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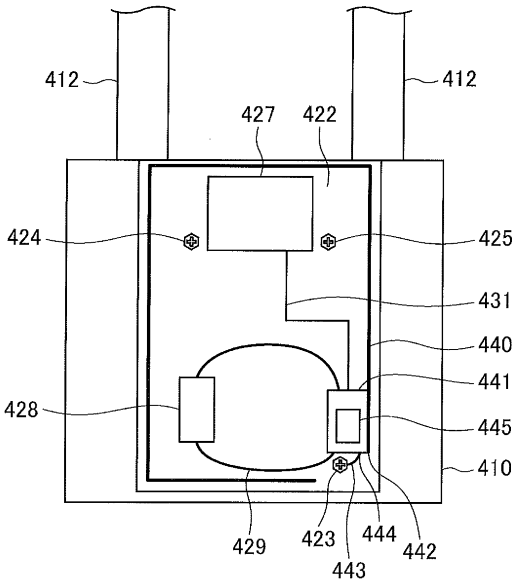
(54) WIRELESS DEVICE

(57) A gas meter includes a metal housing (410), a radiation conductor (440) configured to radiate a radio wave which is a high frequency signal, and a circuit board (441) having a power supply circuit (445) configured to supply high frequency power to the radiation conductor (440). A ground of the circuit board (441), i.e., a ground of the power supply circuit (445) is in electrical connection to the metal housing (410) via a lead wire (443) and one screw (423). A power supply point (442) for the radiation conductor (440) is located in a corner portion of the metal housing (410).

FIG.6



EP 2 863 474 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to wireless devices for flowmeters configured to measure a quantity of flow of a target.

BACKGROUND ART

[0002] In recent years, an automatic meter reading system has been introduced. With this system, gas consumption, power consumption, water consumption and the like are measured by means of flowmeters installed in structures such as houses, and the measured data are collected through wireless communication. The automatic meter reading system requires that the flowmeters be small in size, in view of ease of installation, for example.

[0003] For instance, a gas meter with a metal housing on which a slave unit of a wireless adapter is mounted is suggested as an example of the flowmeters of this type (see Patent Document 1). The slave unit of the wireless adapter described in Patent Document 1 includes therein a board-mounted plate-like antenna. The board-mounted plate-like antenna is configured such that a ground conductor plate is in connection to a short-circuit conductor of a radiation conductor via a wiring pattern of a printed circuit board.

CITATION LIST

PATENT DOCUMENT

[0004] PATENT DOCUMENT 1: Japanese Unexamined Patent Publication No. H10-313212

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0005] High antenna performance can be achieved by utilizing the metal housing of a gas meter as a radiation conductor (a reflection conductor). However, when currents radially flow through the metal housing from a point located near a power supply point of the antenna, effects of the currents of opposite phases cancel each other, and consequently, loss of radiation efficiency is caused. In particular, when the radiation conductor is small relative to a wavelength, the radiation efficiency suffers considerable loss.

[0006] It is therefore an object of the present invention to provide a wireless device which effectively utilizes a metal housing of a flowmeter and thereby provides improved antenna performance.

SOLUTION TO THE PROBLEM

[0007] A wireless device of the present invention is a wireless device for a flowmeter, including: a metal housing of the flowmeter, a radiation conductor configured to radiate a radio wave which is a high frequency signal, and a circuit board including a power supply circuit configured to supply high frequency power to the radiation conductor, wherein the circuit board has a power supply point which electrically connects the power supply circuit to the radiation conductor, and the power supply point is positioned in a corner portion of the metal housing. The configuration in which the power supply point is positioned in the corner portion of the metal housing results in reduction of the loss of the radiation efficiency which could be caused by the currents of opposite phases.

ADVANTAGES OF THE INVENTION

[0008] The present invention has an advantage that wireless devices with improved antenna performance can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a front view illustrating an inner configuration of a flowmeter including a wireless device according to a first embodiment of the present invention.

FIG. 2 is a side view illustrating the configuration of the flowmeter of FIG. 1.

FIG. 3 is a perspective view of a wireless communication unit of the flowmeter of FIG. 1.

FIGS. 4A and 4B are diagrams each illustrating distribution of currents passing through a ground conductor in relation to the position of a ground terminal in the flowmeter of FIG. 1.

FIG. 5 is a perspective view of a variation of the wireless communication unit of FIG. 3.

FIG. 6 is a front view illustrating an inner configuration of a flowmeter including a wireless device according to a second embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0010] Embodiments of the present invention are described below in detail with reference to the drawings.

«First Embodiment»

[0011] FIGS. 1-3 illustrate a configuration of a gas meter which is a flowmeter including a wireless device according to a first embodiment of the present invention. Specifically, FIG. 1 is a front view and FIG. 2 is a side view of the gas meter. FIG. 3 is a perspective view of a wireless communication unit.

[0012] The gas meter of this embodiment includes a metal housing 201, a meter display 202, and a resin hous-

ing 102 mounted on a surface of the metal housing 201. In the resin housing 102, the wireless communication unit including a plate-like radiation conductor 104 forming a main part of an inverted F-shaped plate-like antenna, a circuit board 103 equipped with a power supply circuit, and a ground conductor 107 are housed. Reference numeral 105 denotes a power supply terminal for supplying power from the circuit board 103 to the radiation conductor 104. Reference numeral 106 denotes a short-circuit terminal provided between the radiation conductor 104 and the circuit board 103. Reference numeral 108 denotes a ground terminal provided between the circuit board 103 and the ground conductor 107.

[0013] The circuit board 103 is, e.g., a board with copper-clad surfaces. The power supply circuit, a control circuit, and the like are mounted on the front surface of the circuit board 103. The radiation conductor 104 is spaced from the front surface of the circuit board 103 and disposed in parallel with the circuit board 103. The power supply terminal 105 is disposed perpendicularly to a plane of the radiation conductor 104. The power supply terminal 105 has an end electrically connected to the power supply circuit mounted on the circuit board 103 in an edge portion of the circuit board 103, and the other end electrically connected to an edge portion of the radiation conductor 104. The short-circuit terminal 106 is disposed perpendicularly to a plane of the radiation conductor 104, in a manner similar to the power supply terminal 105. The short-circuit terminal 106 has an end electrically connected to a ground made of a copper foil pattern provided on the circuit board 103, and the other end electrically connected to the radiation conductor 104.

[0014] The ground conductor 107 is disposed near the back surface of the circuit board 103 and in parallel with the circuit board 103. The ground terminal 108 is disposed perpendicularly to a plane of the ground conductor 107. The ground terminal 108 has an end electrically connected to the ground made of the copper foil pattern provided on the circuit board 103, and the other end electrically connected to a corner portion of the ground conductor 107. The point of connection between the circuit board 103 and the ground terminal 108 is spaced from the point of connection between the short-circuit terminal 106 and the circuit board 103.

[0015] The wireless communication unit including the radiation conductor 104, the circuit board 103, and the ground conductor 107 is oriented, in the resin housing 102, such that the power supply terminal 105 is positioned near a corner of metal housing 201. The ground conductor 107 of the wireless communication unit thus orientated is positioned close to the metal housing 201, and consequently, the ground conductor 107 and the metal housing 201 are electromagnetically coupled to each other. Thus, the metal housing 201 and the ground conductor 107 can be considered to be at the same potential with respect to high frequency. In this manner, the metal housing 201 is caused to function as a ground for the inverted F-shaped plate-like antenna. With this configuration, a large space for a ground of an antenna can be ensured even in small wireless terminal equipment, and consequently, high radiation efficiency can be achieved.

[0016] FIGS. 4A and 4B are diagrams each illustrating distribution of currents passing through the ground conductor 107 in relation to the position of the ground terminal 108. In FIG. 4A, where the ground terminal 108 is positioned at the middle of an edge of the ground conductor 107, since the effects of currents of opposite phases cancel each other, loss of the radiation efficiency is caused. In FIG. 4B, where the ground terminal 108 is positioned in a corner portion of the ground conductor 107, since the phases of the currents are not opposite to each other, loss of the radiation efficiency is reduced. This theory holds for distribution of currents passing through the radiation conductor 104 in relation to the position of the power supply terminal 105.

[0017] FIG. 5 illustrates a variation of the wireless communication unit of FIG. 3. This variation includes an inverted L-shaped linear antenna. In FIG. 5, reference numeral 301 denotes a linear radiation conductor, and reference numeral 302 denotes a power supply point for supplying power from the circuit board 103 to the radiation conductor 301. Also in this variation, the power supply point 302 is located in an edge portion of the circuit board 103. Further, this wireless communication unit is oriented such that the power supply point 302 is positioned near a corner of the metal housing 201. In the vicinity of the power supply point 302, the ground conductor 107 is in connection to the ground terminal 108 of the circuit board 103.

«Second Embodiment»

[0018] FIG. 6 is a front view illustrating a configuration of a gas meter which is a flowmeter including a wireless device according to a second embodiment of the present invention.

[0019] The gas meter of this embodiment includes a metal housing 410 connected to pipes 412 and a resin housing 422 mounted on a surface of the metal housing 410. In the metal housing 410, a sensor (not shown) configured to measure a quantity of gas is housed. In the resin housing 422, a measurement circuit board 427, a battery 428, a radiation conductor 440, and a wireless communication circuit board 441 are arranged. The resin housing 422 is fastened to the surface of the metal housing 410 by means of conductive screws 423-425.

[0020] The measurement circuit board 427 is located at the middle of an upper portion of the interior of the resin housing 422. The wireless communication circuit board 441 is located near a lower corner of the interior of the resin housing 422. The battery 428 having metal terminals is positioned as far as possible from the wireless communication circuit board 441. An interconnect wire 431 connects the measurement circuit board 427 to the wireless communication circuit board 441. An inter-

connect wire 429 connects the battery 428 to the wireless communication circuit board 441.

[0021] A power supply circuit 445 configured to supply a high frequency signal to the radiation conductor 440 is mounted on the wireless communication circuit board 441. A power supply point 442 for the radiation conductor 440 is located in a corner portion of the wireless communication circuit board 441. A ground of the wireless communication circuit board 441, i.e., a ground of the power supply circuit 445 is in electrical connection to the metal housing 410 at a joint point 444, via a lead wire 443 and the screw 423. With this configuration, the metal housing 410 and the ground of the power supply circuit 445 are at nearly the same potential, which consequently allows the metal housing 410 having a large area to function as a ground. It is preferable that the joint point 444 of the lead wire 443 and the ground of the wire communication circuit board 441, the lead wire 443, and the screw 423 are located in the vicinity of the power supply point 442, and opposite to the radiation conductor 440 with respect to the power supply point 442.

[0022] The radiation conductor 440 radiates, as a radio wave, the high frequency signal having been modulated by a transmitter circuit. The radiation conductor 440 also receives an external radio wave (an external high frequency signal) and forwards the radio wave to a receiver circuit which demodulates the radio wave. The radiation conductor 440 of this embodiment functions as the inverted L-shaped linear antenna, is in a thin rod shape, and is made of a conductive material such as copper. The length of the radiation conductor 440 is set to $\lambda/4$, where λ is the wavelength of the high frequency signal which is the radio signal.

[0023] At the power supply point 442, a base end of the radiation conductor 440 is in connection to an output section of the wireless communication circuit board 441. The radiation conductor 440 is positioned as far as possible from the metal housing 410. In addition, the radiation conductor 440 is bended and disposed, in the interior of the resin housing 422, such that the portions between the bend points are positioned as far as possible from one another.

[0024] The theory described with reference to FIGS. 4A and 4B holds for distribution of currents passing through the metal housing 410 connected to the ground of the wireless communication circuit board 441 via the screw 423. Specifically, if the screw 423 was positioned at the middle of the metal housing 410, the effects of the currents of opposite phases would cancel each other, and loss of the radiation efficiency would be caused. On the other hand, in this embodiment, in which the screw 423 is positioned in a corner portion of the metal housing 410, since the phases of the currents are not opposite to each other, loss of the radiation efficiency is reduced.

[0025] Instead of the electrical connection to the metal housing 410 by means of the screw 423, the above-described technique with the use of the ground conductor may be employed. Alternatively, the ground area of the wireless communication circuit board 411 may be used as the ground conductor. If this is the case, the ground conductor is disposed between the wireless communication circuit board 441 and the metal housing 410, insulated from the metal housing 410 by the resin housing 422, and electrically connected to the ground of the wireless communication circuit board 441 in the vicinity of the power supply point 442.

[0026] Similarly to the battery 428 having the metal terminals, a component housed in a metal case such as an electrolytic capacitor is desirably positioned as far as possible from the power supply point 442.

[0027] In the first and second embodiments, the inverted F-shaped plate-like antenna and the inverted L-shaped linear antenna have been described. However, the present invention is not limited to the antennas in these shapes. For example, the antenna of the present invention may be, e.g., a plate-like dipole antenna, a loop antenna, or a meander line antenna.

INDUSTRIAL APPLICABILITY

[0028] As described above, the present invention is useful for wireless devices providing improved antenna performance.

DESCRIPTION OF REFERENCE CHARACTERS

[0029]

102	Resin housing
103	Circuit board
104	Radiation conductor
105	Power supply terminal
106	Short-circuit terminal
107	Ground conductor
108	Ground terminal
201	Metal housing
202	Meter display
301	Radiation conductor
302	Power supply point
410	Metal housing
412	Pipe
422	Resin housing
423-425	Screw
427	Measurement circuit board
428	Battery
429	Interconnect wire
431	Interconnect wire
440	Radiation conductor
441	Wireless communication circuit board
442	Power supply point
443	Lead wire
444	Joint point
445	Power supply circuit

Claims

1. A wireless device for a flowmeter, the device comprising:

   a metal housing of the flowmeter,
   a radiation conductor configured to radiate a radio wave which is a high frequency signal, and
   a circuit board including a power supply circuit configured to supply high frequency power to the radiation conductor, wherein
   the circuit board has a power supply point which electrically connects the power supply circuit to the radiation conductor, and
   the power supply point is positioned in a corner portion of the metal housing.

2. The wireless device of claim 1, wherein
   the power supply point is located in a corner portion of the circuit board.

3. The wireless device of claim 1, further comprising:

   a ground conductor disposed between the circuit board and the metal housing, and insulated from the metal housing, wherein
   in a vicinity of the power supply point, the ground conductor is in electrical connection to a ground terminal of the circuit board.

4. The wireless device of claim 1, wherein
   in a vicinity of the power supply point, the metal housing is in electrical connection to a ground terminal of the circuit board.

5. The wireless device of claim 1, further comprising:

   a battery electrically connected to the circuit board, wherein the battery is apart from the power supply point.

FIG.1

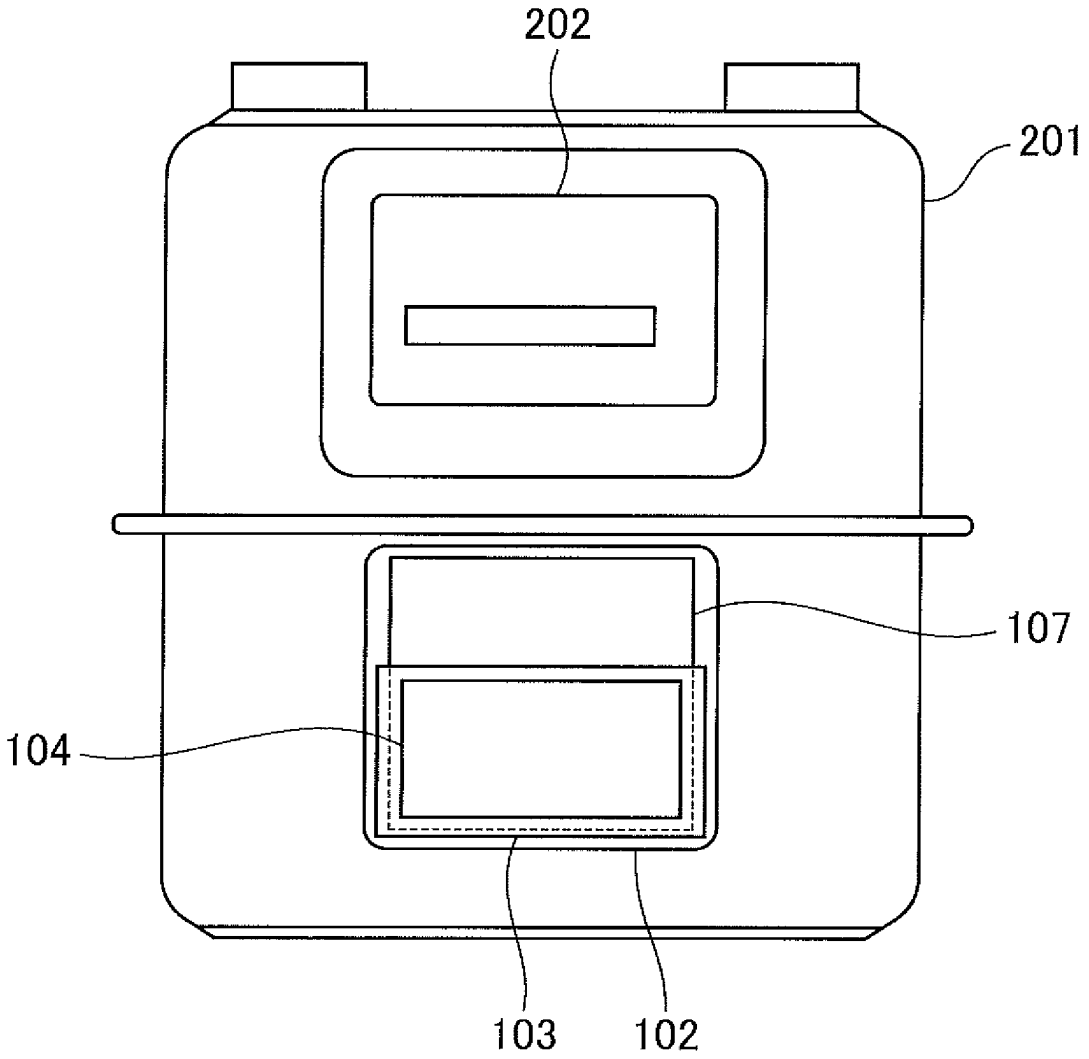


FIG.2

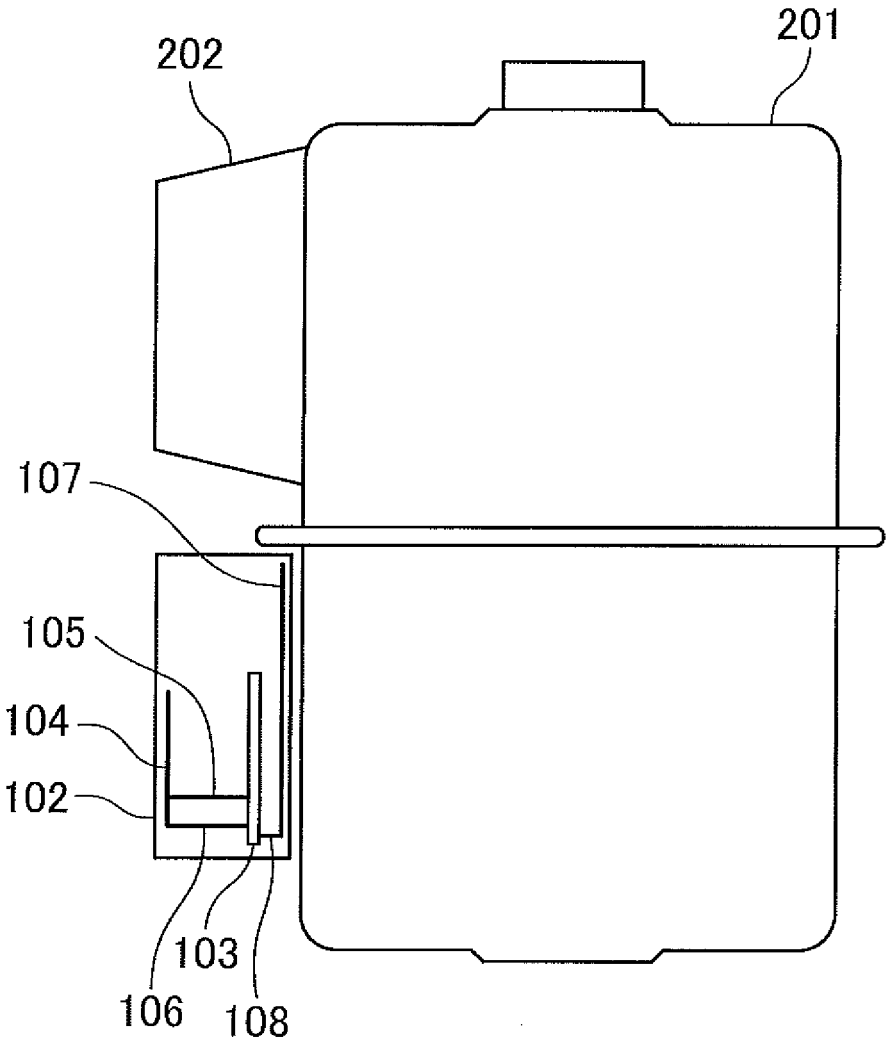


FIG.3

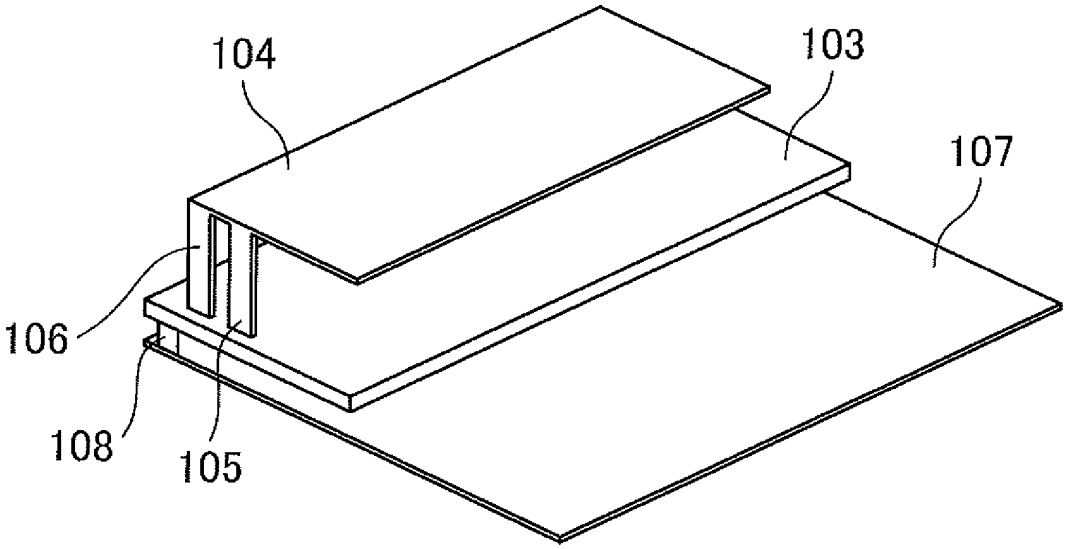


FIG.4A

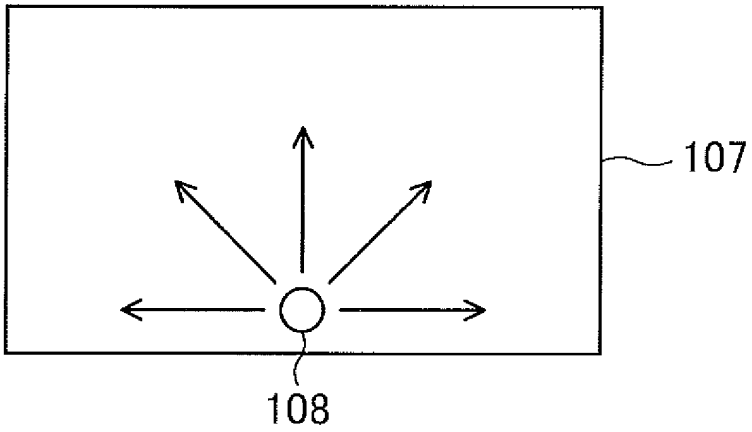


FIG.4B

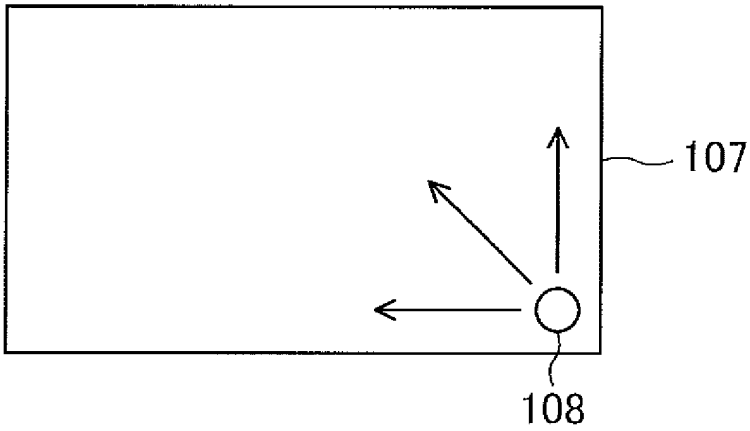


FIG.5

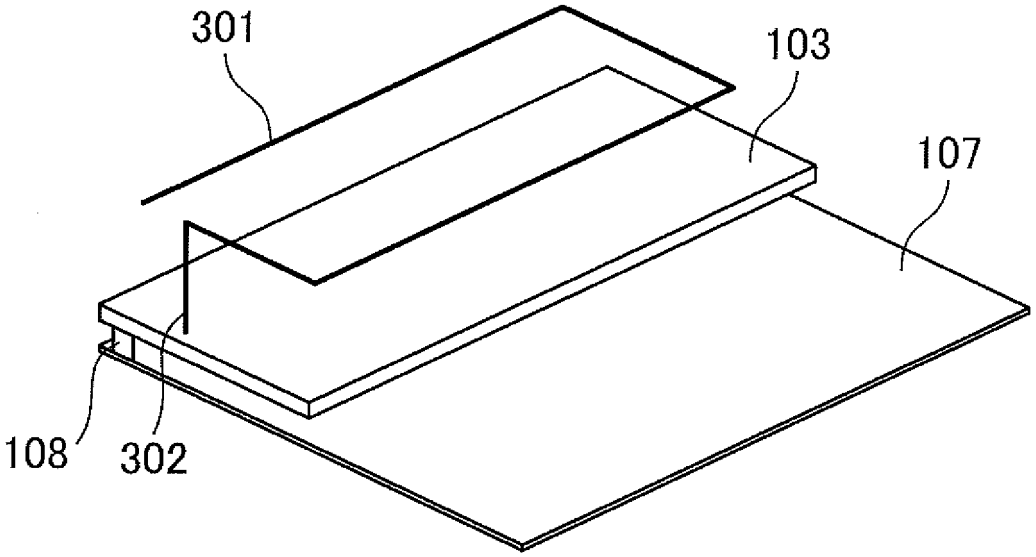
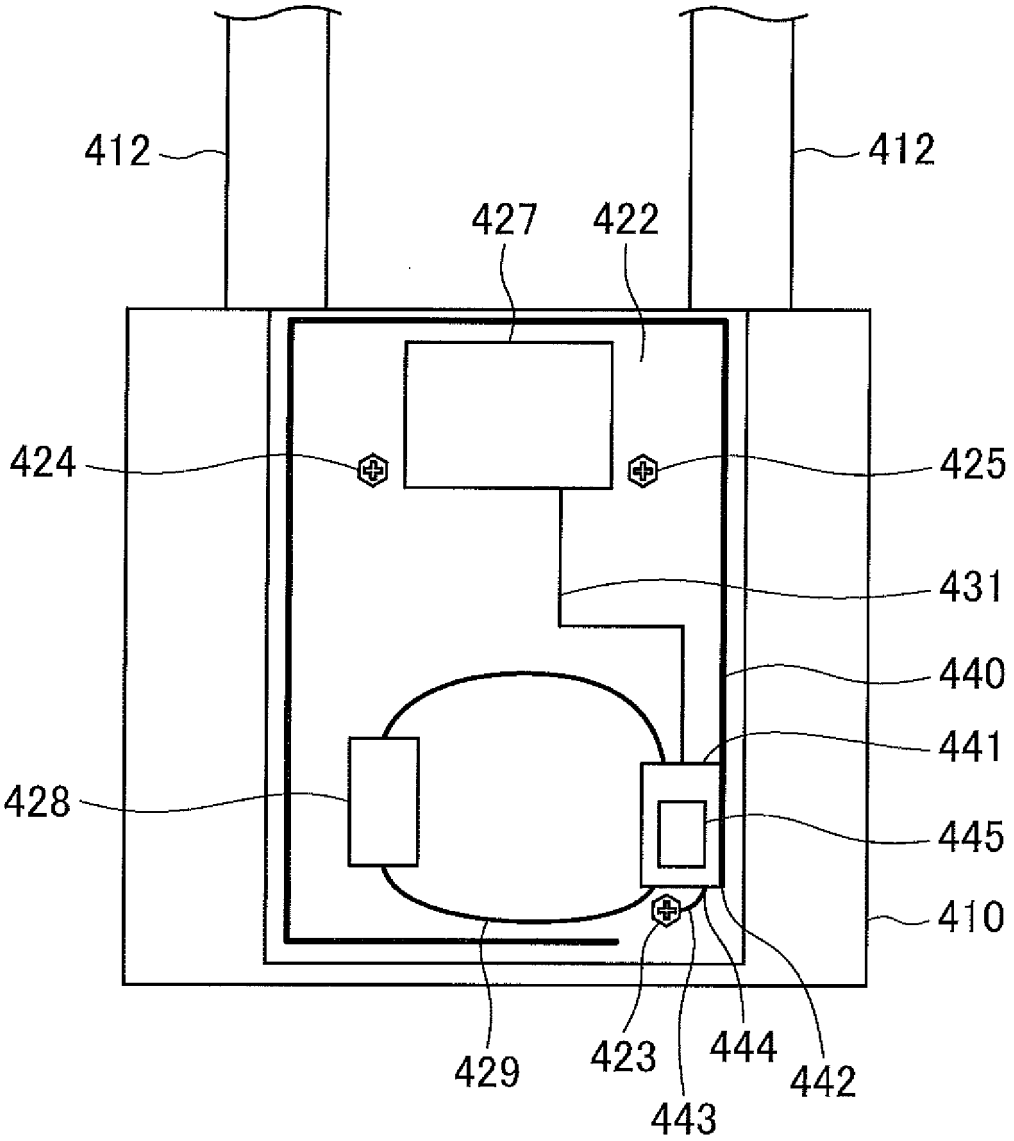


FIG.6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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/003534

A. CLASSIFICATION OF SUBJECT MATTER
H01Q1/24(2006.01)i, *H01Q9/38*(2006.01)i

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)
H01Q1/24, H01Q9/38

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 09-232841 A (Matsushita Electric Industrial Co., Ltd.), 05 September 1997 (05.09.1997), paragraphs [0051] to [0055]; fig. 6 (Family: none)	1,2 3-5
Y	WO 2012/070242 A1 (Panasonic Corp.), 31 May 2012 (31.05.2012), paragraphs [0095] to [0113]; fig. 11, 12 & US 2012/0313824 A1 & CN 102742078 A	3,4
Y	WO 2008/020562 A1 (Toshiba Corp.), 21 February 2008 (21.02.2008), paragraph [0006] & US 2009/0208779 A1 & TW 200830836 A	5

☒ Further documents are listed in the continuation of Box C. ☐ 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
13 August, 2013 (13.08.13)	20 August, 2013 (20.08.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/003534

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2008-072686 A (Hitachi Metals, Ltd.), 27 March 2008 (27.03.2008), paragraph [0071] & US 2007/0290944 A1 & EP 1845582 A1 & EP 2204881 A1 & DE 602007006584 D & KR 10-2007-0101168 A & CN 101055940 A & AT 468626 T	5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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