, and whose number is smaller than the plurality of element coils;

a selecting circuit which includes a plurality of matrix switches connected in multiple stages, selects some of the plurality of element coils, and connects the selected element coils with the plurality of transmitters;

a determining unit determines a connection state of the plurality of matrix switches in accordance with a size of the subject; and

a receiving coil which detects an electromagnetic field emitted from the subject in accordance with the application of a radio-frequency magnetic field produced form the element coils in a state where a gradient magnetic field is applied in accordance with the radio-frequency pulse input based on the connection state.

6. The magnetic resonance imaging apparatus according to claim **5**, further comprising a setting unit which sets at least one of an FOV (field of view), a slice position, and a size of the subject,

wherein the determining unit determines the connection state in accordance with a setting result obtained by the setting unit.

7. The magnetic resonance imaging apparatus according to claim **5**, further comprising a calculating unit which calculates a size of the subject based on image data concerning the subject,

wherein the determining means determines the connection state based on the size of the subject calculated by the calculating unit.

8. A magnetic resonance method for use in a magnetic resonance imaging apparatus comprising:

a high-frequency coil unit including a plurality of element coils; and

a selecting circuit which includes a plurality of matrix switches connected in multiple stages,

said method comprising:

setting an imaging condition;

determining a connection state of the matrix switches in accordance with the set imaging condition;

applying a gradient magnetic field and a radio-frequency pulse to a subject placed in a static magnetic field;

detecting magnetic resonance signals emitted from the subject in accordance with the application of the gradient magnetic field and the radio-frequency pulse, at each of the element coils;

acquiring signals of a plurality of channels based on the magnetic resonance signals detected by the element coils;

selecting part of the signals of the plurality of channels by means of the selecting circuit whose connection state of the matrix switches is the determined connection state; and

receiving and processing signals selected by the selecting circuit.

9. A magnetic resonance imaging method for use in a magnetic resonance imaging apparatus comprising:

a transmission coil having a plurality of element coils; and

a selection circuit including a plurality of matrix switches connected in multiple stages,

said method comprising:

determining a connection state of the matrix switches in accordance with size of a subject;

selecting part of the element coils by means of the selecting circuit whose connection state of the matrix switches is the determined connection state;

transmitting radio-frequency pulses to be applied to the subject placed in a static magnetic field through the element coils, by supplying selected ones of the element coils with radio-frequency pulses which are smaller in number than the element coils; and

detecting an electromagnetic field emitted from the subject in accordance with the application of a radio-frequency magnetic field produced form the selected ones of the element coils in a state where a gradient magnetic field is applied.

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