(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 October 2010 (07.10.2010)

PCT

(10) International Publication Number
WO 2010/114573 A1

(51) International Patent Classification:
A61B 8/00 (2006.01)

(21) International Application Number:
PCT/US2009/048374

(22) International Filing Date:
24 June 2009 (24.06.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/165,630 1 April 2009 (01.04.2009) US

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to the identity of the inventor (Rule 4.17(i))*
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
— *of inventorship (Rule 4.17(iv))*

Published:
— *with international search report (Art. 21(3))*

(54) **Title**: ULTRASOUND PROBE

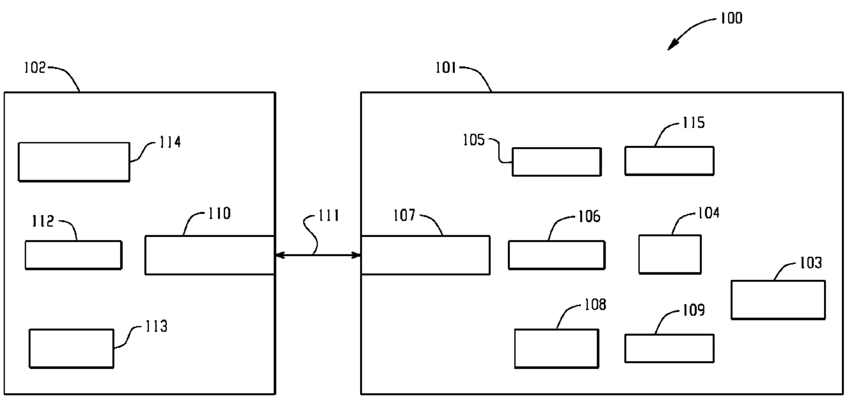

Fig. 1

(57) **Abstract**: An ultrasound imaging probe (101) includes a communications interface (107), including one or more ports (200-205), corresponding to one or more different communication protocols, for communication with ultrasound consoles. The probe (101) also includes a controller (106) that configures the probe (101) for communication with an ultrasound console (102) over a port (200-205) based on a communication between the communications interface (107) and a communications interface (110) of the console (102).

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ULTRASOUND PROBE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority of provisional patent application serial number 61/165,630, filed on April 1, 2009, confirmation number 4363, and entitled “ULTRASOUND PROBE,” which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

The following generally relates to ultrasound probes and more particularly to ultrasound probes configured for multi-dimensional imaging.

BACKGROUND

An ultrasound imaging probe generally includes one or more transducer arrays, affixed to a distal end of a mechanical device or a handle, and can be used for imaging of anatomical structures or organs. Volumetric imaging can be performed by using two-dimensional transducer arrays with no moving parts or by electromechanically moving a one-dimensional transducer array within the probe. Volumetric imaging has been used to visualize three-dimensional structures within the human body such as the kidneys, the uterus, a fetus, etc.

For patient imaging, the probe (and hence the transducer elements) is moved on the surface of the body over the structure of interest. The transducer generates a signal that traverses skin, subcutaneous fat, and/or bone material, reflects off the structure of interest, and is received back and detected at the transducer. The detected information is used to generate an image of the structure of interest. With other ultrasound applications (e.g., transabdominal, endovaginal, and endorectal), the transducer is positioned in and moved within a body cavity to image anatomical structures.

Unfortunately, some ultrasound probes are controllable only through ultrasound imaging systems and configured such that they only work with specific ultrasound imaging systems. As a consequence, a probe configured for multi-dimensional imaging may not be able to be used for multi-dimensional imaging when employed with an ultrasound imaging system that does not support multi-dimensional imaging applications.

In addition, a probe configured with a particular interface may not be able to be used with a console that does not have a complementary interface. In addition, a console may lack suitable circuitry for controlling various components of a probe in communication therewith.

SUMMARY OF THE INVENTION

Aspects of the application address the above matters, and others.

In one aspect, an ultrasound imaging probe includes a communications interface with one port or a plurality of ports corresponding to one or more different communication protocols for communication with ultrasound consoles. The probe also includes a controller that configures the probe for communication with an ultrasound console over a port based on a communication between the communications interface and a communications interface of the console.

In a further aspect, an ultrasound probe includes a transducer array, an electromechanical drive system, a motor, and a controller that controls the drive system and motor to drive the transducer array to at least one of translate or wobble.

In a further aspect, a method includes identifying a type of communications interface of an ultrasound console in communication with an ultrasound imaging probe and selecting a communications port of the probe for communication between the probe and the console based on the identified type of communications interface.

In a further aspect, an ultrasound probe for three and/or four dimensional ultrasound applications includes a controller that configures the probe for use with a console that does not support three and/or four-dimensional ultrasound applications.

Those skilled in the art will recognize still other aspects of the present application upon reading and understanding the attached description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates an example probe and console of an imaging system.

Figure 2 illustrates an example communications interface of a probe.

Figure 3 illustrates an example probe controller logic.

Figure 4 illustrates an example probe with user controls in a dongle.

Figure 5 illustrates an example probe with user controls in a cable.

Figure 6 illustrates an example probe with wireless control.

Figure 7 illustrates one method for using an example probe and console of an imaging system.

Figure 8 illustrates a second method for using an example probe and console of an imaging system.

DETAILED DESCRIPTION

Figure 1 depicts an ultrasound imaging system 100 including a probe 101 and a console 102. The probe 101 is capable of multi-dimensional applications such as two, three and four-dimensional applications and includes a movable transducer array 103 having one or more transducer elements that transmit and detect signals. Non-limiting examples of suitable transducer elements include piezoceramic, MEMS and/or other transducer elements.

An electromechanical drive system 104 moves and/or orients the movable transducer array 103 through a motor 115. In one instance, this includes converting rotational motion of the motor 115 into translational, rotational and/or wobbling movement of the ultrasound transducer array 103. Suitable motors 115 may include but are not limited to a stepper motor, a DC motor, an ultrasonic motor, a piezoelectric motor, an electromagnetic motor, and/or other motor. The illustrated drive system 104 and motor 115 are configured to drive the transducer array 103 alternatively based on one or more predetermined and/or programmable movement patterns.

One or more sensors 105 sense information about the operating conditions of the probe 101. Suitable sensors include an optical or magnetic encoder that senses probe orientation; a temperature sensor that detects a temperature of the drive system 104, the transducer array 103 or one or more other components of the probe 101; a needle guide sensor that senses a needle guide coupled to the probe 101, and/or other sensor.

A controller 106 controls the drive system 104 and hence position of the transducer array 103. In one instance, the controller 106 controls the drive system 104 based on a mode of operation including a master, a slave, a self-booting, software loading, and/or other mode of operation and an application mode such as a two, three or four dimensional application. As described in greater detail below, the controller 106 identifies a suitable mode of operation and application mode based on a communication with the console 102. The controller 106 may also use the information sensed by the sensors 105 and/or user input to identify the mode and application.

A communications interface 107 is configured to receive and transmit information between the probe 101 and the console 102 and/or other device. As described in greater detail below, the interface 107 may be configured with a single communications port or with a plurality of communication ports for communicating with one or more different consoles 102 supporting different communication protocols. The interface 107 includes an analog portion for communication with analog components of the probe 101 and/or a digital portion for communication with digital components of the probe 101. For example, where the transducer array 103 is an analog transducer array, the analog portion is used to communicate with the transducer array 103, and where the drive system 104 is a digital drive system, the digital portion is used to communicate with the drive system 104.

A user interface 108 accepts user input and presents operational and/or application information in a human readable format. Examples of input include signals representing a particular mode of operation and/or application mode. In one embodiment, the user interface 108 accepts user input through a touch pad and/or predetermined control buttons. Additionally or alternatively, the user interface 108 includes an audio input for accepting voice commands or other audio information.

Memory 109 provides storage for data and/or other information, for example, configuration and/or imaging data from the transducer array 103 and/or data from the ultrasound console 102. The memory 109 may include software and/or firmware uploaded by a user. Such software and/or firmware may make the probe 101 specific to the user and/or supporting equipment.

It is to be appreciated that by incorporating the controller 106 in the probe 101 and allowing the configuration of different communication providing one or a plurality of different communication ports by the interface 107 allows the probe 101 to be used with essentially any console 102. For example, where the controller 106 is omitted from the probe 101, the probe 101 may only be employed with a console 102 having control circuitry compatible with or able to drive the drive system 104 and the motor 115 of the probe 101. In another example, where the communication interface 107 only supports a single type of port, the probe 101 may only be employed with a console 102 supporting that type of port.

The console 102 includes a communication interface 110. The probe 101 interfaces with the console 102 through the communication interface 110 over a channel 111, which may be a wired or wireless channel. The console 102 also includes a controller 112, which can send signals indicative of a selected mode of operation and/or application mode to the probe 101. A user interface 113 allows a user to communicate with the probe 101 through the console 102. A presentation component 114 presents image data.

With reference to Figures 1 and 2, Figure 2 illustrates an example of the communications interface 107 with a plurality of communication ports.

In the illustrated example, the communications interface 107 includes an Inter-Integrated Circuit (I^2C) port 200, which generally is a multi-master serial bus used to attach low-speed peripherals to an embedded system. The communications interface 107 further includes a Joint Action Test Group (JTAG) port 201, which is generally a test access port for debugging and probing printed circuit boards.

The communications interface 107 also includes a Serial Peripheral Interface (SPI) port 204, which generally is a synchronous serial data link that allows a single master device. The communications interface 107 further includes a Universal Serial Bus (USB) port 203, which is a standardized interface socket that generally allows connection of peripheral devices.

The communications interface 107 further includes a wireless port such as a Radio Frequency Identification (RFID) port 203. The communications interface 107 may also include one or more other ports (PORT J) 205.

An interface identifier 206 identifies the port in communication with the console 102 and generates a signal indicative thereof. The signal is provided to the controller 106, which configures the probe 101 for communication over the identified port.

With reference to Figures 1 and 3, Figure 3 illustrates an example of the controller 106.

The controller 106 includes a mode bank 300 with one or more predetermined modes such as a master mode 301, a slave mode 302, a boot mode 303, an update mode 304, and one or more other modes 305. A mode selector 306 selects a mode of operation from the mode bank 300 based on various information.

The controller 106 also includes an application bank 307 with one or more predetermined application modes such as a two-dimensional mode 308, a three-dimensional mode 309, and a four-dimensional mode 310. An application selector 311 selects an application mode from the application bank 307 based on various information.

As described herein, the controller 106 configures the probe 101 based on a selected mode of operation, a selected application mode, information sensed by the sensor(s) 105, and a user input. In one instance, the controller 106 recognizes that the console does not support three or four-dimensional applications and configures the probe 101 so that the probe 101 can be used for three or four-dimensional applications using the user interface 108 of the probe 101. In this instance, the multi-dimensional imaging data may be stored in a memory 109 for subsequent retrieval.

A motion controller 312 generates a control signal for the drive system 104 based on the one or more of the selected operation mode, application mode, user input and/or sensor input. The control signal is indicative of movement and/or orientation of the transducer array 103.

Figures 4, 5, and 6 depict alternative embodiments of the probe 101.

Initially referring to Figure 4, the probe 101 includes first and second portions 400 and 401. The first portion 400 includes the transducer array 103, the drive system 104, the motor 115, the sensors 105, the controller 106, and the interface 107. The second portion 401 includes the user interface 108. The second portion 401 is part of dongle 402 and is connected to the first portion 400 through a connection 403, which can be a wired and/or wireless connection.

Turning to Figure 5, the probe 101 includes first and second portions 500 and 501. The first portion 500 includes the transducer array 103, the drive system 104, the motor 115, the sensors 105, the controller 106 and the interface 107, and the second portion 501 includes the user interface 103. In this embodiment, the second portion 501 is integrated in or part of a cable 503, which is used to connect the probe 101 to the console 102.

In Figure 6, the probe 101 includes first and second portions 600 and 601. The first portion 600 includes the transducer array 103, the drive system 104, the motor 115, the sensors 105, the controller 106, and a wireless interface 603. The second portion 601 includes the user interface 108 and a wireless interface 604. In this embodiment, the first and second portions 600 and 601 communicate with each other through the wireless interfaces 603 and 604.

In another embodiment, the controller 106 is located within a handle shield, which is formed as an external probe covering which acts also as a ground plane and heat distributor. In yet another embodiment, the controller 106 is incorporated within a handle in which in multiple components can be interchanged to provide a user or application specific probe. In still another embodiment, the controller 106 is part of independent circuitry which may be coupled to and employed with a plurality of different ultrasound probes, in conjunction with multiple different ultrasound imaging systems.

Figure 7 illustrates a method in connection with Figures 1-3 where the probe 101 is configured to communicate with the console 102 through a single interface.

At 700, the probe 101 is connected to the console 102.

At 701, the probe 101 is powered on. This can be achieved by activating a power switch or toggle of the user interface 108.

At 702, the probe 101 attempts communications with the console 102.

At 703, if the communication fails, the controller 106 places the probe 101 in a default mode, such as, the slave mode 302. In this mode, an application is selected and the probe 101 is controlled through the console 102.

At 704, if the communications is successful, the controller 106 identifies applications (two, three and/or four dimensions) supported by the console 102.

At 705, the controller 106 configures itself based on the identified supported applications. This includes allowing the probe 101 to be operated by the console 102 based on the applications supported by the console 102 and/or operated by the probe 101, including using applications that are not supported by the console 102.

At 706, the controller 106 determines whether the console 102 can act as a master device. At 707, if not, the probe 101 configures the probe 101 as a master device.

At 708, otherwise, the controller 106 configures the probe 101 as a slave device.

At 709, the probe 101 is employed based on user input to the probe 101, the console 102, and/or information sensed by the sensors 105.

Figure 8 illustrates a method in connection with Figures 1-3 where the probe 101 is configured to communicate with the console 102 through one or a plurality of different interfaces.

At 800, the probe 101 is connected to the console 102.

At 801, the probe 101 is powered on. This can be achieved by activating a power switch of the user interface 108.

At 802, the probe 101 attempts communications with the console 102.

At 803, if the communication fails, the controller 106 places the probe 101 in a default mode such as the master mode 301. In this mode, an application is selected and the probe 101 is controlled through the user interface 108.

At 804, if the communications is successful, the interface identifier 206 identifies the type of interface through which the probe 101 and console 102 are connected.

At 805, the interface identifier 206 generates a signal indicative of the identified type of interface.

At 806, the controller 106 configures the probe 101 to communicate based on the identified type of interface.

At 807, the controller 106 identifies applications (two, three and/or four dimensions) supported by the console 102.

At 808, the controller 106 configures itself based on the identified supported applications. This includes allowing the probe 101 to be operated by the console 102 based on the applications supported by the console 102 and/or operated by the probe 101, including using applications that are not supported by the console 102.

At 809, the controller 106 determines whether the console 102 can act as a master device. At 810, if so, the probe 101 configures the probe 101 as a slave device. Of course, the user can override this setting and/or the default settings may be that the probe 101 configures itself as the master device.

At 811, otherwise, the controller 106 configures the probe 101 as the master device.

At 812, the probe 101 is employed based on user input to the probe 101, the console 102, and/or information sensed by the sensors 105. Obtained data may be stored within a memory 109 of the probe 101 or transferred to the ultrasound console 102 or transmitted to other computing devices.

The application has been described with reference to various embodiments. Modifications and alterations will occur to others upon reading the application. It is intended that the invention be construed as including all such modifications and alterations, including insofar as they come within the scope of the appended claims and the equivalents thereof.

CLAIMS

What is claimed is:

1. An ultrasound imaging probe (101), comprising:

a communications interface (107), including one or more ports (200-205), corresponding to one or more different communication protocols, for communication with ultrasound consoles; and

a controller (106) that configures the probe (101) for communication with an ultrasound console (102) over a port (200-205) based on a communication between the communications interface (107) and a communications interface (110) of the console (102).

2. The probe (101) of claim 1, further comprising:

a transducer array (103);

an electromechanical drive system (104); and

a motor (115),wherein controller (106) controls the drive system (104) and the motor (115) to at least one of translate or wobble the transducer array (103).

3. The probe (101) of claim 2, wherein the console (102) does not include circuitry for controlling the drive system (104) and the motor (115).

4. The probe (101) of claim 1, wherein the one or more ports includes at least one of an Inter-Integrated Circuit port (200), a Joint Action Test Group port (201), a Serial Peripheral Interface port (202), a Universal Serial Bus port (203), and a Radio Frequency Identification port (204).

5. The ultrasound probe (101) of claim 1, wherein the communication identifies the communications interface (110) of the console (102).

6. The probe (101) of claim 1, further comprising an application selector (311) that identifies application modes supported by the console (102), wherein the controller (106) configures the probe (101) based on an identified supported application.

7. The probe (101) of claim 1, wherein the controller (106) configures the probe (101) to a default operation and/or application mode when the probe (101) is not in communication with the console (102).

8. The ultrasound probe (101) of claim 1, wherein the probe (101) is configured for three and/or four-dimensional applications and the console (102) does not support three or four-dimensional applications.

9. The ultrasound probe (101) of claim 1, wherein the probe (101) is a master device and the console (102) is a slave device.

10. The ultrasound probe (101) of claim 1, wherein the probe (101) is a slave device and the console (102) is a master device.

11. An ultrasound probe (101), comprising:

a transducer array (103);

an electromechanical drive system (104);

a motor (115); and

a controller (106) that controls the drive system (104) and motor (115) to drive the transducer array (103) to at least one of translate or wobble.

12. The ultrasound probe (101) of claim 11, wherein the electromechanical drive system (104) is housed in a portion of the probe (400, 500, 600) housing the motor (115).

13. The ultrasound probe (101) of claim 11, wherein the controller (106) identifies application modes supported by a console (102) in communication with the probe (101) and configures the probe (101) for operation based on an identified supported application.

14. The ultrasound probe (101) of claim 11, wherein the controller (106) configures the probe (101) for default operation.

15. The ultrasound probe (101) of claim 11, wherein the probe (101) is configured for a three and/or four-dimensional application and a console (102) does not support three or four-dimensional applications.

16. The ultrasound probe (101) of claim 11, further comprising at least one sensor (105), wherein the controller (106) configures the probe (101) based on information sensed by the at least one sensor (105).

17. The ultrasound probe (101) of claim 16, wherein the at least one sensor (105) includes one or more of an optical and/or magnetic encoder that determines an orientation of the probe (101), a temperature sensor that determines a temperature of a component of the probe (101), and a needle guide sensor that senses a needle guide bracket mounted to the probe (101).

18. The ultrasound probe (101) of claim 11, wherein the probe (101) is a master device.

19. The ultrasound probe (101) of claim 11, wherein the probe (101) is a slave device.

20. The ultrasound probe (101) of claim 11, further comprising: a communications interface (107), including one or more ports (200-205), corresponding to one or more different communication protocols, for communication with ultrasound consoles, wherein the controller (106) configures the probe (101) for communication with an ultrasound console (102) over a port (200-205) based on a communication between the communications interface (107) and a communications interface (110) of the console (102).

21. A method, comprising:

identifying a type of communications interface (110) of an ultrasound console (102) in communication with an ultrasound imaging probe (101); and

selecting a communications port of the probe (101) for communication between the probe (101) and the console (102) based on the identified type of communications interface.

22. The method of claim 21, further comprising:

controlling motion of a transducer array (103) of the probe (101) with a drive system (104) and motor (115) integrated in the probe (101).

23. The method of claim 22, wherein the motion includes at least one of translation or wobble.

24. The method of claim 21, wherein the interface type includes at least one of Inter-Integrated Circuit (200), Serial Peripheral Interface (201), Joint Action Test Group (206), Universal Serial Bus (202), and Radio Frequency Identification (203).

25. The method of claim 21, further comprising:

identifying multi-dimensional applications supported by the console (102); and configuring the probe (101) based on the identified applications.

26. The method of claim 21, further comprising:

setting an application mode of the probe (101) based on information entered through a user interface (108) of the probe (101).

27. The method of claim 21, further comprising:

setting an operation mode and/or an application mode of the probe (101) based on information sensed by at least one sensor (105) of the probe (101).

28. An ultrasound probe (101) for three and/or four dimensional ultrasound applications, comprising: a controller (106) that configures the probe (101) for use with a console (102) that does not support three and/or four-dimensional ultrasound applications.

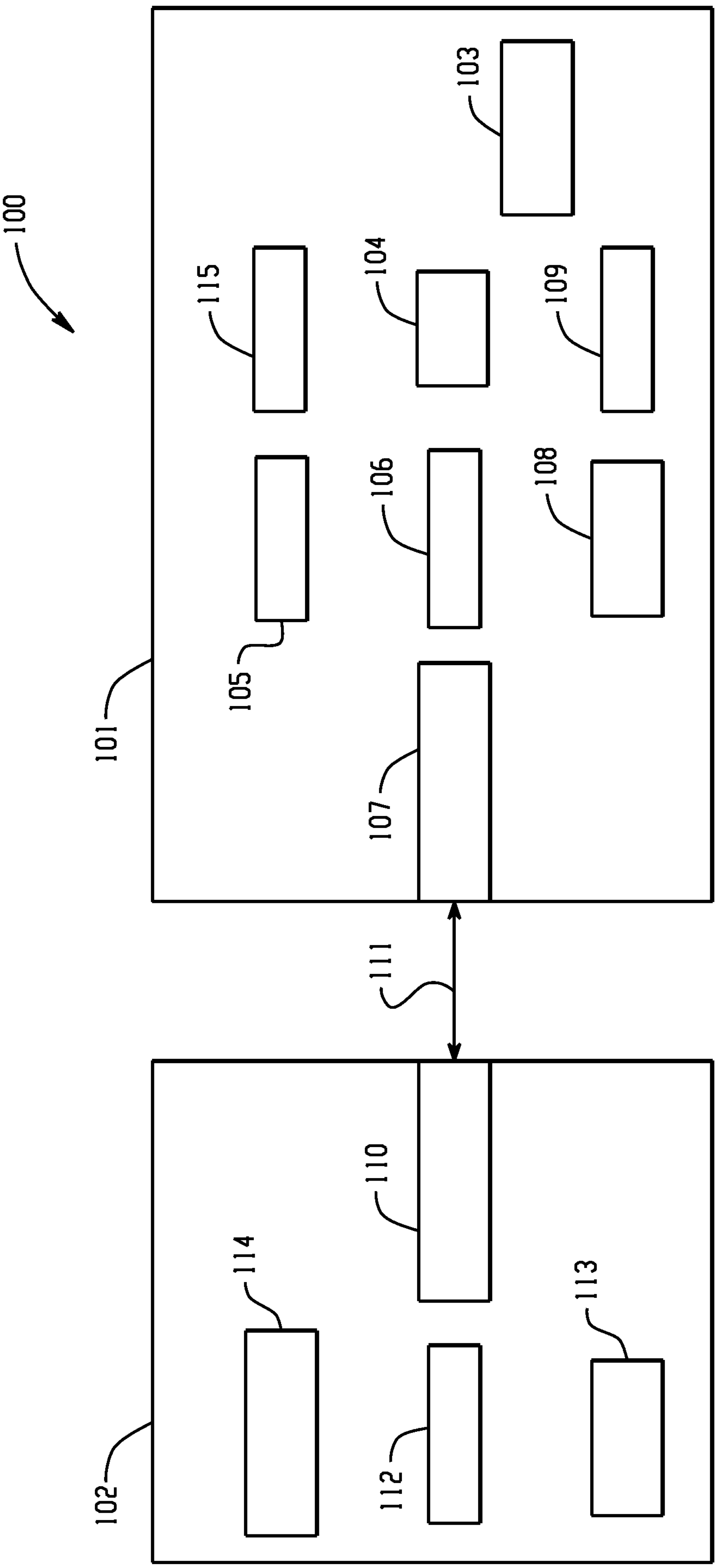

Fig. 1

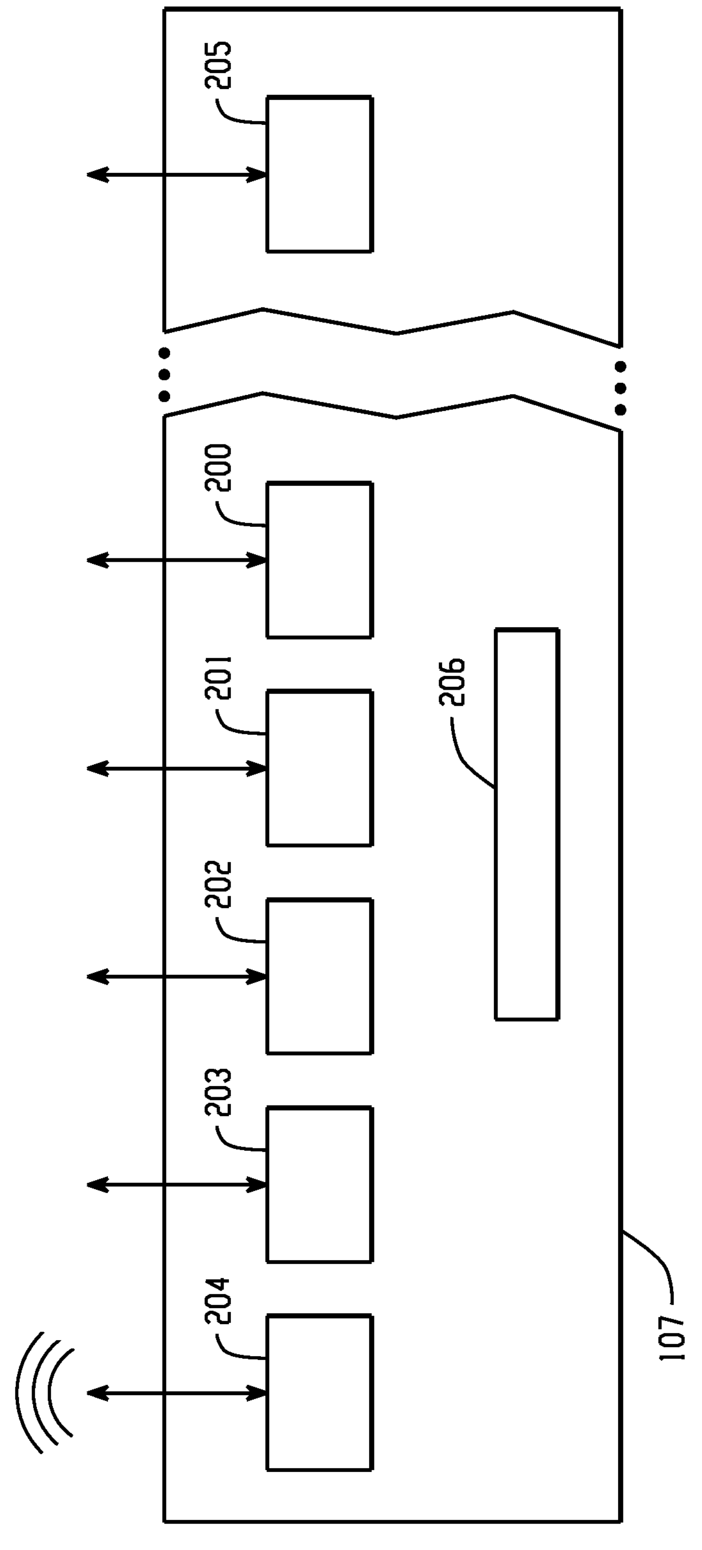

Fig. 2

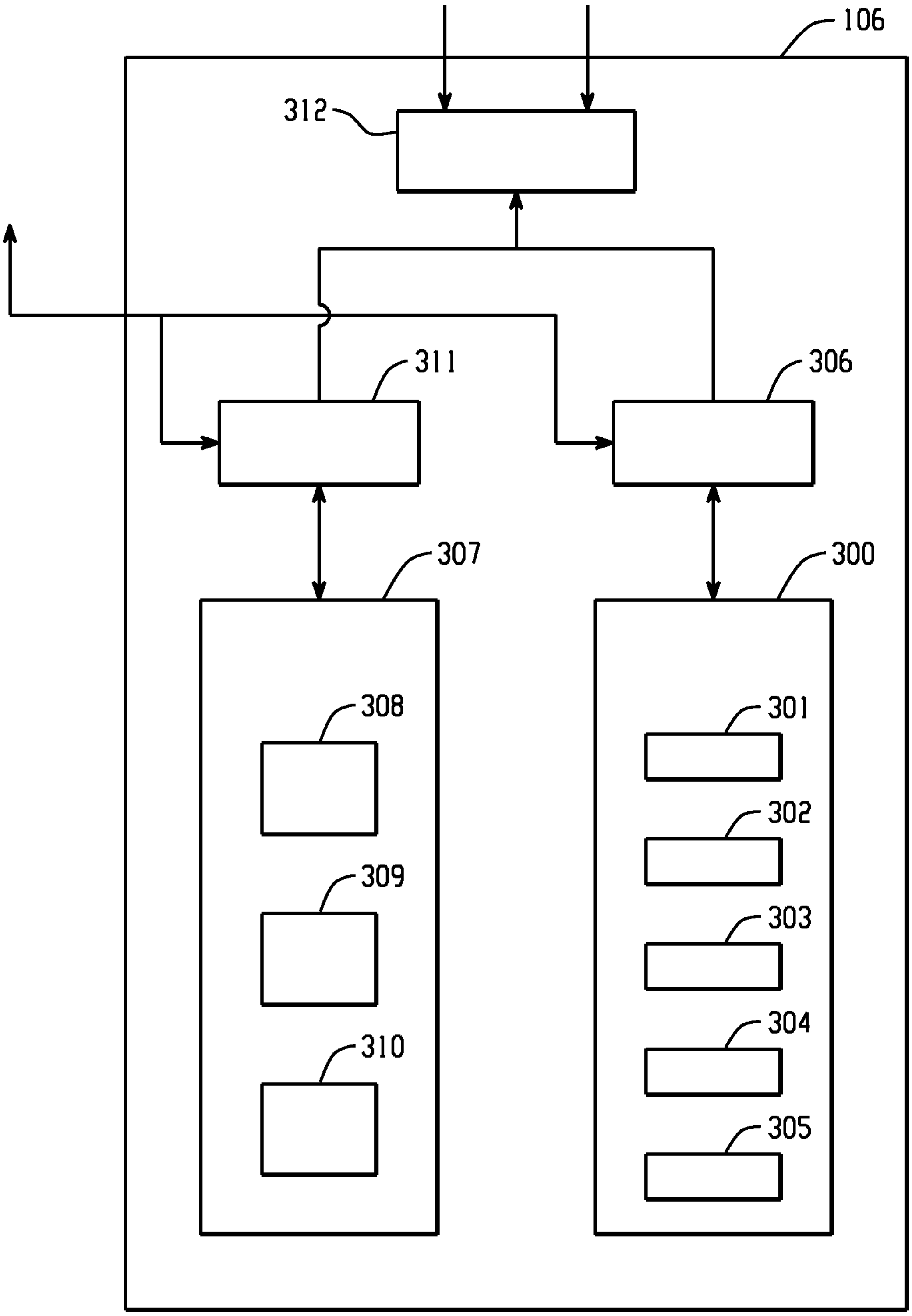

Fig. 3

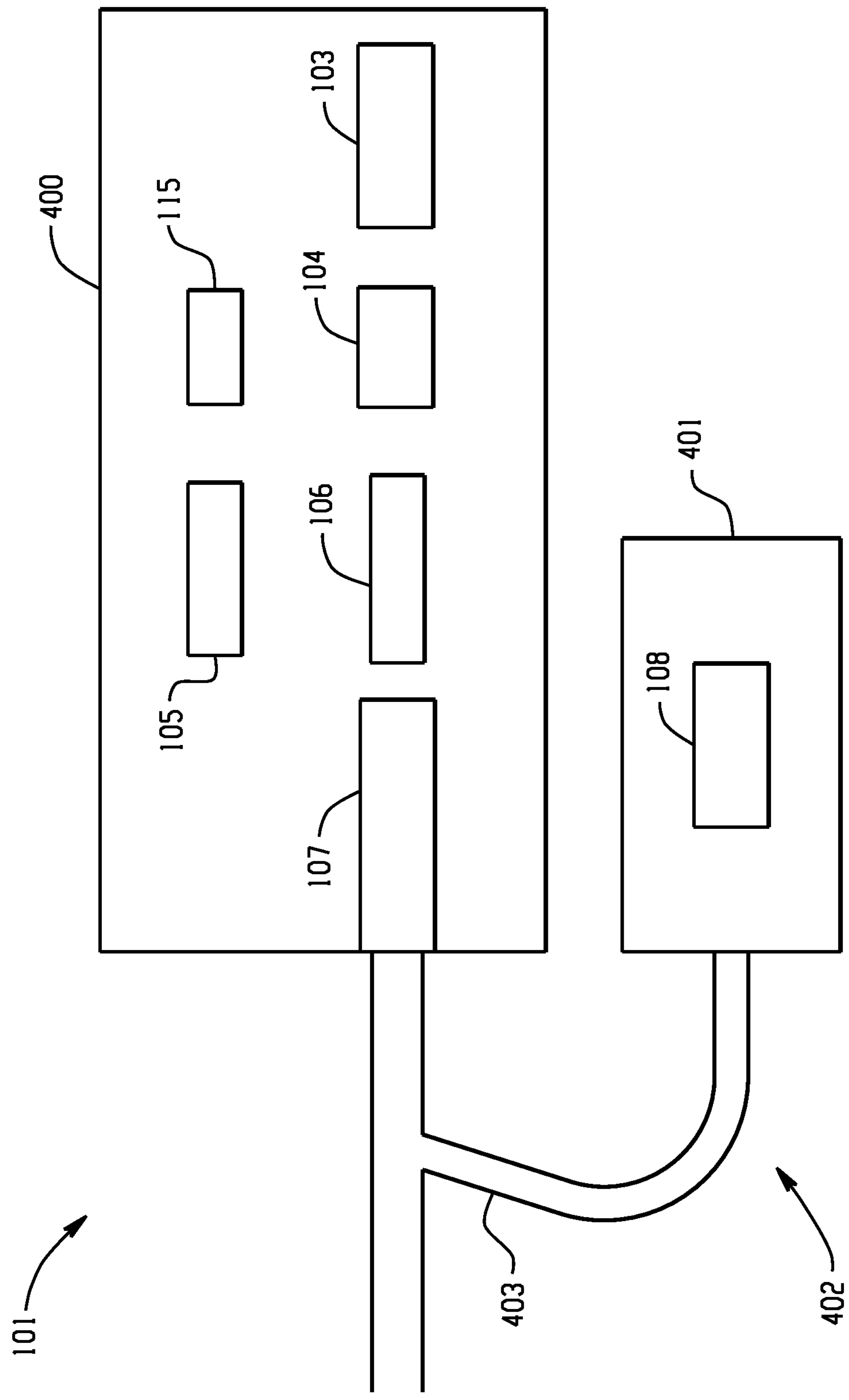

Fig. 4

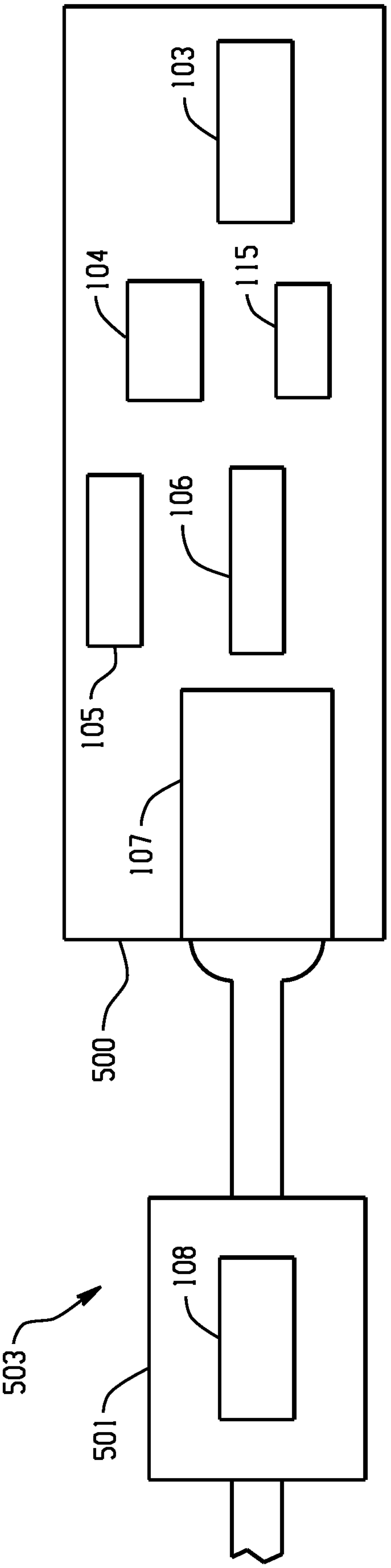
103
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Fig. 5

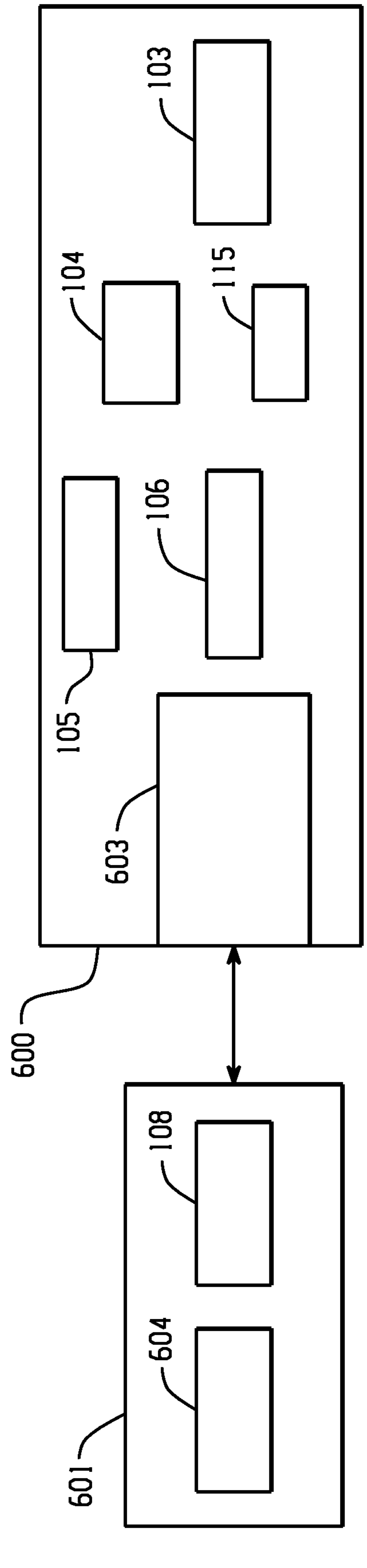
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Fig. 6

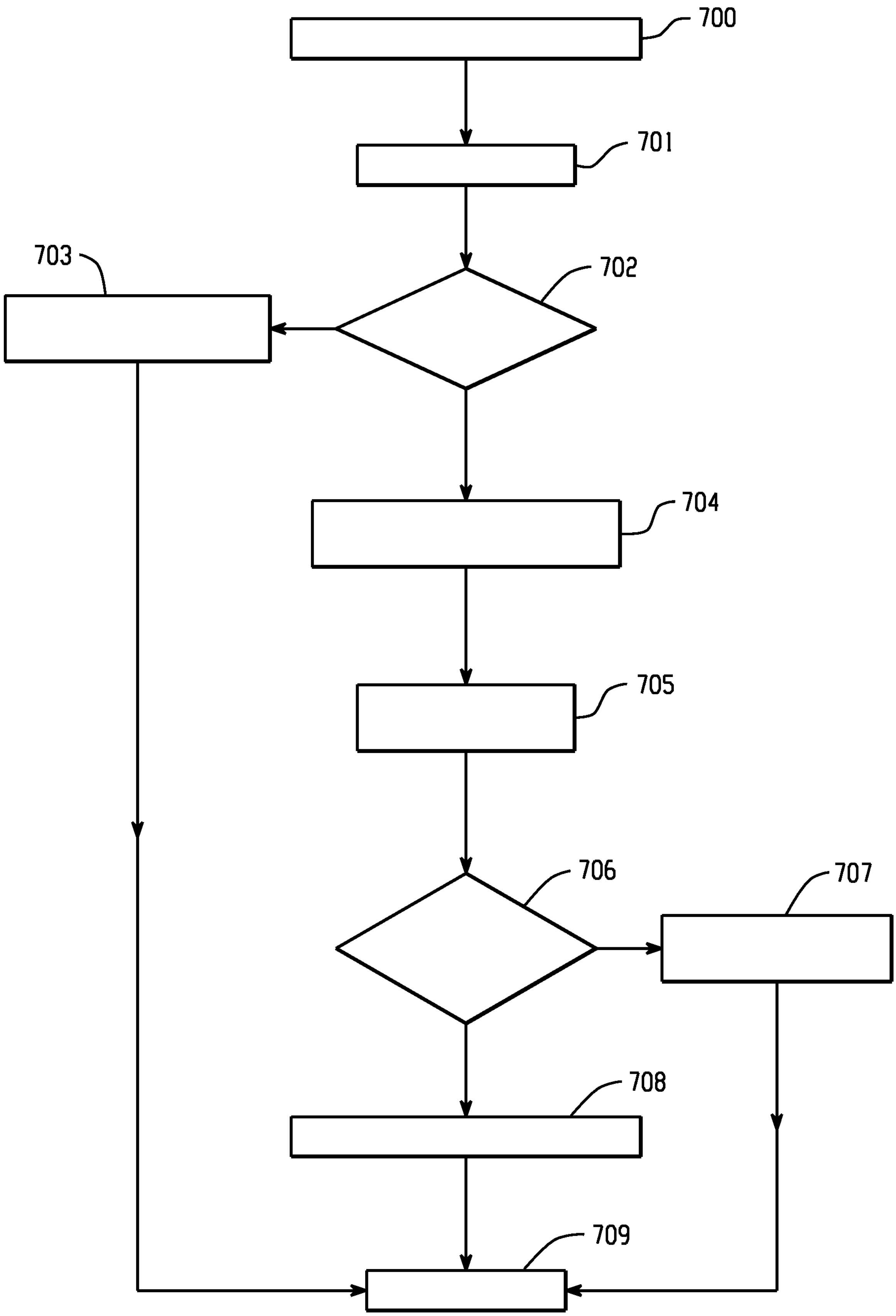

Fig. 7

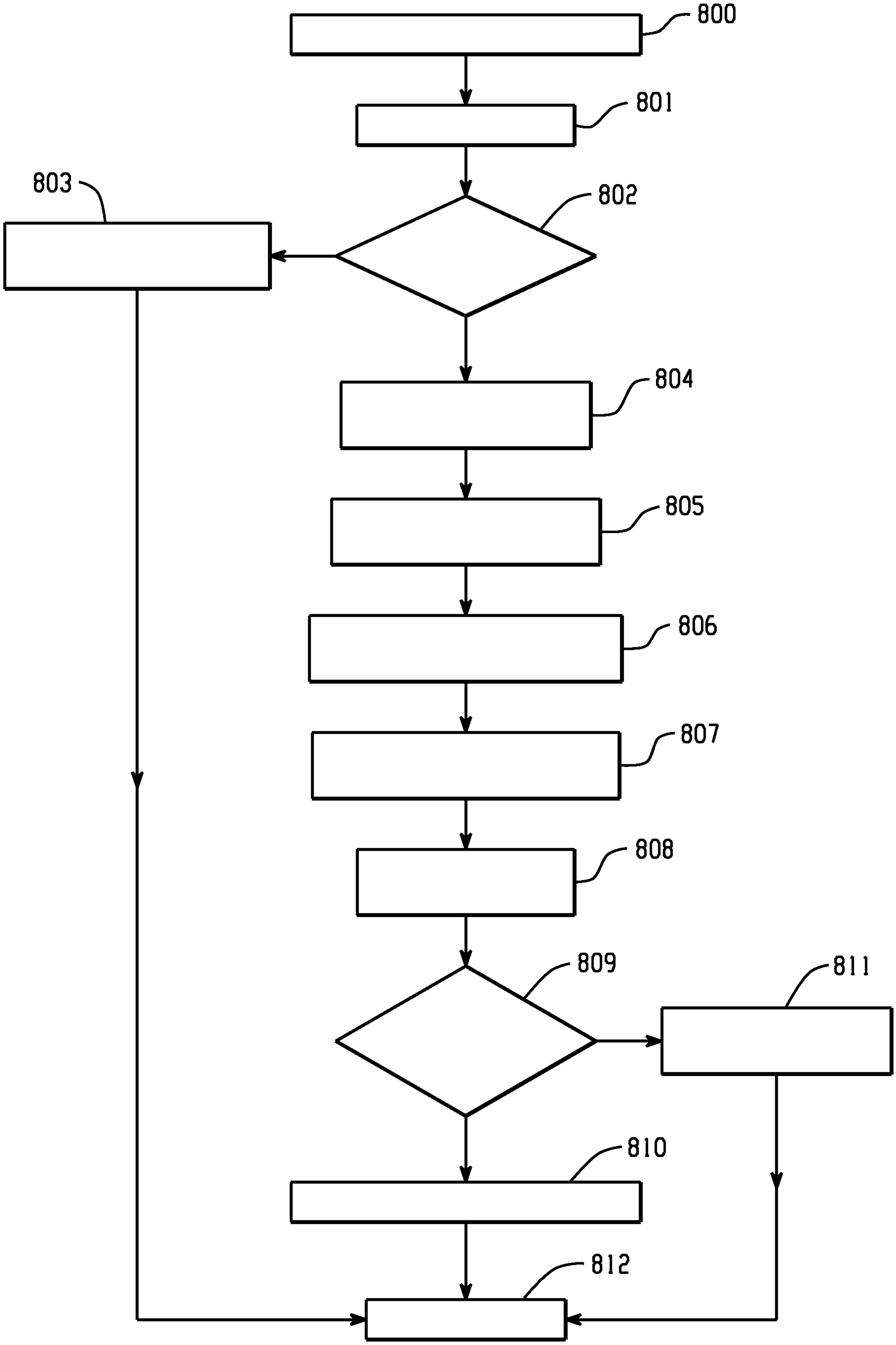

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/048374

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B8/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/015079 A1 (BERGER NOAH [US] ET AL) 22 January 2004 (2004-01-22)	1,4,9
Y	paragraphs [0103], [0144], [0154], [0156], [0158] - [0160]; figure 1; tables 6,7,9	2,3,20
X	US 2007/239019 A1 (RICHARD WILLIAM D [US] ET AL) 11 October 2007 (2007-10-11) paragraphs [0021], [0024], [0026]; figures 1A,1B,2	1,4,10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 September 2009	17/09/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Mecking, Nikolai

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/048374

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/036780 A1 (ABRAHAM THEODORE P [US]) 5 February 2009 (2009-02-05)	11-14, 18,19
Y	paragraphs [0032], [0034], [0038], [0039], [0041], [0046]; figures 1B,2,3	2,3, 15-17, 20,22,23
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International application No
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专利名称(译)	超声探头		
公开(公告)号	EP2413802A1	公开(公告)日	2012-02-08
申请号	EP2009789921	申请日	2009-06-24
申请(专利权)人(译)	ANALOGIC CORPORATION		
当前申请(专利权)人(译)	ANALOGIC CORPORATION		
[标]发明人	GUBBINI ALESSANDRO DRESCHEL WILLIAM R		
发明人	GUBBINI, ALESSANDRO DRESCHEL, WILLIAM, R.		
IPC分类号	A61B8/00		
CPC分类号	A61B8/00 A61B8/12 A61B8/4254 A61B8/4455 A61B8/4461 A61B8/4472 A61B8/4477 A61B8/4488 A61B8/467 A61B8/483 A61B8/546		
优先权	61/165630 2009-04-01 US		
外部链接	Espacenet		

摘要(译)

超声成像探头（101）包括通信接口（107），其包括与一个或多个不同通信协议相对应的一个或多个端口（200-205），用于与超声控制台通信。探针（101）还包括控制器（106），其基于通信接口（107）与通信之间的通信来配置探针（101）以通过端口（200-205）与超声控制台（102）通信。控制台（102）的接口（110）。