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(54) **POWER-SUPPLYING DEVICE, CONTROL METHOD FOR THE SAME, AND POWER-SUPPLYING SYSTEM**

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CPC ***H02J 7/00*** (2013.01); ***H02J 7/00034*** (2020.01); ***H02J 7/00036*** (2020.01); ***H02J 7/00041*** (2020.01); ***H02J 7/00045*** (2020.01); *H02J 7/0049* (2020.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,393,984 A 2/1995 Glavish
5,483,077 A 1/1996 Glavish
5,963,012 A 10/1999 Garcia et al.
6,052,408 A 4/2000 Trompower et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1912786 A 2/2007
CN 1917331 A 2/2007
(Continued)

OTHER PUBLICATIONS

The above patent documents were cited in a Sep. 9, 2016 U.S. Office Action, which is not enclosed, that issued in related U.S. Appl. No. 13/061,433.

(Continued)

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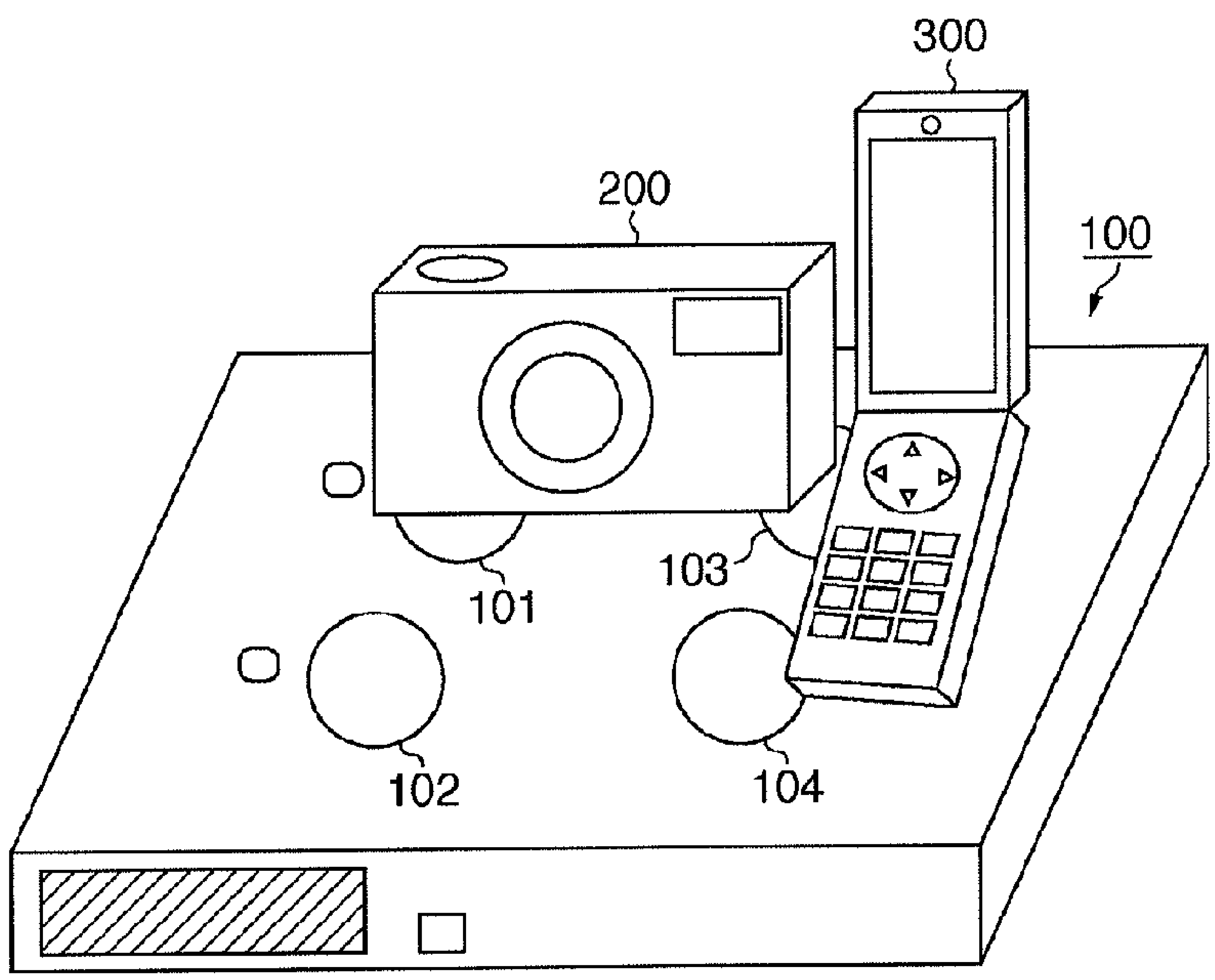
(57) **ABSTRACT**

Even when power is to be simultaneously supplied to a plurality of power-supplied devices by using one primary coil, it is possible to properly supply power to the respective power-supplied devices. More specifically, a power-supplying device stops non-contact power supply in accordance with the detection of a plurality of power-supplied devices set in a power supply area.

40 Claims, 7 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,104,512	A	8/2000	Batey, Jr. et al.	
6,243,240	B1	6/2001	Ozue et al.	
6,429,992	B1	8/2002	Ozue et al.	
6,529,127	B2	3/2003	Townsend et al.	
6,788,486	B1	9/2004	Sakai	
6,900,697	B1	5/2005	Doyle et al.	
6,977,551	B2	12/2005	Ichitsubo et al.	
7,180,404	B2	2/2007	Kunerth et al.	
7,216,243	B2	5/2007	Chou et al.	
7,277,679	B1	10/2007	Barratt et al.	
7,307,521	B2	12/2007	Funk et al.	
7,400,911	B2	7/2008	Planning et al.	
7,529,528	B2	5/2009	Uratani et al.	
7,605,496	B2 *	10/2009	Stevens	H02J 5/005 307/17
7,860,680	B2	12/2010	Arms et al.	
8,059,571	B2	11/2011	Sen et al.	
8,098,684	B2	1/2012	Schopfer et al.	
8,126,433	B2	2/2012	Haartsen	
8,248,024	B2 *	8/2012	Yuan	H02J 50/12 320/108
8,282,009	B2	10/2012	Ahn et al.	
8,295,764	B2	10/2012	Rhodes et al.	
8,305,036	B2 *	11/2012	Toya	H02J 7/025 320/108
8,355,748	B2	1/2013	Abe et al.	
8,463,394	B2	6/2013	Forsell	
8,527,786	B2	9/2013	Nakano	
8,581,444	B2	11/2013	Urano	
8,618,696	B2	12/2013	Kurs et al.	
8,680,715	B2 *	3/2014	Tanabe	H01M 10/44 307/104
8,798,571	B2	8/2014	Shih et al.	
8,805,386	B2	8/2014	Cho	
8,829,727	B2	9/2014	Urano	
8,836,279	B2	9/2014	Nakano	
9,124,121	B2	9/2015	Ben-Shalom et al.	
9,197,143	B1	11/2015	Townsend et al.	
9,301,337	B2	3/2016	Brown et al.	
2002/0176513	A1	11/2002	Gouessant et al.	
2003/0023540	A2	1/2003	Johnson et al.	
2003/0038897	A1	2/2003	Shiotsu	
2003/0129978	A1	7/2003	Akiyama et al.	
2004/0205365	A1	10/2004	Chou et al.	
2005/0068009	A1	3/2005	Aoki	
2005/0140482	A1	6/2005	Cheng et al.	
2005/0227723	A1	10/2005	Lee et al.	
2005/0254647	A1	11/2005	Anandakumar et al.	
2006/0046668	A1	3/2006	Uratani et al.	
2006/0079265	A1	4/2006	Masuda	
2006/0103534	A1	5/2006	Arms et al.	
2006/0103730	A1	5/2006	Jung	
2006/0172782	A1	8/2006	Planning et al.	
2006/0209892	A1	9/2006	MacMullan et al.	
2007/0032098	A1	2/2007	Bowles et al.	
2007/0139000	A1	6/2007	Kozuma et al.	
2007/0189242	A1	8/2007	Hosokawa et al.	
2007/0224951	A1	9/2007	Gilb et al.	
2007/0232344	A1	10/2007	Aoki et al.	
2008/0117117	A1	5/2008	Washiro	
2008/0237355	A1	10/2008	Ahn et al.	
2008/0299927	A1	12/2008	Tenbrook et al.	
2009/0003481	A1	1/2009	Schopfer et al.	
2009/0029652	A1	1/2009	Xie et al.	
2009/0088077	A1	4/2009	Brown et al.	
2009/0175255	A1	7/2009	Akiyama et al.	
2009/0181681	A1	7/2009	Hammond et al.	
2009/0219863	A1	9/2009	Sen et al.	
2009/0243394	A1	10/2009	Levine	
2009/0275293	A1	11/2009	Ida	
2009/0276639	A1	11/2009	Saha et al.	
2010/0039066	A1 *	2/2010	Yuan	H02J 50/12 320/108
2010/0069005	A1	3/2010	Haartsen	
2011/0217927	A1	9/2011	Ben-Shalom et al.	
2011/0244794	A1	10/2011	Nakano	
2011/0248846	A1	10/2011	Belov et al.	
2011/0264297	A1	10/2011	Nakano	
2013/0015249	A1	1/2013	Ahn et al.	
2013/0235757	A1	9/2013	Wang	
2013/0285455	A1	10/2013	Hunter et al.	
2016/0006343	A1	1/2016	Terada et al.	
2016/0156873	A1	6/2016	Toye et al.	
2016/0234631	A1	8/2016	Brown et al.	

FOREIGN PATENT DOCUMENTS

CN	101233666	A	7/2008	
GB	2388716	A *	11/2003	H01F 3/02
GB	2389720	B *	9/2005	H01F 17/0006
JP	09-103037	A	4/1997	
JP	11-098706	A	4/1999	
JP	11-168837	A	6/1999	
JP	2005-110399	A	4/2005	
JP	2005-192392	A	7/2005	
JP	2006-081249	A	3/2006	
JP	2006-211050	A	8/2006	
JP	2006-246633	A	9/2006	
JP	2006-314181	A	11/2006	
JP	2007-089341	A	4/2007	
JP	2007-148564	A	6/2007	
JP	2008-206297	A	9/2008	
WO	WO 2005109597	A1 *	11/2005	H02J 5/005

OTHER PUBLICATIONS

The above references were cited in a Supplementary European Search Report issued on Aug. 14, 2013. which is enclosed, that issued in the corresponding European Patent Application No. 10774980.6.

The above references were cited in a Aug. 30, 2013 European Search Report which is enclosed of the counterpart Europcan Patent Application No. 10774985.5, which is a counterpart application of the related U.S. Appl. No. 13/062,433.

* cited by examiner

FIG. 1

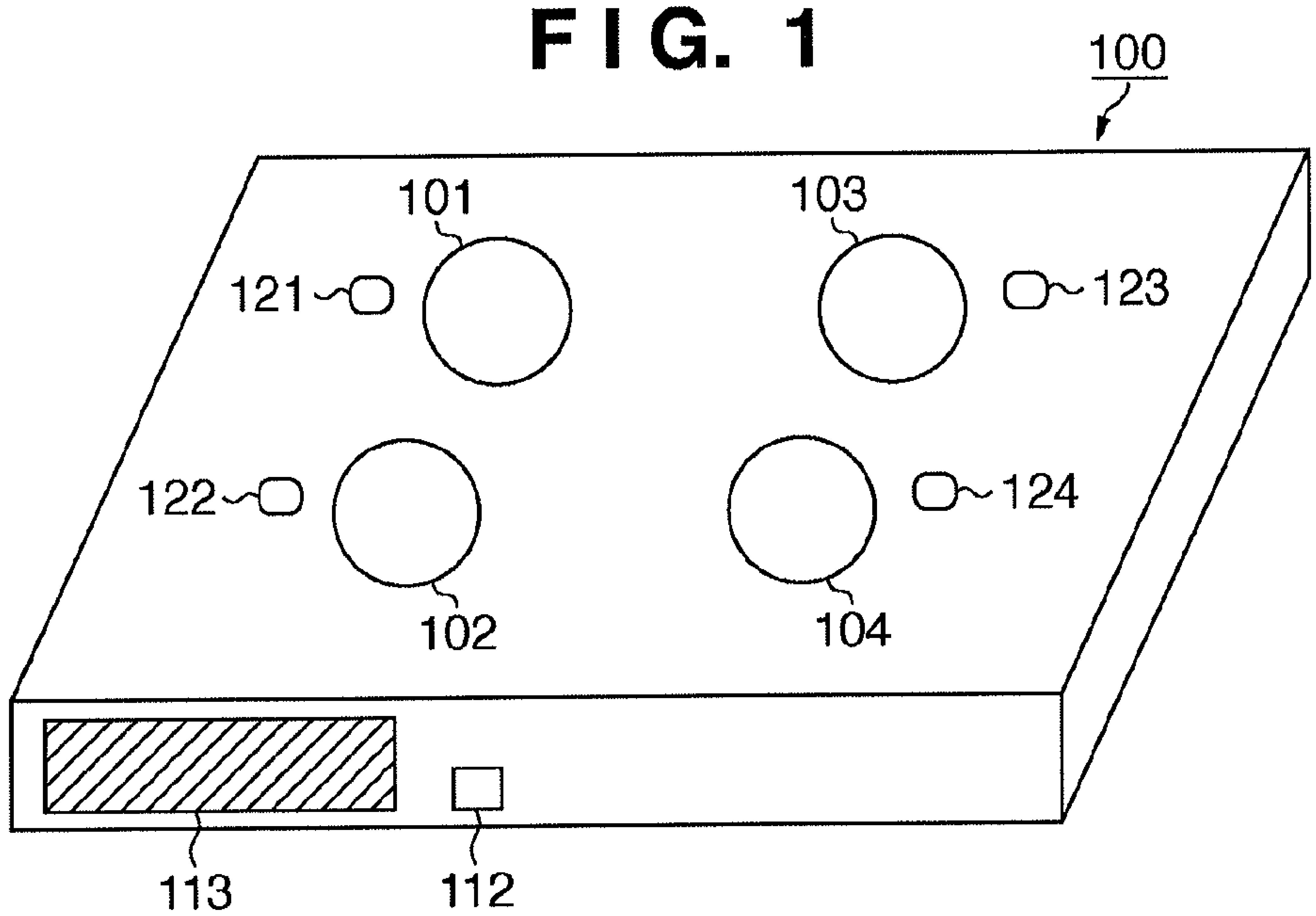

100
101
103
121
123
122
124
102
104
113
112

FIG. 2

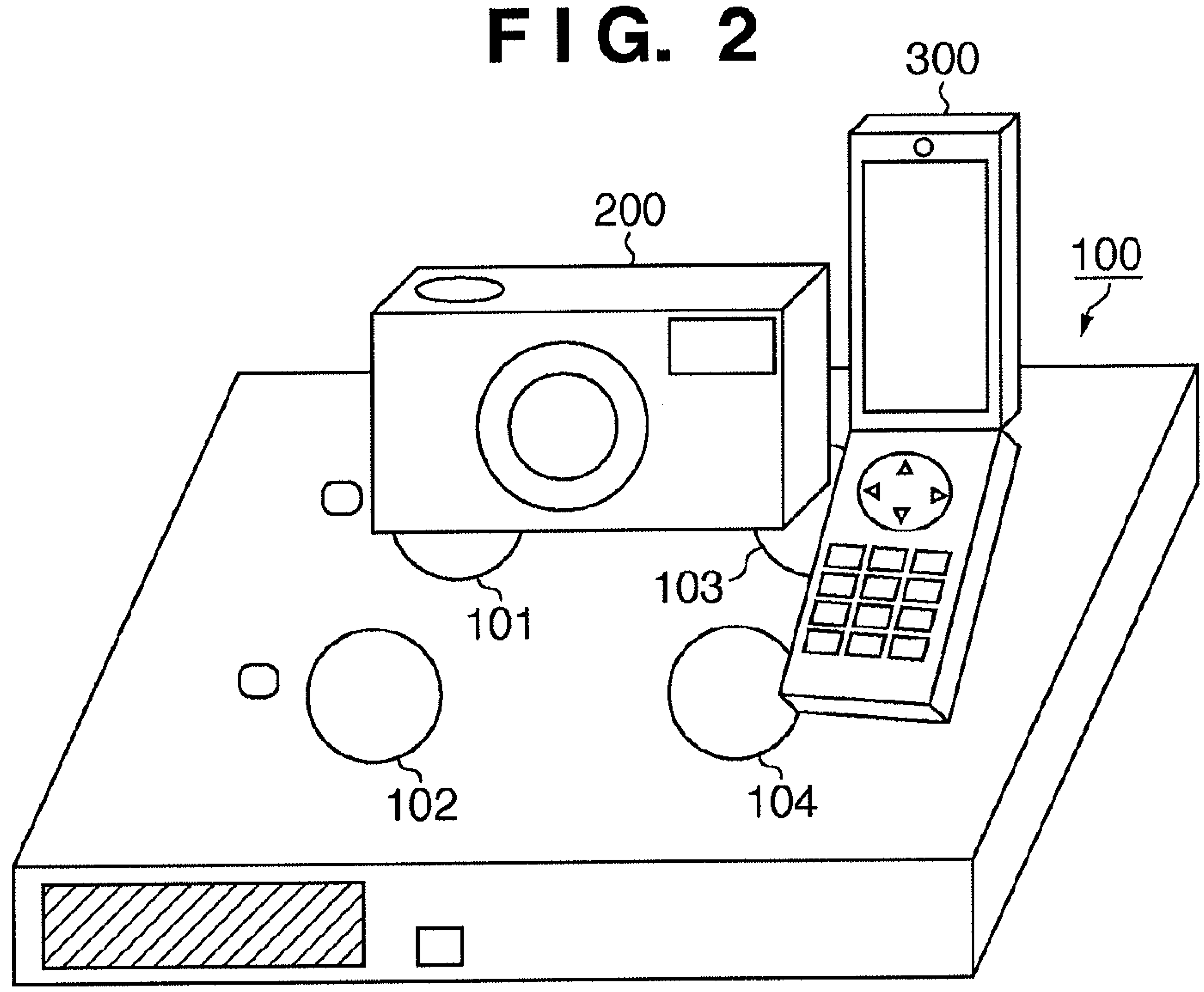

300
200
100
101
103
102
104

FIG. 3

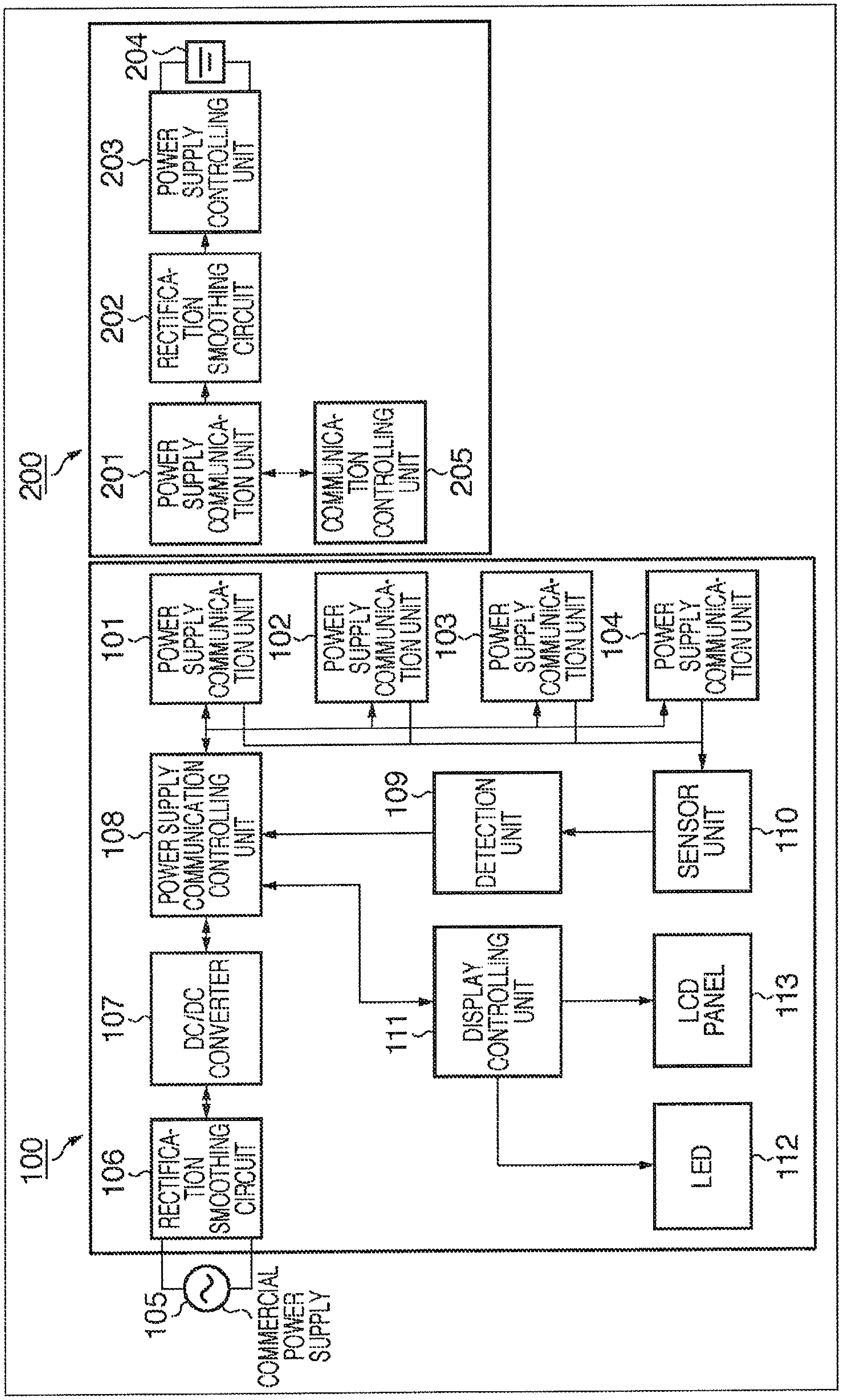

100
200
101
POWER SUPPLY COMMUNICATION UNIT
102
POWER SUPPLY COMMUNICATION UNIT
103
POWER SUPPLY COMMUNICATION UNIT
104
POWER SUPPLY COMMUNICATION UNIT
105
COMMERCIAL POWER SUPPLY
106
RECTIFICATION SMOOTHING CIRCUIT
107
DC/DC CONVERTER
108
POWER SUPPLY COMMUNICATION CONTROLLING UNIT
109
DETECTION UNIT
110
SENSOR UNIT
111
DISPLAY CONTROLLING UNIT
112
LED
113
LCD PANEL
201
POWER SUPPLY COMMUNICATION UNIT
202
RECTIFICATION SMOOTHING CIRCUIT
203
POWER SUPPLY CONTROLLING UNIT
204
205
COMMUNICATION CONTROLLING UNIT

FIG. 4

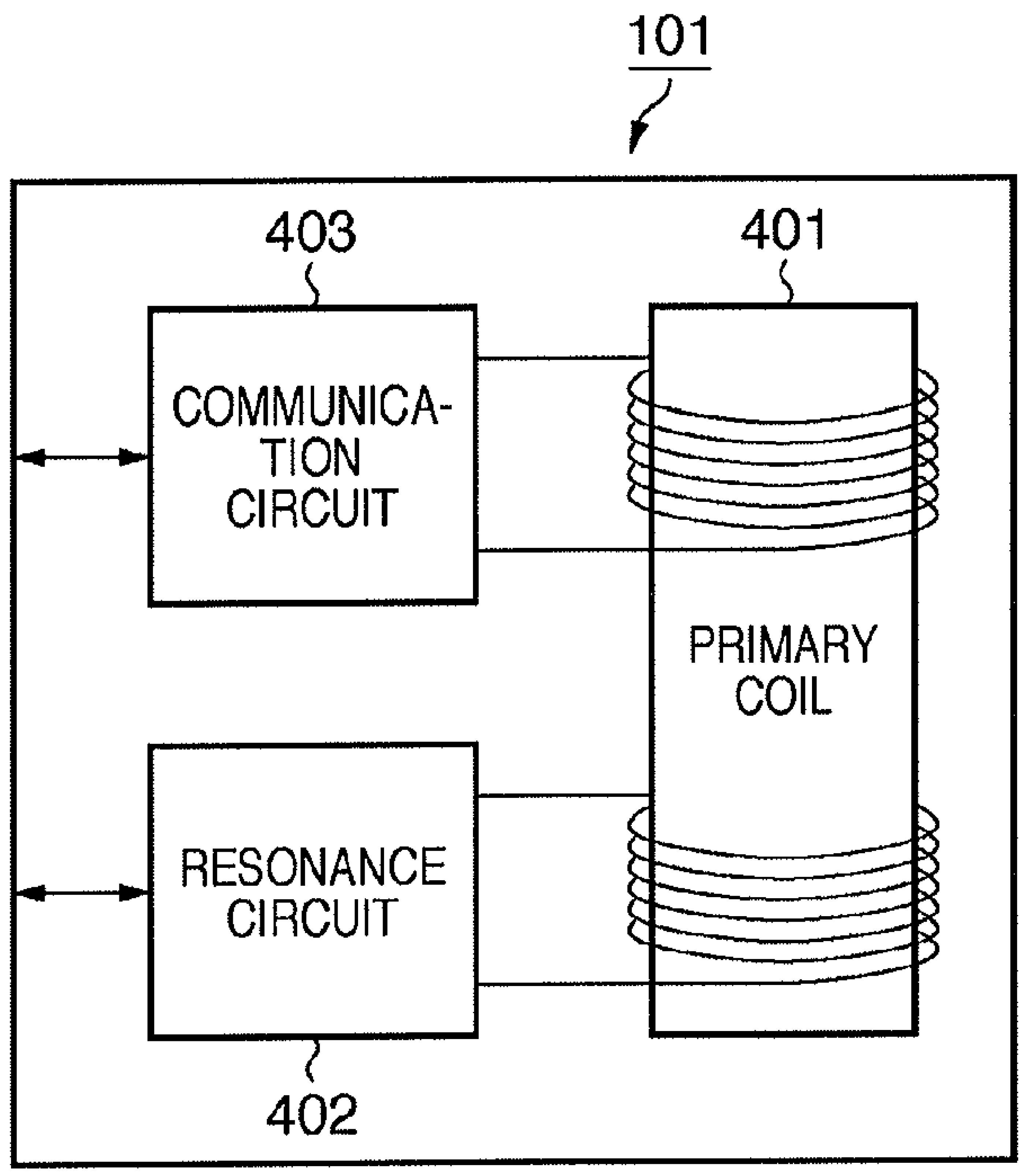


FIG. 5A

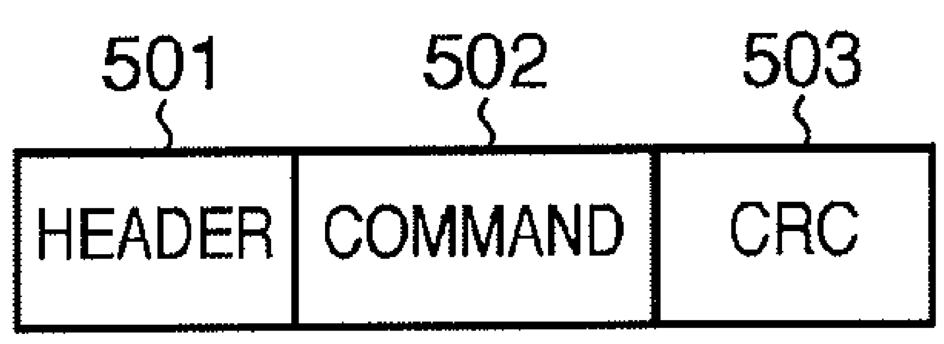


FIG. 5B

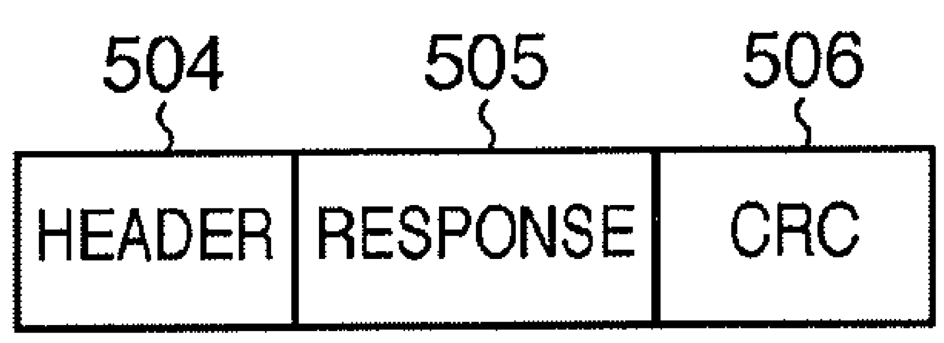


FIG. 5C

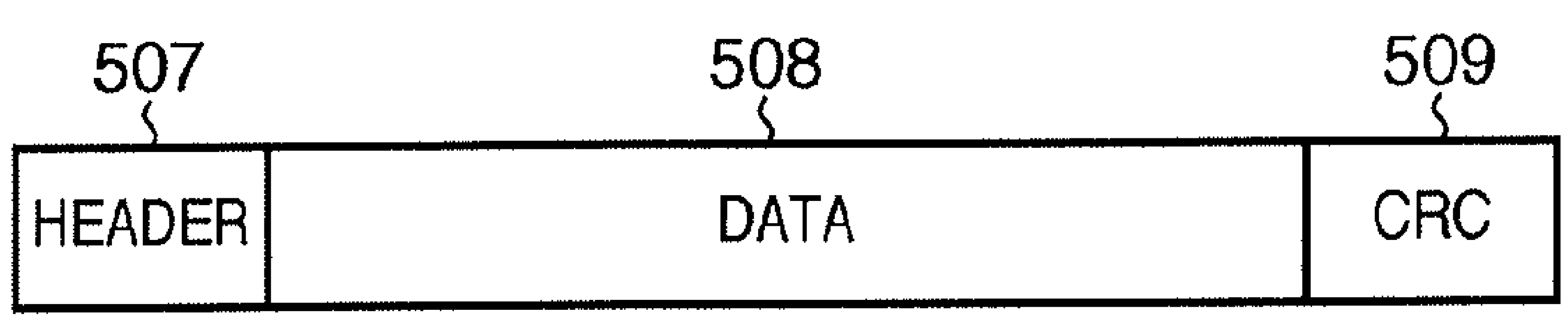


FIG. 6A

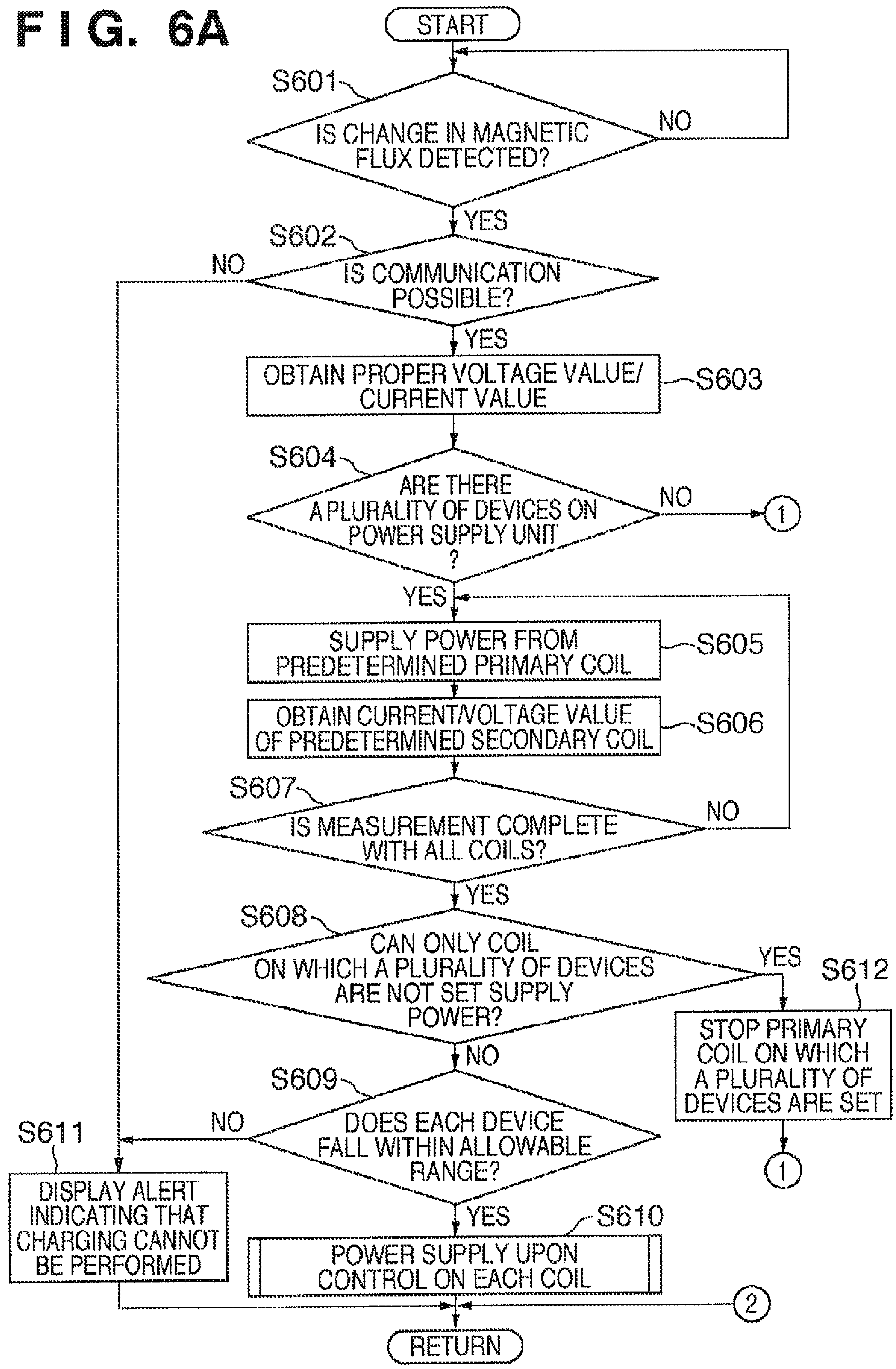

START
S601
IS CHANGE IN MAGNETIC FLUX DETECTED?
NO
YES
S602
IS COMMUNICATION POSSIBLE?
NO
YES
OBTAIN PROPER VOLTAGE VALUE/ CURRENT VALUE
S603
S604
ARE THERE A PLURALITY OF DEVICES ON POWER SUPPLY UNIT ?
NO
1
YES
SUPPLY POWER FROM PREDETERMINED PRIMARY COIL
S605
OBTAIN CURRENT/VOLTAGE VALUE OF PREDETERMINED SECONDARY COIL
S606
S607
IS MEASUREMENT COMPLETE WITH ALL COILS?
NO
YES
S608
CAN ONLY COIL ON WHICH A PLURALITY OF DEVICES ARE NOT SET SUPPLY POWER?
YES
S612
STOP PRIMARY COIL ON WHICH A PLURALITY OF DEVICES ARE SET
1
NO
S609
DOES EACH DEVICE FALL WITHIN ALLOWABLE RANGE?
NO
S611
DISPLAY ALERT INDICATING THAT CHARGING CANNOT BE PERFORMED
YES
S610
POWER SUPPLY UPON CONTROL ON EACH COIL
2
RETURN

FIG. 6B

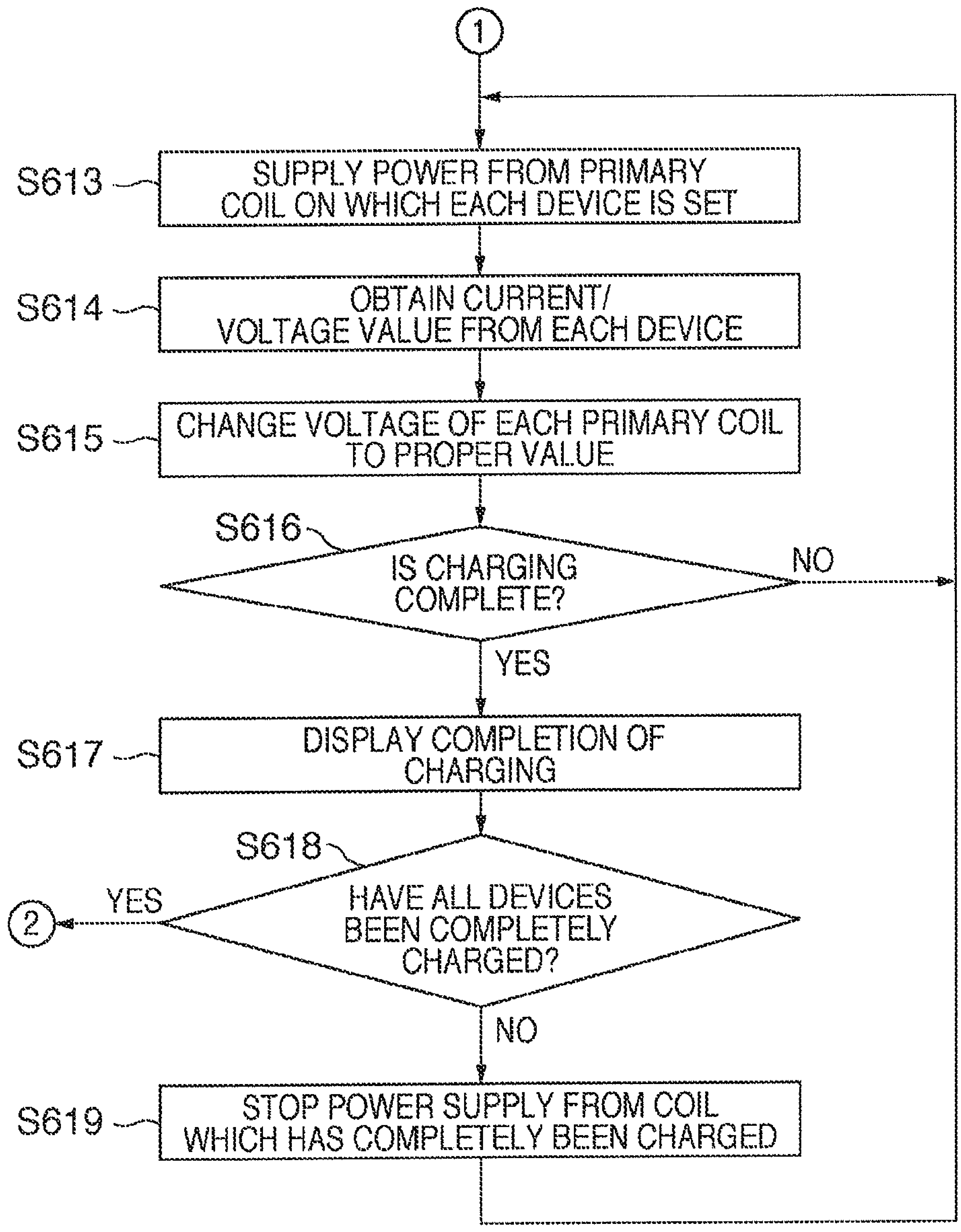
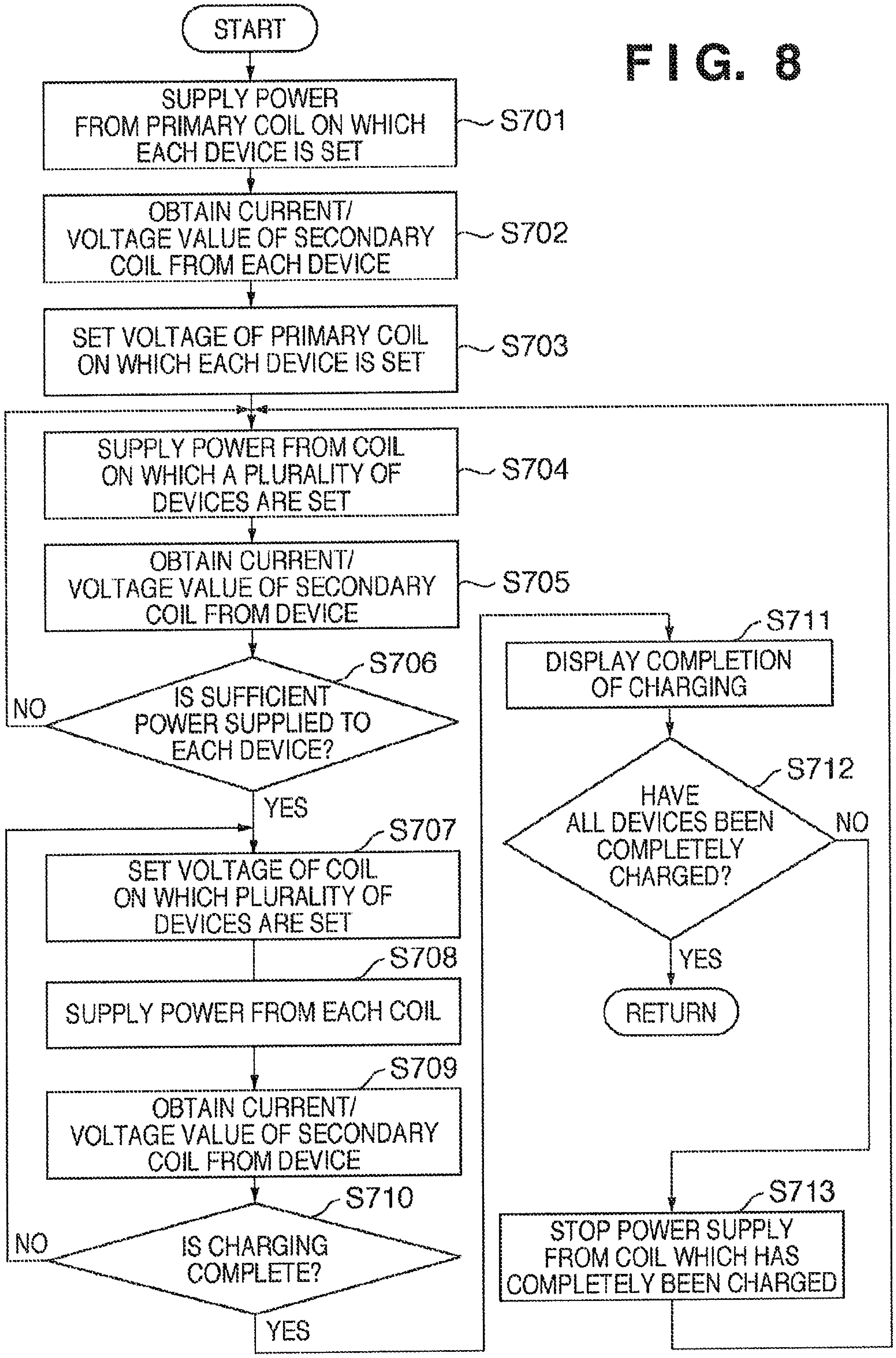

1
S613
SUPPLY POWER FROM PRIMARY COIL ON WHICH EACH DEVICE IS SET
S614
OBTAIN CURRENT/ VOLTAGE VALUE FROM EACH DEVICE
S615
CHANGE VOLTAGE OF EACH PRIMARY COIL TO PROPER VALUE
S616
IS CHARGING COMPLETE?
NO
YES
S617
DISPLAY COMPLETION OF CHARGING
S618
HAVE ALL DEVICES BEEN COMPLETELY CHARGED?
YES
2
NO
S619
STOP POWER SUPPLY FROM COIL WHICH HAS COMPLETELY BEEN CHARGED

FIG. 7

		801 DIGITAL CAMERA	802 CELLULAR PHONE
803	DEVICE NAME	ABC001	XYZ505
804	MAKER NAME	○○	△□
805	ALLOWABLE VOLTAGE VALUE (MIN)	6V	5V
806	ALLOWABLE VOLTAGE VALUE (MAX)	8V	6.5V
807	ALLOWABLE CURRENT VALUE (MIN)	500mA	300mA
808	ALLOWABLE CURRENT VALUE (MAX)	1A	600mA

FIG. 8


START
SUPPLY POWER FROM PRIMARY COIL ON WHICH EACH DEVICE IS SET
S701
OBTAIN CURRENT/ VOLTAGE VALUE OF SECONDARY COIL FROM EACH DEVICE
S702
SET VOLTAGE OF PRIMARY COIL ON WHICH EACH DEVICE IS SET
S703
SUPPLY POWER FROM COIL ON WHICH A PLURALITY OF DEVICES ARE SET
S704
OBTAIN CURRENT/ VOLTAGE VALUE OF SECONDARY COIL FROM DEVICE
S705
IS SUFFICIENT POWER SUPPLIED TO EACH DEVICE?
S706
NO
YES
SET VOLTAGE OF COIL ON WHICH PLURALITY OF DEVICES ARE SET
S707
SUPPLY POWER FROM EACH COIL
S708
OBTAIN CURRENT/ VOLTAGE VALUE OF SECONDARY COIL FROM DEVICE
S709
IS CHARGING COMPLETE?
S710
NO
YES
DISPLAY COMPLETION OF CHARGING
S711
HAVE ALL DEVICES BEEN COMPLETELY CHARGED?
S712
NO
YES
RETURN
STOP POWER SUPPLY FROM COIL WHICH HAS COMPLETELY BEEN CHARGED
S713

POWER-SUPPLYING DEVICE, CONTROL METHOD FOR THE SAME, AND POWER-SUPPLYING SYSTEM

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

TECHNICAL FIELD

The present invention relates to a power-supplying device, a control method for the same, and a power-supplying system.

BACKGROUND ART

Conventionally, there has been known a power-supplying device that supplies power to a power-supplied device in a non-contact manner by using electromagnetic induction. Such a power-supplying device uses a mechanism to generate an electromotive force on the secondary coil side of a power-supplied device by feeding a current to the primary coil side. By using this electromagnetic induction to supply power, the displacement between the primary coil and the secondary coil will become the less power efficiency or cause excessive power supply. For this reason, Japanese Patent Laid-Open No. 9-103037 discloses a method to control the power to be supplied, based on the information received from a power-supplied device.

The above conventional technique, however, is not based on the assumption that power is simultaneously supplied to a plurality of power-supplied devices in a non-contact manner by using one primary coil. Assume a situation in which power is simultaneously supplied to a plurality of power-supplied devices in a non-contact manner by using one primary coil. In this case, in order to properly supply power to the respective power-supplied devices, it is necessary to control power to be supplied in accordance with the power-supplied devices with different allowable amounts associated with power supply, for example, allowable voltage and current values.

SUMMARY OF INVENTION

The present invention has been made in consideration of the above problems in the prior art. The present invention provides a power-supplying device, which can properly supply power to each power-supplied device even if power is simultaneously supplied to the respective power-supplied devices in a non-contact manner by using one primary coil, a control method for the power-supplying device, and a power-supplying system.

The present invention in its first aspect provides a power-supplying device including a plurality of primary coils comprising: power supply means for supplying power in a non-contact manner from each of the plurality of primary coils to at least one power-supplied device set in a power supply area of each of the plurality of primary coils; detecting means for detecting whether a plurality of power-supplied devices are set in the power supply area of one of the plurality of primary coils; and controlling means for controlling the power supply means to stop supplying power from the one of the plurality of primary coils on which the

plurality of power-supplied devices are detected to be set, when the detecting means detects that the plurality of power-supplied devices are set in the power supply area of the one of the plurality of primary coils.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view showing the external arrangement of a power-supplying device according to this embodiment;

FIG. **2** is a perspective view showing an example of a system configuration including a power-supplying device according to this embodiment and power-supplied devices;

FIG. **3** is a block diagram showing the internal arrangements of the power-supplying device according to this embodiment and power-supplied device;

FIG. **4** is a view showing the details of a power supply communication unit in the power-supplying device according to this embodiment;

FIGS. **5**A, **5**B, and **5**C are views each showing an example of a packet structure at the time of communication according to this embodiment;

FIGS. **6**A and **6**B are flowcharts showing processing in the power-supplying device according to this embodiment;

FIG. **7** is a view showing an example of information obtained from power-supplied devices and stored in a memory; and

FIG. **8** is a flowchart showing power supply processing which is processing performed by the power-supplying device according to this embodiment in a case in which a plurality of power-supplied devices are set on one power supply communication unit.

DESCRIPTION OF EMBODIMENTS

An embodiment of the present invention will be described below with reference to the accompanying drawings. However, the embodiment of the present invention exemplifies a preferred embodiment of the present invention, and does not limit the scope of the invention.

FIG. **1** is a perspective view showing the external arrangement of a non-contact type power-supplying device **100** according to this embodiment. As shown in FIG. **1**, the power-supplying device **100** includes power supply communication units **101** to **104** each having a power supply function and a communication function. That is, the power-supplying device **100** includes a plurality of power supply communication units each having one primary coil for supplying power to an external device having a secondary coil. The power-supplying device **100** supplies power, in a non-contact manner, to external devices set in the magnetic fields (power supply areas) generated by the primary coils of the four power supply communication units by generating an electromotive force in the secondary coils of the external devices utilizing an electromagnetic induction. The external devices which receive power supplied from the power-supplying device **100** (in the following description, external devices which receive supplied power will be referred to as power-supplied devices) can charge rechargeable batteries in their main bodies by this power supply. Note that when a plurality of power-supplied devices are set in the magnetic field generated by one primary coil, the power-supplying device **100** can supply power to the power-supplied devices. This embodiment uses the electromagnetic induction scheme as a scheme of supplying power in a non-contact manner. However, it is possible to use any scheme, for example, a magnetic field resonance scheme (magnetic resonance scheme), which is designed to supply power in a non-contact manner by generating power in the coil which a power-supplied device has, using the magnetic field (magnetic force) generated by a coil of a power-supplying device.

The power-supplying device **100** includes an LED **112** and LCD **113** for notifying the user of messages indicating an error during supplying the power, a change of power supply stares, and "charge completion" that indicates the completion of charging of the rechargeable battery of a power-supplied device. Magnetic sensors **121** to **124** such as hall devices are set near the power supply communication units **101** to **104**, respectively. When the magnetic sensor **121** to **124** detect changes in magnetic flux, the power-supplying device **100** detects that power-supplied devices are set in the power supply areas of the power supply communication units **101** to **104**. By determining which one of the magnetic sensors **121** to **124** has detected a change in magnetic flux, the power-supplying device **100** can also determine in which one of the power supply areas of the power supply communication units **101** to **104** a power-supplied device is set.

FIG. **2** is a perspective view showing an example of the system configuration constituted by the power-supplying device **100** and power-supplied devices. In the system configuration exemplified by FIG. **2**, a digital camera **200** and a cellular phone **300** as power-supplied devices are set on the power-supplying device **100** shown in FIG. **1**.

Both the digital camera **200** and the cellular phone **300** incorporate rechargeable batteries which can be charged and secondary coils for receiving power supplied from the power-supplying device **100** in non-contact manner, and are compatible with a method of charging rechargeable batteries by utilizing an electromagnetic induction. In the example shown in FIG. **2**, the digital camera **200** is set in the power supply areas of the power supply communication units **101** and **103**, and receives power from the power supply communication units **101** and **103**. The cellular phone **300** is set in the power supply areas of the power supply communication units **103** and **104**, and receive power from the power supply communication units **103** and **104**.

The digital camera **200** obtains information such as a control signal from the power-supplying device **100** by detecting, via the secondary coil, the magnetic fluxes generated in the primary coils by the communication circuits of the power supply communication units **101** and **103**. The digital camera **200** also rectifies the AC power generated in the secondary coil by the magnetic fluxes generated in the primary coils by the power supply circuits of the power supply communication units **101** and **103**, and receives power from the power-supplying device **100**. Likewise, the cellular phone **300** obtains information such as a control signal from the power-supplying device **100** by detecting, via the secondary coil, the magnetic fluxes generated in the primary coils by the communication circuits of the power supply communication units **103** and **104**. The cellular phone **300** also rectifies the AC power generated in the secondary coil by the magnetic fluxes generated in the primary coils by the power supply circuits of the power supply communication units **103** and **104**, and receives power from the power-supplying device **100**.

Although this embodiment has exemplified a digital camera and a cellular phone as power-supplied devices, power-supplied devices are not limited to these devices. Power-supplied devices may be any devices to and with which the power supply communication units **101** to **104** of the power-supplying device **100** can supply power and communicate.

FIG. **3** is a block diagram showing the internal arrangements of the power-supplying device **100** and digital camera **200** as a power-supplied device according to this embodiment. As shown in FIG. **3**, the power-supplying device **100** includes the power supply communication units **101**, **102**, **103**, and **104**, a commercial power supply **105**, a rectification smoothing circuit **106**, a DC/DC converter **107**, and a power supply communication controlling unit **108**. The power-supplying device **100** further includes a detection unit **109**, a sensor unit **110**, a display controlling unit **111**, the LED **112**, and the LCD **113**. The digital camera **200** as a power-supplied device includes a power supply communication unit **201**, a rectification smoothing circuit **202**, a power supply controlling unit **203**, a rechargeable battery **204**, and a communication controlling unit **205**.

The details of the power supply communication units **101** to **104** will be described in detail first with reference to FIG. **4**. FIG. **4** is a view showing the details of the power supply communication unit **101**. As shown in FIG. **4**, the power supply communication unit **101** includes primary coils **401**, a resonance circuit **402**, and a communication circuit **403**.

The primary coils **401** are two coils respectively serving for communication and power supply, and generate magnetic fluxes by being excited by the resonance circuit **402** and the communication circuit **403**. Upon receiving a control instruction from the power supply communication controlling unit **108** shown in FIG. **3**, the resonance circuit **402** generates a magnetic flux for power supply by exciting the primary coil **401**. Upon receiving a control instruction from the power supply communication controlling unit **108**, the communication circuit **403** generates a magnetic flux for signal transfer by exciting the primary coil **401**.

The communication circuit **403** causes the primary coil **401** to generate a magnetic flux, with information based on the control instruction received from the power supply communication controlling unit **108** being superimposed on a magnetic flux pattern for signal transfer. This can generate an electromotive force based on the magnetic flux in the secondary coil of the digital camera **200** as a power-supplied device. The communication controlling unit **205** of the digital camera **200** can detect the electromotive force and obtain the information superimposed on the magnetic flux. As described above, the power-supplying device **100** can communicate with a power-supplied device by using the magnetic flux for signal transfer which is generated in the primary coil **401**. In contrast to this, the communication circuit **403** can detect the electromotive force generated when the primary coil **401** is excited by the magnetic flux for signal transfer which is generated in the secondary coil of a power-supplied device, and also can detect the information superimposed on the magnetic flux pattern. This makes it possible for the power-supplying device **100** to receive information from a power-supplied device.

The communication circuit **403** causes the primary coil **401** to generate a magnetic flux, with a magnetic flux for power transfer and a magnetic flux for signal transfer being superimposed in a generated oscillating magnetic flux, by transmitting a signal at a frequency different from that of the resonance circuit **402**. Although the power supply communication unit **101** has been exemplified in the description referring to FIG. **4**, the power supply communication units **102**, **103**, **104**, and **201** have the same arrangement. Note that the power supply communication unit **201** of the digital camera **200** as a power-supplied device uses the primary coil **401** as a secondary coil. Note, therefore, that the power supply communication units of a power-supplying device and power-supplied device each having the primary coil **401** or a secondary coil will be described as different units.

As shown in FIG. **3**, the rectification smoothing circuit **106** rectifies and smoothes an AC voltage from the commercial power supply **105**, and applies a DC voltage to the DC/DC converter **107**. The DC/DC converter **107** converts the input DC voltage into a predetermined voltage and sends it to the power supply communication controlling unit **108**.

The power supply communication controlling unit **108** includes a microcontroller and a memory and comprehensively controls each unit of the power-supplying device **100**. Note that the power supply communication controlling unit **108** includes a microcontroller, an internal RAM, and an internal ROM (none of which are shown). The power supply communication controlling unit **108** performs control to determine whether to output the DC voltage sent from the DC/DC converter **107** to each of the power supply communication units **101** to **104**. Upon determining to output the DC voltage, the power supply communication controlling unit **108** outputs it by turning on a switch for controlling each power supply communication unit.

The power supply communication units **101** to **104** each excite the primary coil based on the DC voltage applied from the DC/DC converter **107** via the power supply communication controlling unit **108** to transfer power to the digital camera **200** in a non-contact manner by using electromagnetic induction.

More specifically, the resonance circuit **402** converts the DC voltage into an AC current to generate an AC magnetic field, that is, an oscillating magnetic flux, in the primary coil **401**. This generates an electromotive force due to electromagnetic induction in the secondary coil which the digital camera **200** has, thereby supplying power to the digital camera **200**. The communication circuits **403** of the power supply communication units **101** to **104** each transmit a predetermined control instruction to the digital camera **200** upon superimposing predetermined information on the instruction, when exciting the primary coil, in accordance with a control instruction from the power supply communication controlling unit **108**. That is, the communication circuit **403** generates an oscillating magnetic flux for signal transfer in the primary coil **401** to generate an electromotive force corresponding to the oscillating magnetic flux for signal transfer in the secondary coil of the digital camera **200**, thereby transferring information to the digital camera **200**. Each communication circuit **403** obtains predetermined information from the induced electromotive force generated in the primary coil **401** using the magnetic flux generated in the secondary coil of the digital camera **200**.

The detection unit **109** detects, via the communication circuit **403**, the voltage or current of the induced electromotive force generated in the primary coil of each of the power supply communication units **101** to **104**. The detection unit **109** also obtains sensor information from the sensor unit **110** and transfers the obtained information to the power supply communication controlling unit **108**. The sensor unit **110** is a sensor such as a hall device which measures the strength of a magnetic field. More specifically, the sensor unit **110** includes the magnetic sensor **121** to **124** properly set on the power-supplying device **100**, detects that power-supplied devices are set on the power supply communication units **101** to **104**, and outputs the detected information as sensor information to the detection unit **109**.

The display controlling unit **111** controls display on the LED **112** and LCD **113** under the control of the power supply communication controlling unit **108**. More specifically, upon receiving predetermined event information from the power supply communication controlling unit **108**, the display controlling unit **111** receives a display image corresponding to the event information from the ROM which the power supply communication controlling unit **108** has, and causes the LCD **113** to display the image. Alternatively, the display controlling unit **111** turns the light on the LED **112** in accordance with event information from the power supply communication controlling unit **108**. With this operation, the power-supplying device **100** notifies the user of a message indicating a power supply error, a change in power supply status ("during power supply" or "power supply paused" or "charge completion").

In the digital camera **200**. as the magnetic flux generated by the primary coil of one of the power supply communication units **101** to **104** of the power-supplying device **100** changes, an electromotive force is generated in the secondary coil of the power supply communication unit **201**. As a result, a current flows. Since the voltage (AC) generated in the secondary coil of the power supply communication unit **201** is not stable, the rectification smoothing circuit **202** rectifies and smoothes the voltage, converts it into a DC voltage, and applies it to the power supply controlling unit **203**.

The power supply controlling unit **203** charges the rechargeable battery **204** based on the DC voltage applied from the rectification smoothing circuit **202**. Note that the power supply controlling unit **203** detects the status of the rechargeable battery **204** based on the voltage of the rechargeable battery **204**, the charging time, and the like, and controls the supply of power to the rechargeable battery **204**. The rechargeable battery **204** is, for example, a lithium-ion secondary battery or lithium-hydrogen secondary battery capable of storing power by charging.

In the power supply communication unit **201**, the communication circuit **403** detects the electromotive force generated in the secondary coil by a magnetic flux pattern for signal transfer which is generated by the power supply communication unit **101**, and transmits information superimposed on the magnetic flux pattern to the communication controlling unit **205**. If the received information is a predetermined command, the communication controlling unit **205** returns a response to the command. In addition, the communication controlling unit **205** sends predetermined data to the power supply communication units **101** to **104** of the power-supplying device **100** via the power supply communication unit **201**, as needed. In this case, the power supply communication unit **201** can cause the communication circuit **403** to generate, in the secondary coil, a magnetic flux pattern by superimposing predetermined response information or predetermined data on the power, supplied from the power-supplying device **100** and temporarily stored, by using the power supply controlling unit **203**. The power-supplying device **100** generates an electromotive force in the primary coil **401** of the power supply communication unit **101** in accordance with the magnetic flux pattern generated by the power supply communication unit **201**, and detects a change in electromotive force via the communication circuit **403**, thereby receiving the superimposed information.

Packet structures in communication of information using the excitation of the coil described above will be described below with reference to FIG. **5**A to **5**C. FIG. **5**A is a view showing the packet structure of a command sent from the power-supplying device **100** to a power-supplied device.

As shown in FIG. **5**A, a command sent from a power-supplying device to a power-supplied device is constituted by a header field **501**, a command field **502**, and a CRC field

503. The header field **501** is constituted by a start bit, a device ID, an identification number which is a number assigned to each command to be paired with a response and serves to identify the response, and a command length defining the length of the command. The command field **502** stores a command number for identifying a GetStatusu command, a GetInfo command, a GetCapability command, or the like. The CRC field **503** (Cyclic Redundancy Check) stores data for checking whether the data of the header field **501** and command field **502** are correct.

In this case, the GetStatus command is a command for inquiring a power-supplied device whether it can communicate and can be charged currently. The GetInfo command is a command for inquiring a power-supplied device about the present current/voltage status and the charged status (the charge ratio). The GetCapability command is a command for obtaining allowable amount information associated with power supply, for example, the allowable voltage/current of a power-supplied device. The information obtained from a power-supplied device by the GetInfo command the GetCapability command is power supply information including an allowable amount associated with power supply and a power supply amount indicating the charge ratio. Note that the device ID contained in the header field **501** is used to identify the device to which the command is to be transmitted, and is issued as a broadcast command when the GetInfo command is to be transmitted.

FIG. **5**B is a view showing the packet structure of a response which a power-supplied device transmits in response to a command transmitted from a power-supplying device to the power-supplied device. As shown in FIG. **5**B, a response to a command transmitted to a power-supplied device is constituted by a header field **504**, a response field **505**, and a CRC field **506**.

The header field **504** is constituted by a start bit, an identification number for identifying the response to the received command, a response length defining the length of the response, and the like. The response field **505** stores a response number for determining an ACK response indicating the reception of a command, a NACK response indicating the rejection of a command, or the like. The CRC field **506** stores data for checking whether the data of the data of the header field **504** and response field **505** are correct.

FIG. **5**C is a view showing the packet structure of data transmitted from a power-supplying device to a power-supplied device. As shown in FIG. **5**C, data transmitted to a power-supplied device is constituted by a header field **507**, a data field **508**, and a CRC field **509**.

The header field **507** is constituted by a start bit, a data length defining the length of data, and the like. The data field **508** stores predetermined data corresponding to a command. The CRC field **509** stores data for checking whether the data of the header field **507** and data field **508** are correct.

Note that when such a command is to be transmitted, the communication circuit **403** of the power supply communication unit generates a command as a magnetic flux pattern from the coil of a corresponding device. The magnetic flux pattern generated in the coil of one device generates an electromotive force in the coil of the other device. Detecting this electromotive force makes it possible to receive a command.

A processing procedure in the power-supplying device **100** according to this embodiment will be described below with reference to FIGS. **6**A and **6**B. As shown in FIGS. **6**A and **6**B, when the processing starts, the power supply communication controlling unit **108** determines whether the sensor unit **110** including the magnetic sensor **121** to **124** has detected a change in magnetic flux (S**601**). In this determination in step S**601**, the power supply communication controlling unit **108** detects that any device are set on the power supply communication units **101** to **104**.

Upon detecting that some devices are set in the power supply areas of the power supply communication units **101** to **104**, the power supply communication controlling unit **108** stops driving the resonance circuits of the power supply communication units **101** to **104**. The power supply communication controlling unit **108** then determines whether it can communicate with the detected devices (S**602**). The determination about the capability of communication is performed by causing the power supply communication units **101** to **104** set near those of the magnetic sensors **121** to **124** which have detected the devices to issue the GetStatus command for inquiring the devices whether they can communicate, under the control of the power supply communication controlling unit **108**. As described above, the power supply communication controlling unit **108** issues this command by driving the communication circuit **403** to generate a magnetic flux pattern corresponding to the GetStatus command from the primary coil **401** in the power supply communication units **101** to **104**. If there is no response to this command, the power supply communication controlling unit **108** determines that the devices set in the power supply areas of the power supply communication units **101** to **104** cannot communicate. That is, the power supply communication controlling unit **108** determines that the devices set in the power supply areas of the power supply communication units **101** to **104** are not power-supplied devices which are compatible with power supply from the power supply communication units **101** to **104**. If, therefore, there is no response to the GetStatus command, the power supply communication controlling unit **108** sends a control instruction for the execution of displaying alert indication to the display controlling unit **111**. The display controlling unit **111** then causes the LED **112** or the LCD **113**, under the control of the power supply communication controlling unit **108**, to display the alert indication to indicate that the devices cannot be charged, thereby notifying the user of the corresponding information (S**611**).

In contrast, if the devices set in the power supply areas of the power supply communication units **101** to **104** can communicate and correspond to the power-supplying device **100**, the communication circuit **403** of the power supply communication unit of each power-supplied device returns a response indicating that a command has been received. That is, the communication circuit **403** of each power-supplied device generates a magnetic flux pattern on which response data is superimposed in the secondary coil of the power-supplied device, thereby transmitting a response to the power-supplying device **100**. The power supply communication controlling unit **108** receives the response data by detecting the electromotive force generated in the primary coil **401** of any of the power supply communication units **101** to **104** via the communication circuit **403**. Upon receiving the response data, the power supply communication controlling unit **108** interprets the response data. After the interpretation of the response data, the power supply communication controlling unit **108** obtains power supply information such as the proper voltage and current value of each of the power-supplied devices set in the power supply areas of the power supply communication units **101** to **104** and the DeviceID and VendorID of the power-supplied device (S**603**).

More specifically, the power supply communication controlling unit **108** causes the communication circuit **403** of a predetermined power supply communication unit to generate the GetCapability command from the primary coil **401** to obtain the proper voltage and current value of each of the power-supplied devices set in the power supply areas of the power supply communication units **101** to **104** and DeviceID and VendorID of the power-supplied device. After the power-supplied device which has received the GetCapability command returns a response, the communication controlling unit **205** of the power-supplied device causes the power supply communication unit **201** to transmit the proper voltage and current value of the power-supplied device and the data of DeviceID and VendorID of the power-supplied device to the power-supplying device **100**. Note that the power supply communication controlling unit **108** temporarily stores, in its internal memory, the proper voltage and current value of the power-supplied device and the data of DeviceID and VendorID of the power-supplied device, which have been received by one of the power supply communication units **101** to **104**.

An example of the power supply information obtained from power-supplied devices and stored in the memory will be described with reference to FIG. **7**. As shown in FIG. **7**, the data obtained from power-supplied devices are stored in the memory in correspondence with the respective devices, for example, a digital camera **801** and a cellular phone **802**. The memory stores, as power supply information of each device, the data obtained from each power-supplied device, including a device name **803**, a maker name **804**, an allowable voltage value (MIN) **805**, an allowable voltage value (MAX) **806**, an allowable current value (MIN) **807**, and an allowable current value (MAX) **808**.

Upon obtaining data from power-supplied devices, the power supply communication controlling unit **108** determinates whether a plurality of power-supplied devices are set in the power supply area of one power supply communication unit, as shown in FIG. **2** (S**604**). That is, in step S**604**, the power supply communication controlling unit **108** detects whether any one of the power supply communication units **101** to **104** is ready for supplying power to a plurality of power-supplied devices. Whether power-supplied devices are set in the power supply area of one power supply communication unit can be determined by performing communication from each of the power supply communication units **101** to **104** and determining whether the respective power supply communication units receive responses from a plurality of power-supplied devices. In step S**604**, therefore, if one power supply communication unit receives responses from a plurality of power-supplied devices, the power supply communication controlling unit **108** determinates that a plurality of power-supplied devices are set in the power supply area of one power supply communication unit.

If a plurality of power-supplied devices are not set in the power supply area of one power supply communication unit, the power supply communication controlling unit **108** issues power supply instructions to the power supply communication units, which have detected the respective power-supplied devices, to start power supply from the primary coils **401** of the respective devices to the power-supplied devices (S**613**). Note that this power supply instruction is issued based on the information of the allowable current/voltage obtained in step S**603** to control the power (supply power amount) supplied from the primary coil so as not to exceed the allowable current/voltage of each power-supplied device. That is, the power supply communication controlling unit **108** controls the resonance circuit **402** in the power supply communication unit to excite the primary coil **401** so as to supply power within the range of the allowable current/voltage of the power-supplied device set in the power supply area of each power supply communication unit.

The power supply communication controlling unit **108** then controls the communication circuit **403** of the power supply communication unit to send the GetInfo command from the primary coil **401** of the power supply communication unit which is performing non-contact power supply. The power supply communication controlling unit **108** then obtains, from each power-supplied device, the information of the present current, present voltage, and charged status as a response to the transmitted command (S**614**). The power supply communication controlling unit **108** determines a proper voltage value and current value from the information of the current, voltage, and charged status obtained from each power-supplied device. The power supply communication controlling unit **108** then causes the resonance circuit **402** to change the setting of the magnetic flux for power supply generated in the primary coil **401** of the power supply communication unit on which the power-supplied device is set, so as to generate a proper voltage value and current value in the secondary coil of the power-supplied device (S**615**).

Based on the power supply information obtained in step S**614**, the power supply communication controlling unit **108** then determines whether the charged status of the power-supplied device is in a FULL (fully charged) status, and charging is complete (S**616**). If the charged status is not a FULL status, the power supply communication controlling unit **108** returns the process to step S**613** to continuously execute the processing in steps S**613** to S**615**.

If the charged status is a FULL status, the power supply communication controlling unit **108** controls the resonance circuit **402** of the power supply communication unit which is supplying power to the power-supplied device, so as to stop supplying power to the power-supplied device whose charged status is a FULL status. The power supply communication controlling unit **108** notifies the user of information indicating the completion of charging, including information specifying a device, via the display controlling unit **111** using the LED **112** and the LCD **113** (S**617**).

After the notification, the power supply communication controlling unit **108** determinates whether the charged statuses of the power-supplied devices set on all the power supply communication units are the FULL status, and charging of all the power-supplied devices is complete (S**618**). Upon determining that charging of all the power-supplied devices is complete, the power supply communication controlling unit **108** terminates the power supply processing. Upon determining that charging of all the power-supplied devices is not complete, the power supply communication controlling unit **108** controls the resonance circuit **402** to stop supplying power from the primary coil **401** in the power supply communication unit which is supplying power to the power-supplied device which has been fully charged (S**619**). Thereafter, the power supply communication controlling unit **108** returns the process to step S**613** to continue power supply to the power-supplied device which has not been fully charged.

Upon determining in step S**604** that a plurality of power-supplied devices are set on one power supply communication unit like, for example, the power supply communication unit **103** in FIG. **2** (are set in the power supply area), the power supply communication controlling unit **108** controls the resonance circuit **402** to start supplying power from the power supply communication units **101**, **103**, and **104** on which the power-supplied devices are set (S**605**). The power supply communication controlling unit **108** then obtains the information of the current, voltage, and charged status of each power-supplied device during charging via the communication circuit **403** of the power supply communication unit which is supplying power, as in step S**614** (S**606**). The power supply communication controlling unit **108** determines whether the processing in steps S**605** and S**606** has been executed for all the power supply communication units on whose power supply areas the power-supplied devices are set. If the power supply communication controlling unit **108** determines that the processing has been executed for all the power supply communication units, the process shifts to step S**608**. Otherwise, the power supply communication controlling unit **108** repeatedly executes the processing in steps S**605** and S**606** (S**607**).

Based on the power supply information obtained in steps S**605** to S**607**, the power supply communication controlling unit **108** calculates how much power can be supplied to each power-supplied device with the power supplied from each power supply communication unit. Based on the calculation result, the power supply communication controlling unit **108** then determines whether only power supply communication units on which the plurality of power-supplied devices are not set can independently perform non-contact power supply to the respective power-supplied devices (S**608**). More specifically, in the case shown in FIG. **2**, for the digital camera **200**, the power supply communication controlling unit **108** determines, based on the information of the current, voltage, and charged status during charging when only the power supply communication unit **101** supplies power, whether power supply can be performed. For the cellular phone **300**, the power supply communication controlling unit **108** determines, based on the information of the current, voltage, and charged status during charging when only the power supply communication unit **104** supplies power, whether power supply can be performed.

Upon determining in step S**608** that a power supply communication unit other than a power supply communication unit on which a plurality of power-supplied devices are set can supply sufficient power to each power-supplied device, the power supply communication controlling unit **108** controls the resonance circuit **402** so as to stop supplying power from the primary coil **401** of the power supply communication unit on which the plurality of power-supplied devices are set (S**612**). Upon stopping power supply from the primary coil of the power supply communication unit on which the plurality of power-supplied devices are set, the power supply communication controlling unit **108** shifts the process to step S**613** to continue the processing. Note that a series of processes from step S**613** are the same as those described above.

If the power supply communication controlling unit **108** determines in step S**608** that sufficient power cannot be supplied to the respective power-supplied devices without power supply from the power supply communication units on which the plurality of power-supplied devices are set, the process advances to step S**609**. In step S**609**, the power supply communication controlling unit **108** calculates a current/voltage value supplied to each power-supplied device, including power supplied from the power supply communication units on which the plurality of power-supplied devices are set, based on the power supply information obtained in steps S**605** to S**607**. The power supply communication controlling unit **108** determines whether the calculated current/voltage value supplied to each power-supplied device satisfies the allowable voltage/current value of each power-supplied device obtained in step S**603**. More specifically, the current/voltage value supplied to one power-supplied device is expressed by the sum of current/voltage values supplied from the respective power supply communication units, on which the one power-supplied device is set, to the one power-supplied device, which are obtained by the processing in steps S**605** to S**607**. That is, the power supply communication controlling unit **108** determines in step S**609** whether the sum of the current/voltage values which can be supplied from the power supply communication units including the one on which the plurality of power-supplied devices are set exceeds the lower limit value of the allowable range of currents and voltages of the plurality of power-supplied devices.

If the power supply communication units including the one on which the plurality of power-supplied devices are set cannot supply power corresponding to the allowable voltage/current value of each power-supplied device, the power supply communication controlling unit **108** sends a control instruction for displaying the alert indication to the display controlling unit **111**. With this operation, the power-supplying device **100** causes the display controlling unit **111** to display the alert indication that the devices cannot be charged, using the LED **112** and the LCD **113**, thereby notifying the user of the corresponding information (S**611**).

If the power supply communication units including the one on which the plurality of power-supplied devices are set can supply power corresponding to the allowable voltage/current value of each power-supplied device, the power supply communication controlling unit **108** controls each power supply communication unit to supply power to each power-supplied device (S**610**), and terminates the processing.

Power supply processing to be performed when a power supply communication unit on which a plurality of power-supplied devices are set also supplies power in step S**610** will be described below with reference to FIG. **8**. As shown in FIG. **8**, when the processing starts, the power supply communication controlling unit **108** transmits a power supply instruction to a power supply communication unit on which a plurality of power-supplied devices are not set, based on the information of the allowable current/voltage obtained in step S**603**, thereby starting power supply from the primary coil **401** (S**701**). Thereafter, the power supply communication controlling unit **108** causes the the communication circuit **403** of a predetermined power supply communication unit to transmit a magnetic flux pattern corresponding to the GetInfo command from the primary coil **401**, and obtains the information of the present current, voltage, and charged status from each power-supplied device (S**702**).

The power supply communication controlling unit **108** then sets the voltage of the power supply communication unit on which a plurality of power-supplied devices are not set, so as to supply a proper amount of power to each power-supplied device (S**703**). More specifically, the power supply communication controlling unit **108** sets a voltage value that allows the power-supplied device to obtain power sufficient for charging within the allowable voltage/current value, based on the information of the current, voltage, and charged status obtained in step S**702** and the allowable voltage/current value of the power-supplied device which is obtained in step S**603**.

The power supply communication controlling unit **108** then starts supplying power from the power supply communication unit on which a plurality of power-supplied devices are set (S**704**). As in step S**702**, the power supply communication controlling unit **108** obtains the information of the present voltage, current, and charged status from each power-supplied device by using the GetInfo command (**S705**).

Based on the power supply information obtained in step **S705**, the power supply communication controlling unit **108** determinates whether the plurality of power-supplied devices set on one power supply communication unit fall within the range of the allowable voltage/current value and are in a proper charged status (**S706**). Upon determining in step **S706** that the power-supplied devices are not in a proper charged status, the power supply communication controlling unit **108** returns the process to step **S704** to increase the power if it is small or to decrease the power if it is large, thereby adjusting the power supplied to the power supply communication unit on which the plurality of power-supplied devices are set. By repeating the processing in steps **S704** to **S706** in this manner, the power supply communication controlling unit **108** finds a proper setting for the amount of power to be supplied from the power supply communication unit on which the plurality of power-supplied devices are set.

Upon finding a setting for the supply of proper power that satisfies an allowable voltage/current for each power-supplied device (YES in step **S706**), the power supply communication controlling unit **108** sets the power to be supplied from the power supply communication unit on which the plurality of power-supplied devices are set (**S707**). Upon completing this setting, the power supply communication controlling unit **108** transmits a power supply instruction for performing main charging to each power supply communication unit on which a power-supplied device is set, thereby starting power supply (**S708**).

The power supply communication controlling unit **108** then obtains the information of the current/voltage value and charged status of each power-supplied device during power supply as in step **S705** (**S709**), and determines whether there is any power-supplied device which has been completely charged (**S710**). If there is no power-supplied device which has been completely charged, the power supply communication controlling unit **108** repeatedly performs the processing in steps **S707** to **S709**. If there is a power-supplied device which has been completely charged, the power supply communication controlling unit **108** sends a control instruction for displaying to the display controlling unit **111**. And then, the display controlling unit **111** displays an indication, which the power-supplied device has been completely charged, by using the LED **112** or the LCD **113** (**S711**).

The power supply communication controlling unit **108** then determines whether all the power-supplied devices have been completely charged (**S712**). If all the power-supplied devices have been completely charged, the power supply communication controlling unit **108** terminates the processing. If all the power-supplied devices have not been completely charged, the power supply communication controlling unit **108** stops power supply and communication from the power supply communication unit on which only the power-supplied devices which have been completely charged are set (**S713**). Assume that the power supply communication controlling unit **108** does not stop power supply from the power supply communication unit on which the plurality of power-supplied devices are set.

The power supply communication controlling unit **108** then returns the process to step **S704** to continue the processing in steps **S704** to **S706** to make a check to find a proper setting for the amount of power to be supplied from the power supply communication unit on which the plurality of power-supplied devices are set. That is, if one of the plurality of power-supplied devices set on one power supply communication unit has been completely charged, the power supply communication controlling unit **108** brings the power closer to the minimum value of the allowable voltage/current value of the completely charged power-supplied device and checks whether the power-supplied devices to which power is being supplied can be further charged. The power supply communication controlling unit **108** performs power supply according to the series of processes in steps **S707** to **S710** with the amount of power set by this check. Performing the above power supply processing allows the power-supplying device **100** according to this embodiment to charge the rechargeable batteries of a plurality of power-supplied devices even if they have different allowable voltage/current values. This embodiment has exemplified non-contact power supply using the electromagnetic induction scheme. However, the present invention can be applied to the magnetic field resonance scheme (magnetic resonance scheme) and the radio wave transmission scheme. The magnetic field resonance scheme uses the principle that causing magnetic field variations with a predetermined period on the primary coil side will generate an electromotive force in the secondary coil of a power-supplied device having a resonance frequency matching the predetermined period. That is, in the magnetic field resonance scheme, controlling the magnitude of magnetic field variations caused by a power-supplying device can control the amount of power to be supplied to a power-supplied device.

Note that the description of the above embodiment is an example. The present invention is not limited to this. The arrangement and operation of the above embodiment can be changed as needed.

Other Embodiments

Aspects of the present invention can also be realized by a computer of a system or apparatus (or devices such as a CPU or MPU) that reads out and executes a program recorded on a memory device to perform the functions of the above-described embodiment(s), and by a method, the steps of which are performed by a computer of a system or apparatus by, for example, reading out and executing a program recorded on a memory device to perform the functions of the above-described embodiment(s). For this purpose, the program is provided to the computer for example via a network or from a recording medium of various types serving as the memory device (for example, computer-readable medium).

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2009-117041, filed May 13, 2009, and No. 2010-104233, filed Apr. 28, 2010, which are hereby incorporated by reference herein in their entirety.

The invention claimed is:

1. A power-supplying device including a plurality of primary coils comprising:

- a power supply unit configured to supply power in a non-contact manner from at least one of the plurality of primary coils to at least one power-supplied device set in a power supply area of at least one of the plurality of primary coils;

a detecting unit configured to detect whether a plurality of power-supplied devices are set in the power supply area of one of the plurality of primary coils; and

a controlling unit configured to control the power supply unit to stop supplying power from the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, when the detecting unit detects that the plurality of power-supplied devices are set in the power supply area of the one of the plurality of primary coils.

2. The *power-supplying* device according to claim **1**, further comprising a communication unit configured to obtain allowability information associated with power supplied to the at least one power-supplied device by communicating with the at least one power-supplied device set in the power supply area of at least one of the plurality of primary coils,

wherein the controlling unit controls the power supply unit to supply power from the plurality of primary coils, other than the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, to at least one of the plurality of power-supplied devices based on the allowability information obtained by the communication unit.

3. The *power-supplying* device according to claim **2**,

wherein the controlling unit determines whether power supplied by the power supply unit to at least one of the plurality of power-supplied devices set on *at least one of* the [primary coil] *plurality of primary coils* falls within an allowable range of voltage and current determined based on the allowability information, when the power supply unit is stopped supplying power from the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, and

the controlling unit controls the power supply unit to resume supplying power from the one of the plurality of primary coils, when determining that the power supplied to at least one of the plurality of power-supplied devices set on the one of the plurality of primary coils falls outside the allowable range.

4. The *power-supplying* device according to claim **3**, further comprising an alert unit configured to issue an alert when the power supplied to at least one of the plurality of power-supplied devices falls outside the allowable range determined based on the allowability information.

5. A control method for a power-supplying device comprising a power supply unit, including a plurality of primary coils, [configured to supply power in a non-contact manner from at least one of the plurality of primary coils to at least one power-supplied device set in a power supply area of at least one of the plurality of primary coils,] characterized by comprising:

a supplying step of supplying power in a non-contact manner from at least one of the plurality of primary coils to at least one power-supplied device set in a power supply area of at least one of the plurality of primary coils;

a detecting step of detecting whether a plurality of power-supplied devices are set in the power supply area of one of the plurality of primary coils; and

a controlling step of controlling the power supply unit to stop supplying power from the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, when it is detected in the [detection] *detecting* step that the plurality of power-supplied devices are set in the power supply area of the one of the plurality of primary coils.

6. The method according to claim **5**, characterized by further comprising a communication step of obtaining allowability information associated with power supplied to the at least one power-supplied device by communicating with the at least one power-supplied device set in the power supply area of at least one of the plurality of primary coils,

wherein in the controlling step, the power supply unit is controlled to supply power from the plurality of primary coils, other than the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, to at least one of the plurality of power-supplied devices based on the allowability information obtained in the communication step.

7. The method according to claim **6**, characterized in that in the controlling step, it is determined whether power supplied by the power supply unit to at least one of the plurality of power-supplied devices set on *at least one of* the [primary coil] *plurality of primary coils* falls within an allowable range of a voltage and current determined based on the allowability information, when the power supply unit is stopped supplying power from the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, and

the power supply unit is controlled to resume supplying power from the one of the plurality of primary coils, when it is determined that the power supplied to at least one of the plurality of power-supplied devices set on the one of the plurality of primary coils falls outside the allowable range.

8. The method according to claim **7**, characterized by further comprising an alert step of issuing an alert when the power supplied to at least one of the plurality of power-supplied devices falls outside the allowable range determined based on the allowability information.

9. A [power-supplying] system comprising a power-supplying device and at least one power-supplied device, wherein the power-supplying device comprises

a plurality of primary coils,

a power supply unit configured to supply power in a non-contact manner from at least one of the plurality of primary coils to the at least one power-supplied device set in a power supply area of at least one of the plurality of primary coils,

a detecting unit configured to detect whether a plurality of power-supplied devices are set in the power supply area of one of the plurality of primary coils, and

a controlling unit configured to control the power supply unit to stop supplying power from the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, when the detecting unit detects that the plurality of power-supplied devices are set in the power supply area of the one of the plurality of primary coils, and

the at least one power-supplied device each comprises power receiving unit including a secondary coil which receives power supplied from the power supply unit when the power-supplied device is set on any of the plurality of primary coils.

10. The *power-supplying* device according to claim **1**,

wherein the controlling unit controls the power supply unit to supply power from the plurality of primary coils, other than the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, to at least one of the plurality of power-supplied devices.

11. The method according to claim **5**,

wherein in the controlling step, the power supply unit is controlled to supply power from the plurality of primary coils, other than the one of the plurality of primary coils on which the plurality of power-supplied devices are detected to be set, to at least one of the plurality of power-supplied devices.

12. A power-supplying device comprising:

a first power supply circuit that wirelessly supplies power to a power-supplied device in a predetermined area;

at least one processor programmed to perform:

determining that one or more power-supplied devices is or are located in the predetermined area;

obtaining first information regarding allowable power for each of a plurality of power-supplied devices located in the predetermined area and second information regarding power respectively supplied from the first power supply circuit to each of the plurality of power-supplied devices located in the predetermined area;

controlling wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area by using the first information and the second information.

13. The power-supplying device according to claim 12, wherein the at least one processor controls whether to limit wireless power supply from the first power supply circuit to the plurality of power-supplied devices or not, by using the first information and the second information.

14. The power-supplying device according to claim 12, wherein the at least one processor controls whether to limit wireless power supply from the first power supply circuit to the plurality of power-supplied devices depending on whether or not power respectively supplied from the first power supply circuit to each of the plurality of power-supplied devices meets the allowable power for each of the plurality of power-supplied devices.

15. The power-supplying device according to claim 12,

wherein the first information includes information of an allowable power range,

wherein the at least one processor controls wireless power supply from the first power supply unit to the plurality of power-supplied devices located in the predetermined area such that power supplied by the first power supply circuit is within the allowable power range.

16. The power-supplying device according to claim 15,

wherein the first information includes information of an upper limit of the allowable power and information of a lower limit of the allowable power, and

wherein the allowable power range is defined by the information of the upper limit of the allowable power and the information of the lower limit of the allowable power.

17. The power-supplying device according to claim 12,

wherein the first information includes information of an allowable voltage range,

wherein the at least one processor controls wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area such that power supplied by the first power supply circuit is not out of the allowable voltage range.

18. The power-supplying device according to claim 12,

wherein the first information includes information of a maximum allowable voltage which indicates an upper limit of an allowable voltage and information of a minimum allowable voltage which indicates a lower limit of the allowable voltage, and

wherein the at least one processor controls wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area such that a voltage of power supplied by the first power supply circuit to the plurality of power-supplied devices does not exceed the maximum allowable voltage for the plurality of power-supplied devices.

19. The power-supplying device according to claim 12,

wherein the first information includes information of an allowable voltage range, and

wherein the at least one processor controls wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area such that respective voltages of power supplied by the first power supply circuit to each of the plurality of power-supplied devices do not exceed respective allowable voltage ranges.

20. The power-supplying device according to claim 12,

wherein the at least one processor obtains the second information repeatedly.

21. The power-supplying device according to claim 20,

wherein the at least one processor controls wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area whenever the second information is obtained.

22. The power-supplying device according to claim 12,

wherein the at least one processor obtains the second information while the first power supply circuit is supplying power.

23. The power-supplying device according to claim 12,

wherein the first power supply circuit wirelessly supplies power using an electromagnetic induction scheme or a magnetic field resonance scheme.

24. The power supplying device according to claim 12, further comprises:

a second power supply circuit that is different from the first power supply circuit, and

wherein the at least one processor obtains a third information regarding power respectively supplied from the second power supply circuit to each of the plurality of power-supplied devices located in the predetermined area, and

wherein the at least one processor controls wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area by using the third information.

25. The power-supplying device according to claim 24, wherein the at least one processor controls whether to limit wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area or not, by using the third information.

26. The power-supplying device according to claim 12, wherein the at least one processor determining that one or more power-supplied devices is or are located in the predetermined area by detecting, using sensors, that one or more power-supplied devices is or are located in the predetermined area.

27. A control method comprising:

wirelessly supplying power to a power-supplied device in a predetermined area by using a power supply circuit;

detecting that one or more power-supplied devices is or are located in the predetermined area;

obtaining first information regarding allowable power for each of a plurality of power-supplied devices located in the predetermined area;

obtaining second information regarding power respectively supplied from the power supply circuit to each of the plurality of power-supplied devices located in the predetermined area;

controlling wireless power supply from the power supply circuit to the plurality of power-supplied devices located in the predetermined area by using the first information and the second information.

28. The control method according to claim 27, further comprises:

controlling whether to limit wireless power supply from the first power supply circuit to the plurality of power-supplied devices or not, by using the first information and the second information.

29. The control method according to claim 27, further comprises:

controlling whether to limit wireless power supply from the first power supply circuit to the plurality of power-supplied devices depending on whether or not power respectively supplied from the first power supply circuit to each of the plurality of power-supplied devices meets the allowable power for each of the plurality of power-supplied devices.

30. The control method according to claim 27, further comprises:

controlling wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area such that power supplied by the first power supply circuit is within an allowable power range, wherein the first information includes information of the allowable power range.

31. The control method according to claim 30,

wherein the first information includes information of an upper limit of the allowable power and information of a lower limit of the allowable power, and

wherein the allowable power range is defined by the information of the upper limit of the allowable power and the information of the lower limit of the allowable power.

32. The control method according to claim 27, further comprises:

controlling wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area such that power supplied by the first power supply circuit is not out of an allowable voltage range, wherein the first information includes information of the allowable voltage range.

33. The control method according to claim 27, further comprises:

controlling wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area such that a voltage of power supplied by the first power supply circuit to the plurality of power-supplied devices does not exceed a maximum allowable voltage for the plurality of power-supplied devices, wherein the first information includes information of the maximum allowable voltage which indicates an upper limit of an allowable voltage and information of a minimum allowable voltage which indicates a lower limit of the allowable voltage.

34. The control method according to claim 27, further comprises:

controlling wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area such that respective voltages of power supplied by the first power supply circuit to each of the plurality of power-supplied devices do not exceed respective allowable voltage ranges, wherein the first information includes information of the allowable voltage range.

35. The control method according to claim 27, further comprising:

obtaining the second information.

36. The control method according to claim 35, further comprises:

controlling wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area whenever the second information is obtained.

37. The control method according to claim 27, further comprises:

obtaining the second information while the first power supply circuit is supplying power.

38. The control method according to claim 27, further comprises:

wirelessly supplying power by the first power supply circuit using an electromagnetic induction scheme or a magnetic field resonance scheme.

39. The control method according to claim 27, further comprises:

obtaining a third information regarding power respectively supplied from a second power supply circuit that is different from the first power supply circuit to each of the plurality of power-supplied devices located in the predetermined area, and

controlling wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area by using the third information.

40. The control method according to claim 39, further comprises:

controlling whether to limit wireless power supply from the first power supply circuit to the plurality of power-supplied devices located in the predetermined area or not, by using the third information.

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