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(54) CHARGING APPARATUS

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(57) **ABSTRACT**

A charging apparatus includes: a charging unit configured to perform a contactless charging operation for a placed external device; a detector configured to detect a position of a placed object; a determining unit configured to determine that the placed object is an external device compatible with the charging unit; and a control unit configured to control the charging unit such that, during the contactless charging operation for an external device compatible with the charging unit, the charging operation for the external device being charged is restricted when an object that is determined by the determining unit not to be an external device compatible with the charging unit, has been placed within a predetermined distance from the charging unit.

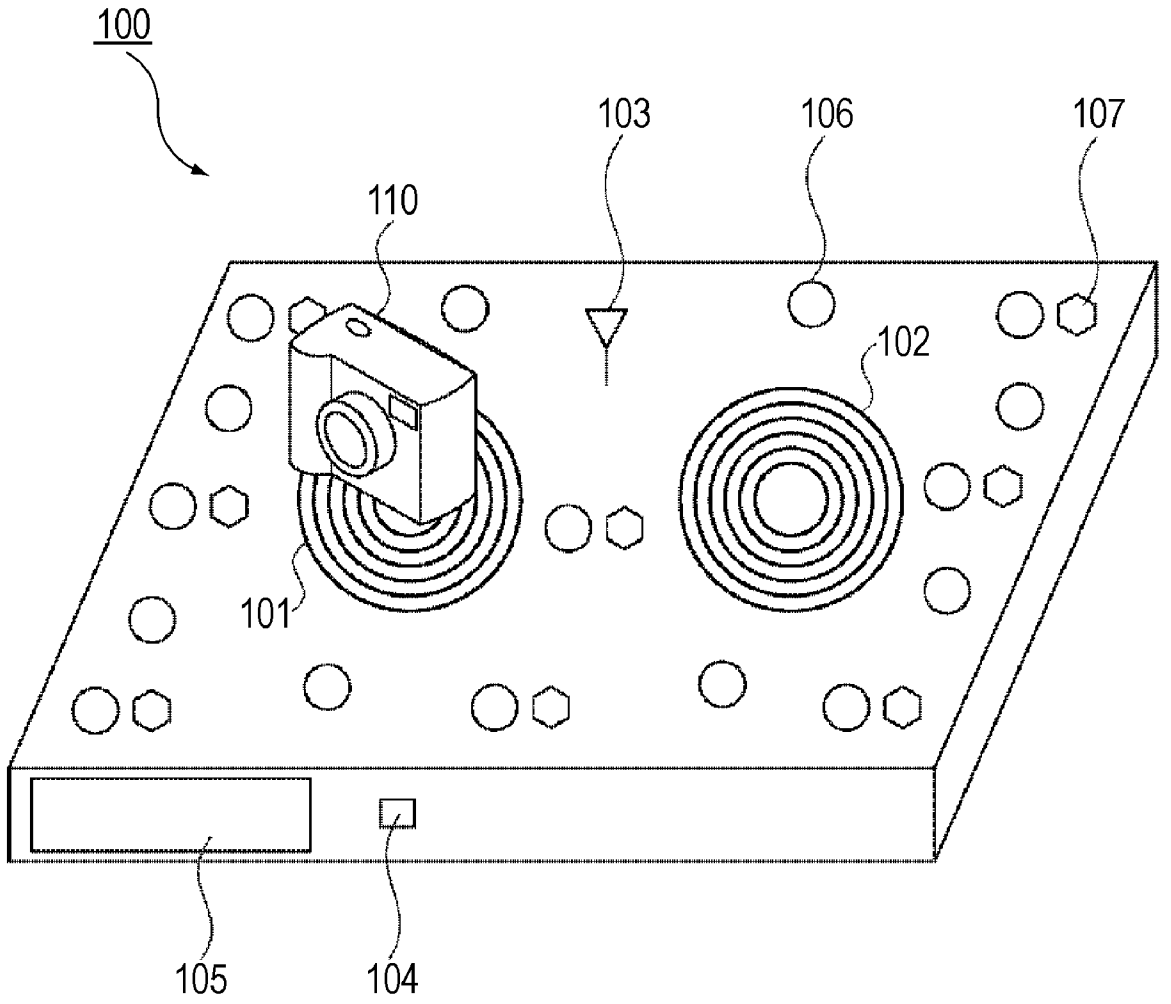


FIG. 1

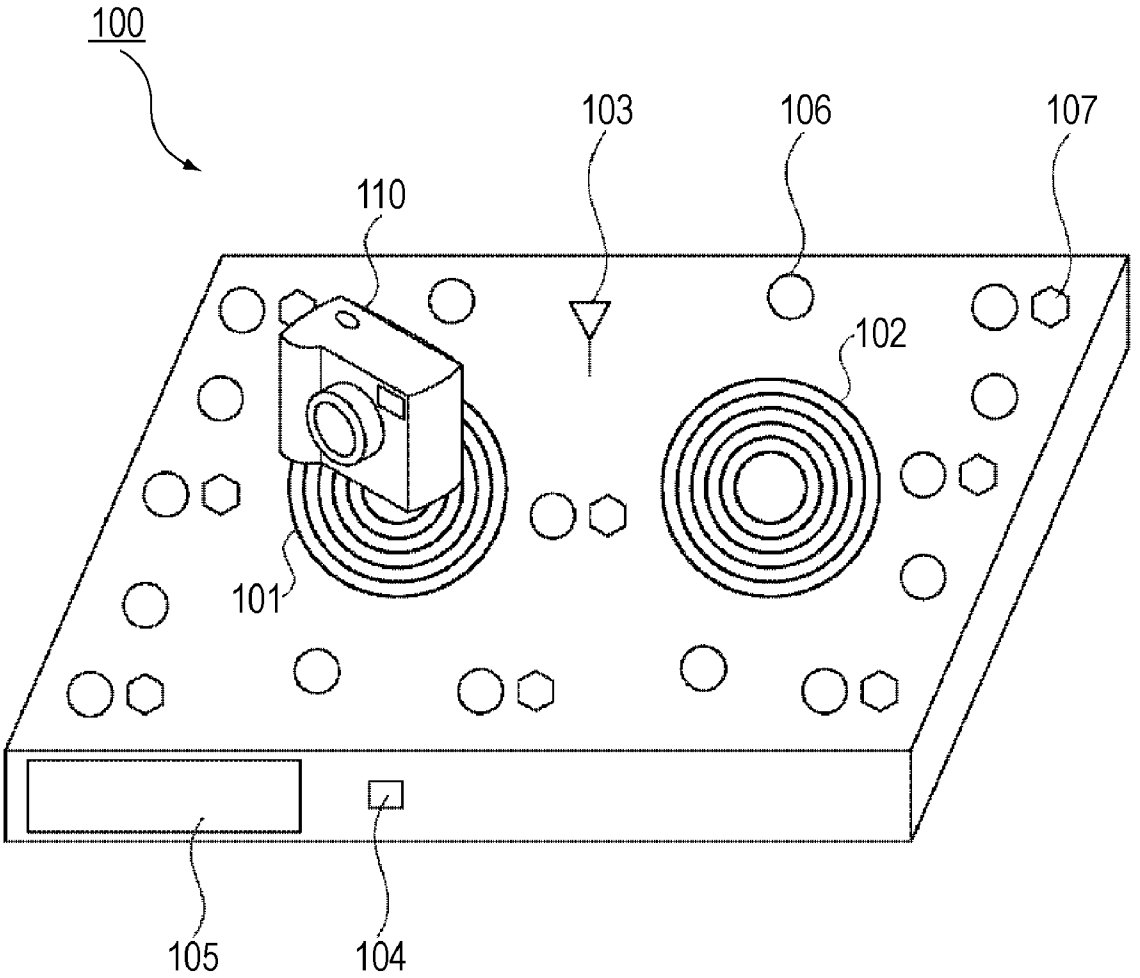


FIG. 2

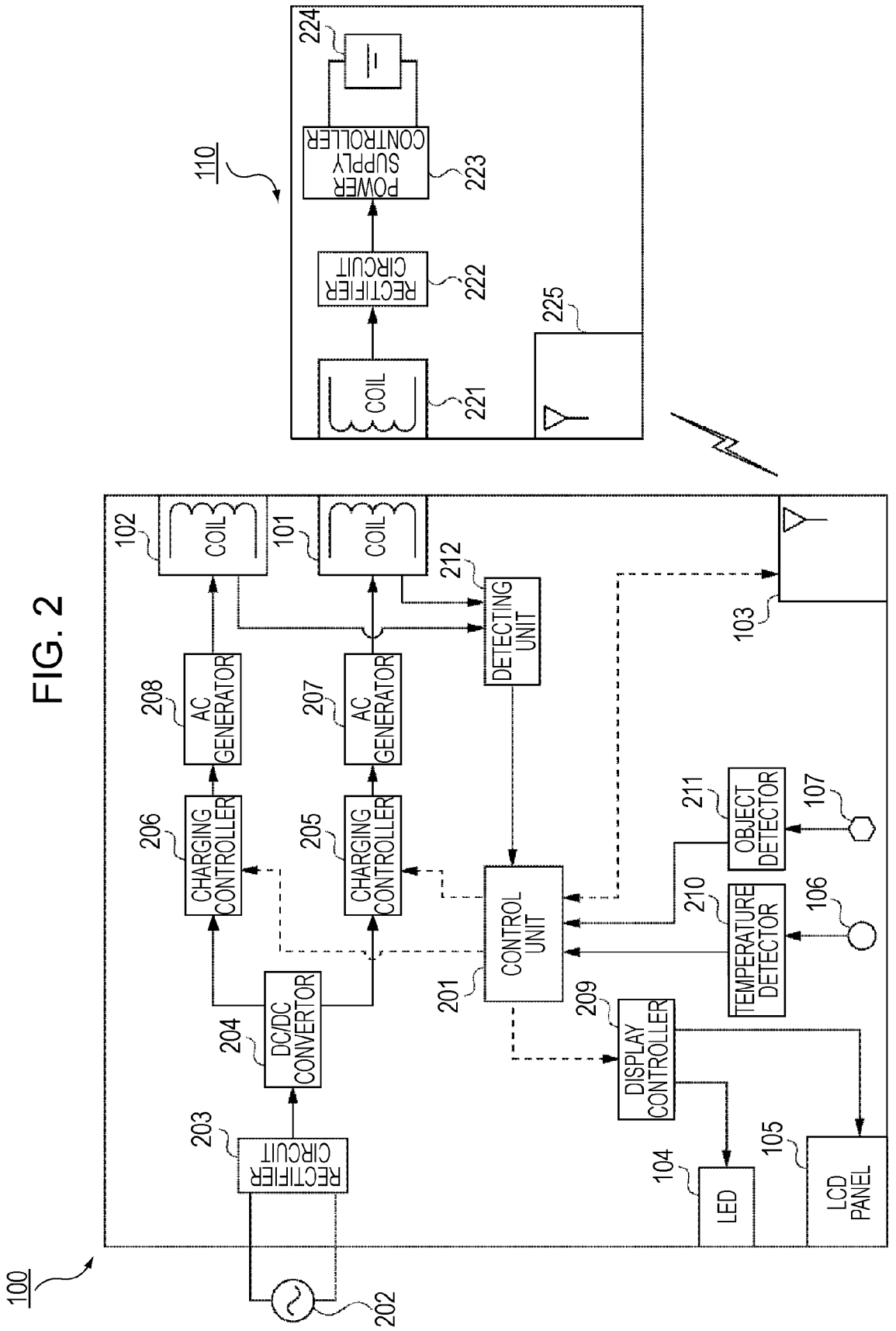

110
224
223
POWER SUPPLY CONTROLLER
222
RECTIFIER CIRCUIT
221
COIL
225
100
102
101
212
103
208
207
DETECTING UNIT
AC GENERATOR
206
205
CHARGING CONTROLLER
211
107
OBJECT DETECTOR
210
106
TEMPERATURE DETECTOR
201
CONTROL UNIT
209
DISPLAY CONTROLLER
204
DC/DC CONVERTOR
203
RECTIFIER CIRCUIT
104
LED
105
LCD PANEL
202

FIG. 3

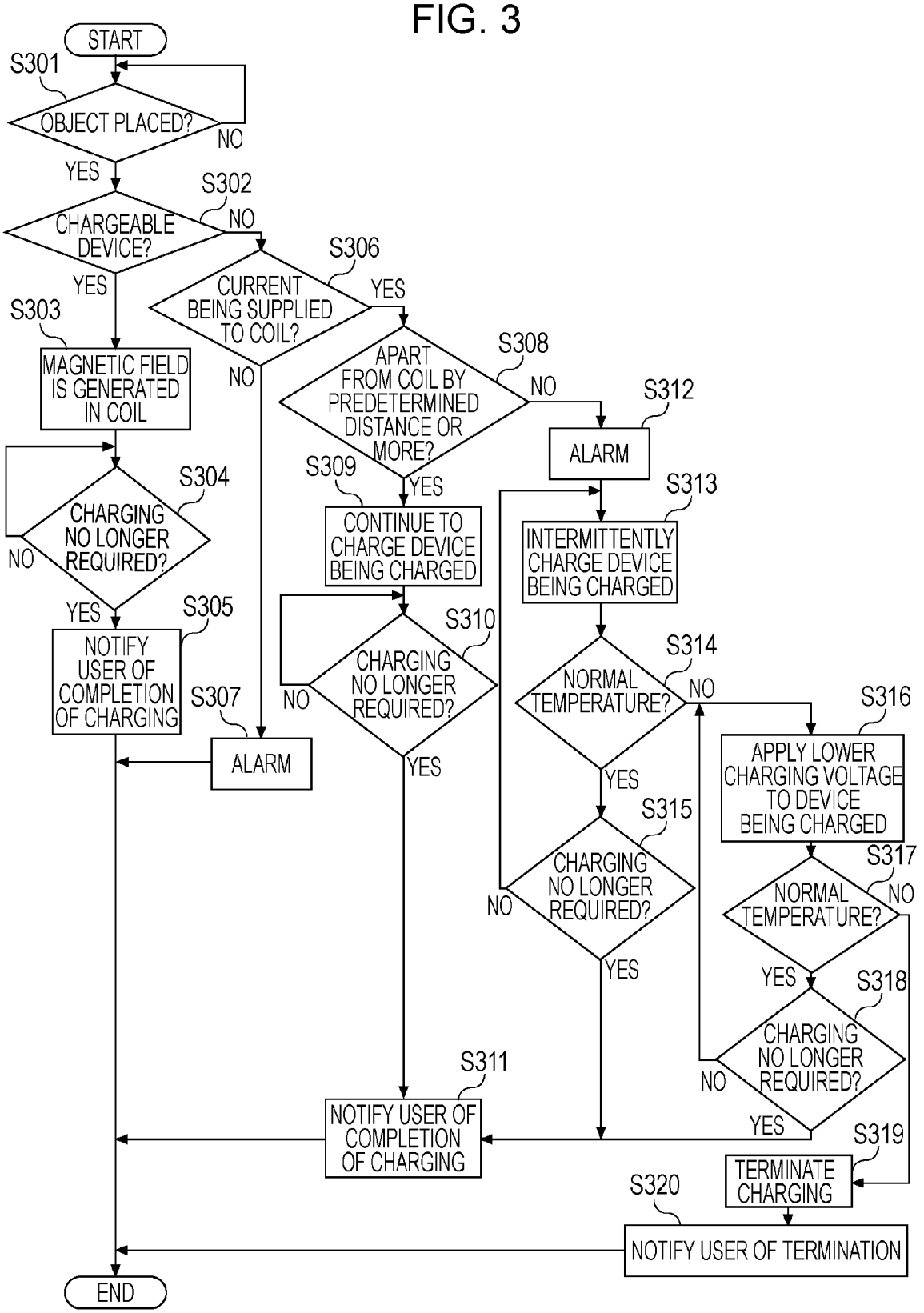

START
S301
OBJECT PLACED?
NO
YES
S302
CHARGEABLE DEVICE?
NO
YES
S303
MAGNETIC FIELD IS GENERATED IN COIL
S304
CHARGING NO LONGER REQUIRED?
NO
YES
S305
NOTIFY USER OF COMPLETION OF CHARGING
S306
CURRENT BEING SUPPLIED TO COIL?
YES
NO
S307
ALARM
S308
APART FROM COIL BY PREDETERMINED DISTANCE OR MORE?
NO
YES
S309
CONTINUE TO CHARGE DEVICE BEING CHARGED
S310
CHARGING NO LONGER REQUIRED?
NO
YES
S311
NOTIFY USER OF COMPLETION OF CHARGING
S312
ALARM
S313
INTERMITTENTLY CHARGE DEVICE BEING CHARGED
S314
NORMAL TEMPERATURE?
NO
YES
S315
CHARGING NO LONGER REQUIRED?
NO
YES
S316
APPLY LOWER CHARGING VOLTAGE TO DEVICE BEING CHARGED
S317
NORMAL TEMPERATURE?
NO
YES
S318
CHARGING NO LONGER REQUIRED?
NO
YES
S319
TERMINATE CHARGING
S320
NOTIFY USER OF TERMINATION
END

FIG. 4

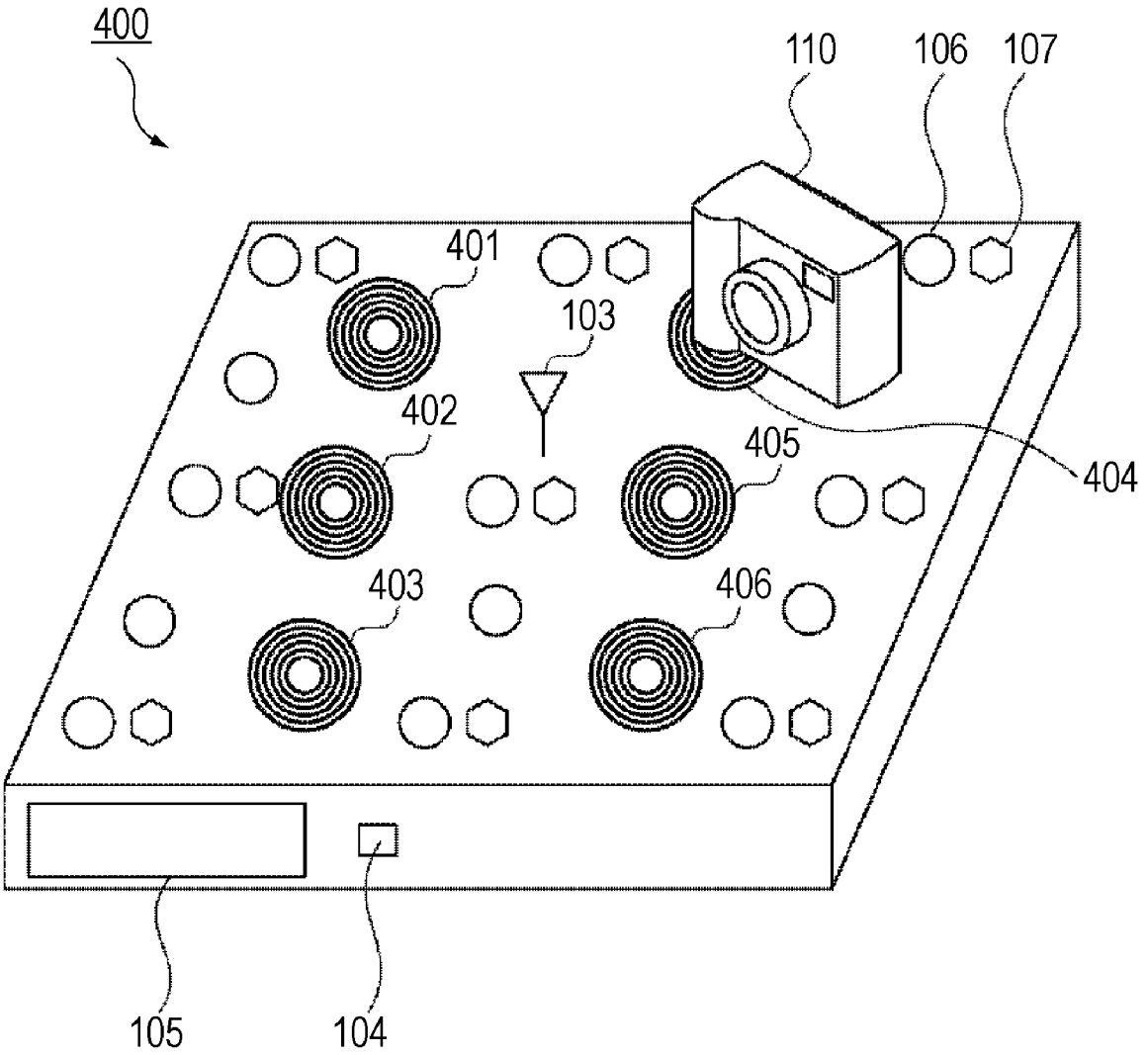


FIG. 5

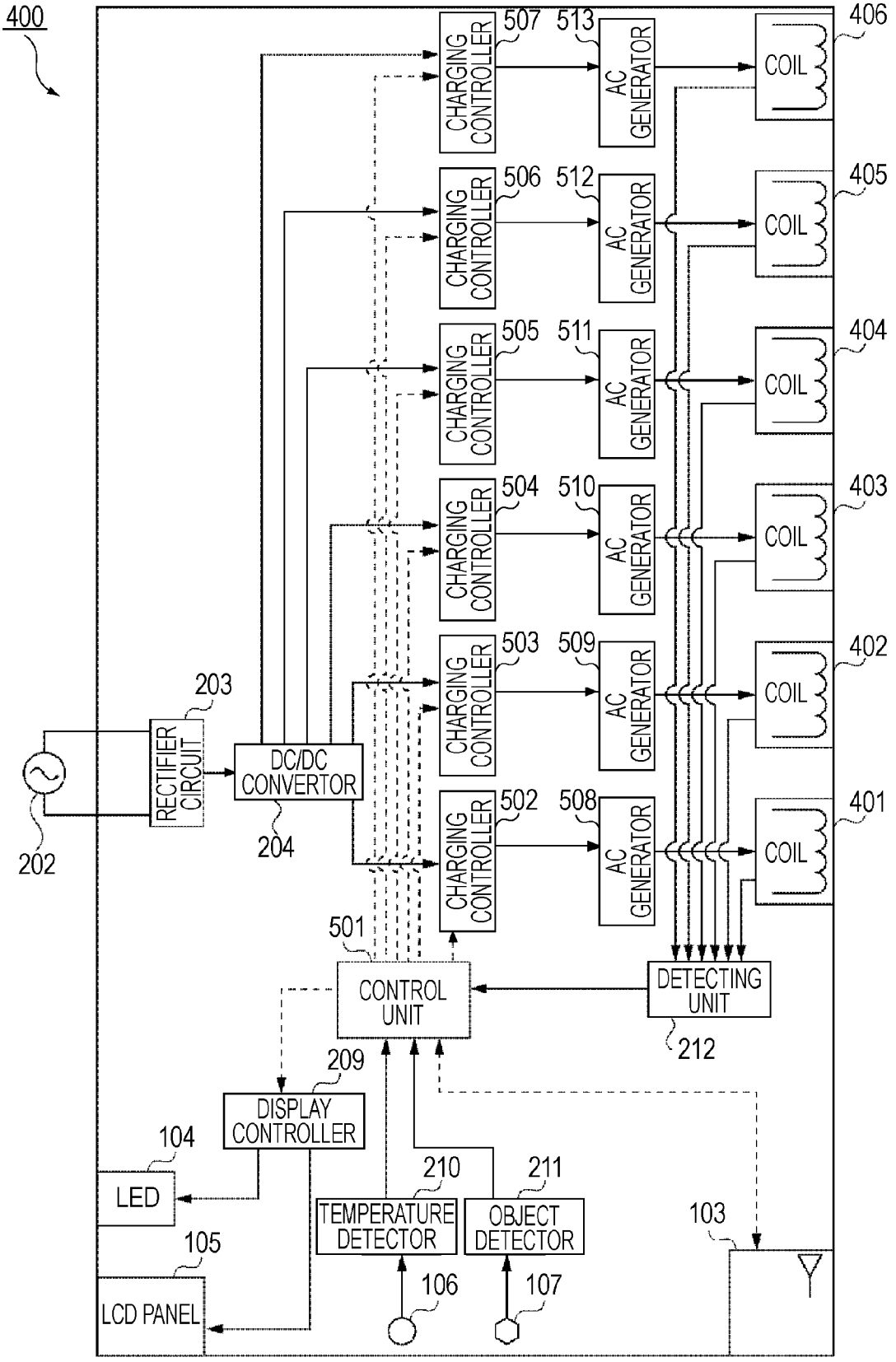
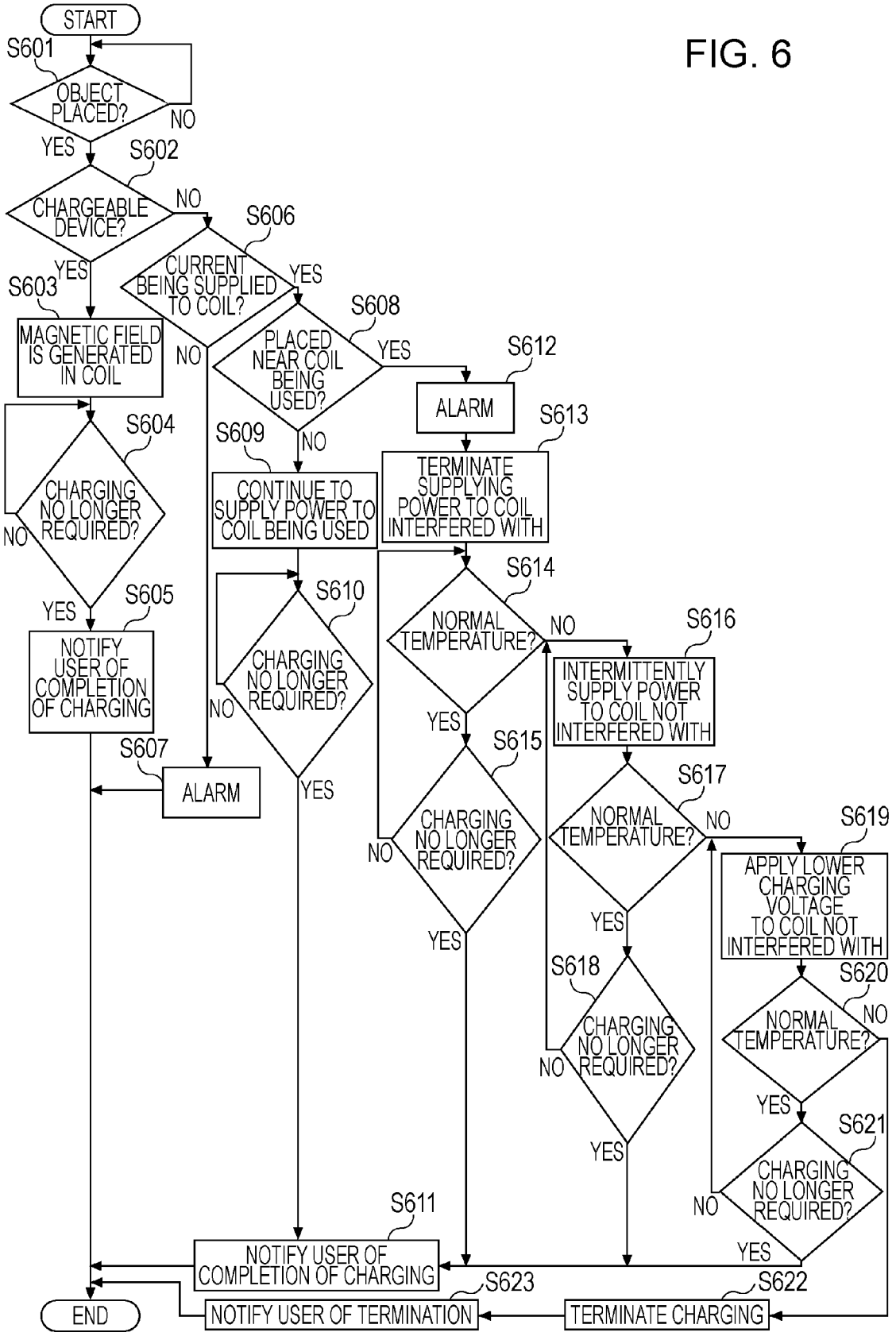

400
CHARGING CONTROLLER
507
513
AC GENERATOR
COIL
406
506
512
405
505
511
404
504
510
403
503
509
402
502
508
401
203
RECTIFIER CIRCUIT
DC/DC CONVERTOR
204
202
501
CONTROL UNIT
DETECTING UNIT
212
209
DISPLAY CONTROLLER
104
LED
210
211
TEMPERATURE DETECTOR
OBJECT DETECTOR
103
105
LCD PANEL
106
107

FIG. 6


START
S601
OBJECT PLACED?
NO
YES
S602
CHARGEABLE DEVICE?
NO
YES
S603
MAGNETIC FIELD IS GENERATED IN COIL
S604
CHARGING NO LONGER REQUIRED?
NO
YES
S605
NOTIFY USER OF COMPLETION OF CHARGING
S606
CURRENT BEING SUPPLIED TO COIL?
YES
NO
S607
ALARM
S608
PLACED NEAR COIL BEING USED?
YES
NO
S609
CONTINUE TO SUPPLY POWER TO COIL BEING USED
S610
CHARGING NO LONGER REQUIRED?
NO
YES
S611
NOTIFY USER OF COMPLETION OF CHARGING
S612
ALARM
S613
TERMINATE SUPPLYING POWER TO COIL INTERFERED WITH
S614
NORMAL TEMPERATURE?
NO
YES
S615
CHARGING NO LONGER REQUIRED?
NO
YES
S616
INTERMITTENTLY SUPPLY POWER TO COIL NOT INTERFERED WITH
S617
NORMAL TEMPERATURE?
NO
YES
S618
CHARGING NO LONGER REQUIRED?
NO
YES
S619
APPLY LOWER CHARGING VOLTAGE TO COIL NOT INTERFERED WITH
S620
NORMAL TEMPERATURE?
NO
YES
S621
CHARGING NO LONGER REQUIRED?
NO
YES
S622
TERMINATE CHARGING
S623
NOTIFY USER OF TERMINATION
END

CHARGING APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a charging apparatus, and in particular to a charging apparatus that provides electric power to external devices using electromagnetic induction.

[0003] 2. Description of the Related Art

[0004] Contactless charging apparatuses that use electromagnetic induction have been known. Such charging apparatuses utilize the principle of electromagnetic induction in which a magnetic field generated by an electric current flowing in a primary coil provided in a charging apparatus causes a voltage to be generated across both ends of a secondary coil provided in an external device. In these charging apparatuses, when a foreign object such as a piece of metal (for example, a coin) is placed within the magnetic field generated by the primary coil, an eddy-current flowing in the piece of metal may cause heat to be generated due to the internal resistance of the piece of metal.

[0005] To address such a problem, a charging apparatus has been proposed (for example, US 2007/0069687) that does not activate a charging circuit of the charging apparatus until it detects that a chargeable device has been placed on the charging apparatus, by means of authentication using a contactless IC card.

[0006] However, the charging apparatus described above does not take into consideration a case in which a plurality of devices are being charged in parallel. Hence, when a chargeable device and a non-chargeable device are placed on the charging apparatus at the same time, for example, there remains a problem in which a charging operation may possibly be started despite the presence of a non-chargeable device on the charging apparatus, causing the non-chargeable device to generate heat.

SUMMARY OF THE INVENTION

[0007] The present invention addresses such problems as described above, and provides a charging apparatus that can suppress heat generation even when a non-chargeable device or a foreign object is placed together with a chargeable device on the charging apparatus.

[0008] According to an aspect of the present invention, a charging apparatus includes a charging unit configured to perform a contactless charging operation for a placed external device; a position detector configured to detect a position of a placed object; a determining unit configured to determine whether the placed object is not an external device compatible with the charging unit; and a control unit configured to control the charging unit such that, during the contactless charging operation for an external device compatible with the charging unit, the charging operation for the external device being charged is restricted when an object that is determined by the determining unit not to be an external device compatible with the charging unit, has been placed within a predetermined distance from the charging unit.

[0009] 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 THE DRAWINGS

[0010] FIG. **1** is a perspective view of a structure of a charging apparatus according to a first embodiment of the present invention.

[0011] FIG. **2** is a block diagram of the charging apparatus according to the first embodiment of the present invention.

[0012] FIG. **3** is a flowchart showing the steps of a charging operation of the charging apparatus according to the first embodiment of the present invention.

[0013] FIG. **4** is a perspective view of a structure of a charging apparatus according to a second embodiment of the present invention.

[0014] FIG. **5** is a block diagram of the charging apparatus according to the second embodiment of the present invention.

[0015] FIG. **6** is a flowchart showing the steps of a charging operation of the charging apparatus according to the second embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0016] Embodiments of the present invention will be described in detail with reference to the attached drawings. A charging apparatus that can charge a plurality of devices will be described. Note that DC means direct current and AC means alternating current, hereinafter.

[0017] FIG. **1** shows a structure of a charging apparatus according to a first embodiment. A charging apparatus **100** includes two coils **101** and **102**. A magnetic field generated by passing a current through each of the coils **101** and **102** causes a voltage to be generated, due to electromagnetic induction, across both ends of a coil in a device to be charged that is placed above the coil **101** or **102**. The coils **101** and **102** may be exposed or may be covered with an outer case made of a non-conductive material such as plastic or a resin.

[0018] The charging apparatus **100** also includes an IC communication unit **103** used to communicate with an IC tag provided in a device being charged that is placed on the charging apparatus **100**. An IC chip within the IC tag provided in the device being charged records therein information indicating that the device being charged is a device that can be charged with the charging apparatus **100** of the present embodiment. The IC communication unit **103** receives the information indicating the chargeability of the device, and determines whether or not the information indicates that the device is chargeable with the charging apparatus **100**. The IC communication unit **103** may be either exposed or housed in the outer case.

[0019] The charging apparatus **100** further includes a light emitting device (LED) **104** and a liquid crystal display (LCD) panel **105**, used for notifying a user of such occurrences as a charging error, a change in state of charging, and the completion of charging.

[0020] The charging apparatus **100** is also provided with a plurality of temperature sensors such as thermistors **106** used for sensing temperatures, and a plurality of magnetic sensors such as Hall elements **107** used for sensing an object. The thermistors **106** and the Hall elements **107** may be either exposed or disposed under an outer case having a high thermal conductivity.

[0021] Referring to FIG. **1**, a digital camera **110** is placed at a position corresponding to the coil **101** of the charging apparatus **100**. The digital camera **110** includes a coil and an IC tag that records information indicating that the camera **110** is a device chargeable with the charging apparatus **100** according to the present embodiment. The digital camera **110** can charge a secondary battery within the camera **110** using the principle of electromagnetic induction. Here, the digital camera **110** is assumed to include an IC tag and a coil, but an external unit including an IC tag and a coil may be used to charge the digital

camera **110**. Further, even when a device has no secondary battery within it, the device can be made to operate normally by starting a charging operation.

[0022] Referring to FIG. **1**, the outline of the charging operation is described.

[0023] Although a digital camera is described as a device to be charged, the device may be any electronic device, such as a cellular phone, a portable audio player, a portable game player, or a notebook personal computer.

[0024] When the Hall elements **107** sense that the digital camera **110** has been placed above the coil **101**, the IC communication unit **103** communicates with the IC tag in the digital camera **110**. Specifically, a radio wave transmitted from the IC communication unit **103** is received by the antenna of the IC tag in the digital camera **110**, and the IC tag is activated using electromotive force generated due to resonance effect of the antenna. Then information is read out from the IC chip in the IC tag and is transmitted from the antenna of the IC tag. The information read out from the IC chip in the IC tag of the digital camera **110** is received by the IC communication unit **103** of the charging apparatus **100**. The information received from the IC tag of the digital camera **110** is used to determine whether or not the device is chargeable. When the received information indicates that the device is chargeable, the device is determined to be chargeable, and when the received information indicates that the device is not chargeable, the device is determined to be non-chargeable. When no information is received even though the IC communication unit **103** started communication (for example, when an object with no IC tag is placed or when activation of an IC tag fails), the device is determined to be non-chargeable. The operation described above is called "IC authentication" hereafter in the present embodiment.

[0025] When the result of "IC authentication" shows that the information received from an IC tag indicates a chargeable device, a current is passed through the coil **101**, which generates a magnetic field.

[0026] The coil built into the digital camera **110** charges the secondary battery utilizing electromotive force due to the magnetic field generated in the coil **101**.

[0027] Alternatively, the generated electromotive force may be used to provide power to be consumed by the digital camera **110** during normal operation, instead of being used for charging the secondary battery.

[0028] The system configuration of the charging apparatus **100** according to the present embodiment will now be described.

[0029] FIG. **2** shows block diagrams of the charging apparatus **100** according to the present embodiment and a charging circuit of the digital camera **110**.

[0030] The charging apparatus **100** includes the coils **101** and **102**, the IC communication unit **103**, the LED **104**, the LCD panel **105**, the thermistors **106**, and the Hall elements **107**. The charging apparatus **100** also includes a control unit **201** that controls each of its blocks. The charging apparatus **100** also includes, as circuits for feeding the coils **101** and **102**, a commercial-power-supply input unit **202**, a rectifier circuit **203**, a DC/DC converter **204**, charging controllers **205** and **206**, and AC generators **207** and **208**. The charging apparatus **100** also includes a display controller **209** that controls the display operation of the LED **104** and the LCD panel **105**. The charging apparatus **100** also includes a temperature detector **210** that sends temperature values sensed by the thermistors **106** to the control unit **201** and an object detector **211** that detects the strengths of magnetic fields at positions where the Hall elements **107** are located and sends information on the presence or absence of an object to the control unit **201**. The charging apparatus **100** also includes a detecting unit **212** that detects voltages and/or currents of the coils **101** and **102**.

[0031] In the present embodiment, the input AC from a commercial power supply is converted to a DC in the charging apparatus **100**, but this conversion may be performed by an AC adapter etc. connected to the charging apparatus **100**.

[0032] The digital camera **110**, which is a device to be charged, has a block for a charging operation including a coil **221**, a rectifier circuit **222**, a power supply controller **223**, a secondary battery **224**, and an IC tag **225**.

[0033] Referring to FIG. **2**, a normal charging operation of the present embodiment will now be described.

[0034] When the digital camera **110** is placed on the charging apparatus **100**, the object detector **211**, receiving signals indicating changes in magnetic field sensed by the Hall elements **107**, detects the position of an object and notifies the control unit **201** of the placement and the position of the object. Then the IC communication unit **103** is controlled by the control unit **201** to start "IC authentication". The IC communication unit **103** performs "IC authentication" of the IC tag of the digital camera **110**, and determines whether or not the placed object is a chargeable device.

[0035] When it is determined, as the result of the "IC authentication", that a chargeable device has been placed, the IC communication unit **103** notifies the control unit **201** that a chargeable device has been placed.

[0036] As for a power supply, an AC voltage from the commercial-power-supply input unit **202** is rectified by the rectifier circuit **203** to produce a DC voltage to be applied to the DC/DC converter **204**. The DC/DC converter **204** converts the input DC voltage to a predetermined voltage, which is applied to the charging controllers **205** and **206**.

[0037] The control unit **201**, when notified by the IC communication unit **103** that a chargeable device has been placed, controls the charging controllers **205** and **206** that receive the DC voltage provided from the DC/DC converter **204**, such that DC voltages are applied to the AC generators **207** and **208**. Here, the control unit **201** controls the currents and/or voltages supplied to the AC generators **207** and **208**, by controlling the charging controllers **205** and **206**. The AC generators **207** and **208** convert the input DC voltages to AC voltages, which are applied to the coils **101** and **102**. The coils **101** and **102** generate AC magnetic fields in accordance with the applied AC voltages. The digital camera **110** includes a charging mechanism. The AC magnetic field generated by the coil **101** causes an AC voltage to be generated across both ends of the coil **221** provided in the digital camera **110**. The generated AC voltage is rectified by the rectifier circuit **222** of the digital camera **110**, and the obtained DC voltage is applied to the power supply controller **223**, which charges the secondary battery **224**.

[0038] A normal charging operation is thus performed.

[0039] Referring to FIGS. **2** and **3**, a method for controlling a charging operation according to the present embodiment will now be described.

[0040] FIG. **3** is a flowchart showing the steps of a charging operation according to the present embodiment.

[0041] The charging apparatus **100** performs "IC authentication" when it detects that an object has been placed (YES in step S**301**). When the object is determined to be a chargeable

device as the result of the "IC authentication" (YES in step S**302**), the control unit **201** causes AC magnetic fields to be generated in the coils **101** and **102**, by controlling the charging controllers **205** and **206** (step S**303**). The AC magnetic fields generated in the coils **101** and **102** enable charging to be performed inside the placed chargeable device.

[0042] The detecting unit **212**, during the charging, continues to send the current and voltage data of the coils **101** and **102** to the control unit **201**. When the device being charged no longer needs to be charged since, for example, the charging has finished, the power consumed in the device being charged drops, which leads to a drop in current of the corresponding coil. In the present embodiment, for example, the power supply controller **223** monitors the voltage of the secondary battery **224**, and when it detects that the voltage has reached a predetermined voltage, suppresses the requirement for power. This leads to a drop in current of the corresponding coil **101**. The control unit **201**, which detected a drop in current of the coil **101** and/or the coil **102**, determines that charging is no longer required. When a drop is not observed, it is determined that charging is still required (step S**304**).

[0043] When it is determined that charging is no longer required (YES in step S**304**), the control unit **201** controls the charging controllers **205** and **206** such that supplying of power to the coils **101** and **102** is stopped, and instructs the display controller **209** to notify a user of completion of the charging operation. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color; or makes the LCD panel **105** display a completion-of-charging message, for example (step S**305**). The completion of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0044] When the object is determined to be a non-chargeable device as the result of the "IC authentication" (NO in step S**302**), the control unit **201** determines whether or not the charging controllers **205** and **206** are in a state of supplying currents to the coils **101** and **102** (step S**306**). This is equivalent to determining whether or not AC magnetic fields have already been generated in the coils **101** and **102**, or determining whether or not a certain chargeable device has already been placed in a state of being charged. An alarm message may be displayed which shows that a non-chargeable device or a foreign object has been placed when the object is determined to be a non-chargeable device as the result of the "IC authentication" (NO in step S**302**).

[0045] When currents are not being supplied to the coils **101** and **102** (NO in step S**306**), the control unit **201** instructs the display controller **209** to display an alarm showing that a non-chargeable device or a foreign object has been placed (step S**307**). The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color to act as an alarm. Likewise, the LCD panel **105** displays a message acting as an alarm. The alarm may be realized by display as described above, or may be an audio message from a loudspeaker (not shown).

[0046] When currents are being supplied to the coils **101** and **102** (YES in step S**306**), the control unit **201** receives the position data of the object from the object detector **211**. Then the control unit **201** determines whether or not the newly placed object has been placed apart from the coils **101** and **102** by a predetermined distance or more (step S**308**). This is equivalent to determining whether or not the newly placed object has been placed within a predetermined distance from the coils **101** and **102**. The object detector **211** can perform position detecting, i.e., locating the position of a placed object, by detecting and comparing all the outputs of the Hall elements **107**. Here, a predetermined distance means a distance beyond which a newly placed object, if made of metal, is unlikely to be heated due to magnetic fields generated by the coils **101** and **102**. It also means a distance within which a newly placed object disturbs electromagnetic induction utilized by a device that is already being charged. This may be determined on the basis of experiments, for example.

[0047] When the distance between the newly placed object and the device being charged is a predetermined distance or more (YES in step S**308**), the control unit **201** controls the charging controllers **205** and **206** such that power is continued to be supplied to the coils **101** and **102** (step S**309**).

[0048] When the device being charged no longer needs to be charged since the charging has finished, for example, the power consumed in the device being charged drops, which leads to a drop in current of the corresponding coil. The control unit **201**, which detected the drop in current of the coils **101** and **102**, determines that charging is no longer required. When a drop is not observed, it is determined that charging is still required (step S**310**).

[0049] When it is determined that charging is no longer required (YES in step S**310**), the control unit **201** controls the charging controllers **205** and **206** such that supplying of power to the coils **101** and **102** is stopped, and instructs the display controller **209** to notify a user of completion of the charging operation. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color; or makes the LCD panel **105** display a completion-of-charging message, for example (step S**311**). The completion of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0050] When the distance between the newly placed object and the device being charged is less than a predetermined distance (NO in step S**308**), the control unit **201** instructs the display controller **209** to display an alarm showing that a non-chargeable device or a foreign object has been placed (step S**312**). The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color to act as an alarm. Likewise, the LCD panel **105** displays a message acting as an alarm. The alarm may be realized by display as described above, or may be an audio message from a loudspeaker (not shown).

[0051] Then, the control unit **201** controls the charging controllers **205** and **206** such that power is intermittently supplied to the coils **101** and **102**. By means of this control, the device being charged can be intermittently charged (step S**313**). The interval between the intermittent power supplying operations is modifiable. At this time, the control unit **201** may instruct the display controller **209** to notify a user of the intermittent charging by using the LED **104**, the LCD panel **105**, a loudspeaker (not shown), etc.

[0052] Next, the control unit **201** determines whether or not the temperatures of the device being charged and the newly placed object are abnormally high on the basis of temperatures detected by the temperature detector **210** (step S**314**). The determination is made on the basis of the temperatures sensed by the thermistors **106** that are arranged near the position of the newly placed object detected in step S**306**. A condition determined to be abnormal may be a temperature

equal to or higher than a predetermined value or a rate of increase in temperature equal to or higher than a predetermined value.

[0053] When the temperatures detected by the temperature detector **210** are normal (YES in step S**314**), the control unit **201** determines whether or not more charging is required on the basis of the voltage and current data of the coils **101** and **102** (step S**315**).

[0054] When it is determined that charging is no longer required (YES in step S**315**), the control unit **201** controls the charging controllers **205** and **206** such that supplying of power to the coils **101** and **102** is stopped, and instructs the display controller **209** to notify a user of completion of the charging operation. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color, or makes the LCD panel **105** display a completion-of-charging message, for example (step S**311**). The completion of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0055] When it is determined that charging is still required (NO in step S**315**), the control unit **201** controls the charging controllers **205** and **206** such that the intermittent supply of power to the coils **101** and **102** is continued.

[0056] When the temperatures detected by the temperature detector **210** are abnormal (NO in step S**314**), the control unit **201** controls the charging controllers **205** and **206** such that the voltage (charging voltage) applied to the coils **101** and **102** becomes lower than before (step S**316**). At this time, the control unit **201** may instruct the display controller **209** to notify a user of lower-voltage charging by using the LED **104**, the LCD panel **105**, a loudspeaker (not shown), etc.

[0057] Next, the control unit **201** determines whether or not the temperatures of the device being charged and the newly placed object are abnormally high on the basis of the temperatures detected by the temperature detector **210** (step S**317**).

[0058] When the temperatures detected by the temperature detector **210** are normal (YES in step S**317**), the control unit **201** determines whether or not more charging is required on the basis of the voltage and current data of the coils **101** and **102** obtained by the detecting unit **212** (step S**318**).

[0059] When it is determined that charging is no longer required (YES in step S**318**), the control unit **201** controls the charging controllers **205** and **206** such that supplying of power to the coils **101** and **102** is stopped, and instructs the display controller **209** to notify a user of completion of the charging operation. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color; or makes the LCD panel **105** display a completion-of-charging message, for example (step S**311**). The completion of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0060] When the temperatures detected by the temperature detector **210** are abnormal (NO in step S**317**), the control unit **201** controls the charging controllers **205** and **206** such that supplying of power to the coils **101** and **102** is terminated (step S**319**), and instructs the display controller **209** to notify a user that the charging operation has been terminated. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color; or makes the LCD panel **105** display a termination-of-charging message, for example (step S**320**). The termination of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0061] Note that the above-described sequence of steps S**312** to S**315** may be swapped with the above-described sequence of steps S**316** to S**318**. Only one of the sequence of steps S**312** to S**315** and the sequence of steps S**316** to S**318** may also be used.

[0062] By using the method of controlling a charging operation described above, a charging apparatus according to the present embodiment can suppress heat generation even when a non-chargeable device or a foreign object is placed together with a chargeable device on the charging apparatus. Further, the possibility of unfavorably influencing the charging operation for a chargeable device can be lowered, and a chargeable device, if in a chargeable state, can be charged.

[0063] Another embodiment of a charging apparatus is described.

[0064] A charging apparatus using two coils was described in the first embodiment. In a second embodiment, a charging apparatus using more coils is described.

[0065] FIG. **4** shows a structure of a charging apparatus according to the second embodiment. The components of the charging apparatus having functions similar to those of the components of the charging apparatus in the first embodiment are denoted by the same numerals and their descriptions are omitted.

[0066] A charging apparatus **400** according to the present embodiment includes coils **401** to **406**. These coils cause magnetic fields to be generated by passing currents through them in a way similar to that in the coils of the first embodiment. A voltage is generated, due to electromagnetic induction, across both ends of a coil in a device to be charged that is placed above the coils.

[0067] FIG. **5** is a block diagram of the charging apparatus **400** according to the present embodiment. The components having functions similar to those of the components in the first embodiment are denoted by the same numerals and their descriptions are omitted.

[0068] Referring to FIG. **5**, the charging apparatus **400** includes a control unit **501** that controls each block of the charging apparatus **400**. Charging controllers **502** to **507** respectively control currents and/or voltages provided to AC generators **508** to **513**. The AC generators **508** to **513** convert the provided DC voltages to AC voltages, which are applied to the coils **401** to **406**.

[0069] The charging apparatus **400** according to the present embodiment can change which coil power is supplied to in accordance with the position of an object that is detected by the object detector **211**. Specifically, the control unit **501** controls the charging controllers **502** to **507** such that power is supplied to a coil near the position of the object detected by the object detector **211**. Here, the power may be supplied to a single or a plurality of coils. For instance, in the example shown in FIG. **4**, since the position of the digital camera **110** can be detected, a magnetic field can be generated in the coil **404**. The charging apparatus **400** of the present embodiment can also charge one device using a plurality of coils.

[0070] Referring to FIGS. **5** and **6**, a method for controlling a charging operation in the above-described charging apparatus **400** will now be described.

[0071] FIG. **6** is a flowchart showing the steps of a charging operation according to the present embodiment.

[0072] The charging apparatus **400** performs "IC authentication" when it detects that an object has been placed (YES in step S**601**). When the object is determined to be a chargeable device as the result of the "IC authentication" (YES in step S**602**), the control unit **501** causes an AC magnetic field to be generated in a coil near the position where the object has been placed, by controlling the charging controllers **502** to **507** (step S**603**). The AC magnetic field generated in the coil enables charging to be performed inside the placed chargeable device.

[0073] The detecting unit **212**, during the charging, continues to send the current and voltage data of the coil to the control unit **501**. When the device being charged no longer needs to be charged since the charging has finished, for example, the power consumed in the device being charged drops, which leads to a drop in current of the corresponding coil. The control unit **501**, which detected the drop in current of the coil supplying power, determines that charging is no longer required. When a drop is not observed, it is determined that charging is still required (step S**604**).

[0074] When it is determined that charging is no longer required (YES in step S**604**), the control unit **501** controls the corresponding charging controller such that supplying of power to the coil is stopped, and instructs the display controller **209** to notify a user of completion of the charging operation. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color, or makes the LCD panel **105** display a completion-of-charge message, for example (step S**605**). The completion of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0075] When the object is determined to be a non-chargeable device as the result of the "IC authentication" (NO in step S**602**), the control unit **501** determines whether or not any of the charging controllers **502** to **507** is in a state of supplying a current to the corresponding coil (step S**606**). This is equivalent to determining whether or not AC magnetic fields have already been generated in some of the coils **401** to **406**, or determining whether or not a certain chargeable device has already been placed in a state of being charged. An alarm message may be displayed which shows that a non-chargeable device or a foreign object has been placed, when the object is determined to be a non-chargeable device as the result of the "IC authentication" (NO in step S**602**).

[0076] When currents are not being supplied to the coils **401** to **406** (NO in step S**606**), the control unit **501** instructs the display controller **209** to display an alarm showing that a non-chargeable device or a foreign object has been placed (step S**607**). The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color to act as an alarm. Likewise, the LCD panel **105** displays a message acting as an alarm. The alarm may be realized by display as described above, or may be an audio message from a loudspeaker (not shown).

[0077] Assuming that power is being supplied to the coils **402** and **405**, for example (YES in step S**606**), the control unit **501** determines whether or not the newly placed object has been placed apart from the coils already receiving power by a predetermined distance or more (step S**608**). The object detector **211** can detect the position of the newly placed object by detecting and comparing all the outputs of the Hall elements **107**. Here, a predetermined distance means a distance beyond which a newly placed object, if made of metal, is unlikely to be heated, for example. This can be determined on the basis of experiments etc. Alternatively, the positional relationship may be checked as to whether or not the newly placed object disturbs electromagnetic induction being utilized by a device that is already being charged. This can also be determined on the basis of experiments etc.

[0078] When the distances between the newly placed object and the coils **402** and **405** in a state of charging are a predetermined distance or more (YES in step S**608**), the control unit **501** controls the charging controllers **503** and **506** such that power is continued to be supplied to the coils **402** and **405** (step S**609**).

[0079] When the device being charged no longer needs to be charged since the charging has finished, for example, the power consumed in the device being charged drops, which leads to a drop in current of the corresponding coils. The control unit **501**, which detected the drops in current of the coils **402** and **405**, determines that charging is no longer required. When a drop is not observed, it is determined that charging is still required (step S**610**).

[0080] When it is determined that charging is no longer required (YES in step S**610**), the control unit **501** controls the charging controllers **503** and **506** such that supplying of power to the coils **402** and **405** is stopped, and instructs the display controller **209** to notify a user of completion of the charging operation. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color, or makes the LCD panel **105** display a completion-of-charge message, for example (step S**611**). The completion of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0081] When the distances between the newly placed object and the coils **402** and **405** in a state of charging are less than a predetermined distance (YES in step S**608**), the control unit **501** instructs the display controller **209** to display an alarm showing that a non-chargeable device or a foreign object has been placed (step S**612**). The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color to act as an alarm. The LCD panel **105** displays a message acting as an alarm. The alarm may be realized by display as described above, or may be an audio message from a loudspeaker (not shown).

[0082] Assume that an object has been newly placed near the coil **402**. Then the charging controller **503** is controlled by the control unit **501** to stop supplying power to the coil **402**, which is within the predetermined distance from the newly placed object (step S**613**). In this case, by providing an LED etc. (not shown) near each coil, a user may be notified of the coil that has stopped receiving power using the illumination states of the LED. Alternatively, the LED **104** or the LCD panel **105** may be used to notify the user of which coil has stopped receiving power.

[0083] Next, the control unit **501** determines whether or not the temperatures of the device being charged and the newly placed object are abnormally high on the basis of temperatures detected by the temperature detector **210** (step S**614**). The determination is made on the basis of temperatures sensed by the thermistors **106** that are arranged near the position of the newly placed object detected in step S**606**. The condition determined to be abnormal may be a temperature equal to or higher than a predetermined value or a rate of increase in temperature equal to or higher than a predetermined value.

[0084] When the temperatures detected by the temperature detector **210** are normal (YES in step S**614**), the control unit **501** determines whether or not more charging is required on the basis of the voltage and current data of the coil **405** (step S**615**).

[0085] When it is determined that charging is no longer required (YES in step S**615**), the flow proceeds to step S**611**, where supplying of power to the coil **405** is stopped and completion of the charging operation is notified.

[0086] When the temperatures detected by the temperature detector **210** are abnormal (NO in step S**614**), the control unit **501** controls the charging controller **506** such that power is supplied intermittently to the coil **405** (step S**616**). At this time, the control unit **501** may instruct the display controller **209** to notify a user of intermittent charging by using the LED **104**, the LCD panel **105**, a loudspeaker (not shown), etc.

[0087] Next, the control unit **501** determines whether or not the temperatures of the device being charged and the newly placed object are abnormally high on the basis of the temperatures detected by the temperature detector **210** (step S**617**).

[0088] When the temperatures detected by the temperature detector **210** are normal (YES in step S**617**), the control unit **501** determines whether or not more charging is required on the basis of the voltage and current data of the coil **405** (step S**618**).

[0089] When it is determined that charging is no longer required (YES in step S**618**), the flow proceeds to step S**611**, where supplying of power to the coil **405** is stopped and completion of the charging operation is notified.

[0090] When the temperatures detected by the temperature detector **210** are abnormal (NO in step S**617**), the control unit **501** controls the charging controller **506** such that the voltage applied to the coil **405** becomes lower than before (step S**619**). At this time, the control unit **501** may instruct the display controller **209** to notify a user of lower-voltage charging by using the LED **104**, the LCD panel **105**, a loudspeaker (not shown), etc.

[0091] Next, the control unit **501** determines whether or not the temperatures of the device being charged and the newly placed object are abnormally high on the basis of the temperatures detected by the temperature detector **210** (step S**620**).

[0092] When the temperatures detected by the temperature detector **210** are normal (YES in step S**620**), the control unit **501** determines whether or not more charging is required on the basis of the voltage and current data of the coil **405** (step S**621**).

[0093] When it is determined that charging is no longer required (YES in step S**621**), the flow proceeds to step S**611**, where supplying of power to the coil **405** is stopped and completion of the charging operation is notified.

[0094] When the temperatures detected by the temperature detector **210** are abnormal (NO in step S**620**), the control unit **501** controls the charging controller **506** such that supplying of power to the coil **405** is terminated (step S**622**), and instructs the display controller **209** to notify a user that the charging operation has been terminated. The display controller **209** makes the LED **104** blink, be turned on, or change the luminescent color, or makes the LCD panel **105** display a termination-of-charging message, for example (step S**623**). The termination of charging may be notified by means of display as described above, or may be notified by means of an audio message using a loudspeaker (not shown) etc.

[0095] Note that the sequence of steps S**612** to S**615**, the sequence of steps S**616** to S**618**, and the sequence of steps S**619** to S**621** described above may be swapped with one another. Only one or two of these sequences of steps may also be used.

[0096] A charging apparatus according to the present embodiment can suppress heat generation even when a non-chargeable device or a foreign object is placed together with a chargeable device on the charging apparatus. Further, the possibility of unfavorably influencing the charging operation for a chargeable device can be lowered, and a chargeable device, if in a chargeable state, can be charged.

[0097] In the first and second embodiments, a device to be charged is placed on a charging apparatus; however, by making the chargeable apparatus stand on its side, a device to be charged may be placed near the coils, which are now arranged along the vertical surface of the charging apparatus. For instance a device to be charged may be placed on stands that are provided near the coils, or may be hanged using hangers such as hooks that are provided such that the device is placed near the coils. These ways of placement are also included in embodiments of the invention.

[0098] The method of contactless charging is not limited to the method of charging using electromagnetic induction as described in the embodiments. Other examples include a method of charging in which a radio wave transmitted from a charging apparatus is received with an antenna, and power is taken out from the received radio wave. Another example is a method of charging in which a charging apparatus produces a vibrating electric or magnetic field, which causes resonance in a resonant circuit provided in a device to be charged, allowing the device to take out power.

[0099] 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 modifications and equivalent structures and functions.

[0100] This application claims the benefit of Japanese Patent Application No. 2008-057309 filed Mar. 7, 2008, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A charging apparatus comprising:

a charging unit configured to perform a contactless charging operation for a placed external device;

a position detector configured to detect a position of a placed object;

a determining unit configured to determine whether the placed object is not an external device compatible with the charging unit; and

a control unit configured to control the charging unit such that, during the contactless charging operation for an external device compatible with the charging unit, the charging operation for the external device being charged is restricted when an object that is determined by the determining unit not to be an external device compatible with the charging unit, has been placed within a predetermined distance from the charging unit.

2. The charging apparatus according to claim **1**, wherein the control unit controls the charging unit such that, during the contactless charging operation for the external device compatible with the charging unit, the external device being charged is intermittently charged when the object that is

determined by the determining unit not to be an external device compatible with the charging unit, has been placed within the predetermined distance from the charging unit.

3. The charging apparatus according to claim **1**, wherein the control unit controls the charging unit such that, during the contactless charging operation for the external device compatible with the charging unit, a charging voltage applied to the external device being charged is lowered when the object that is determined by the determining unit not to be an external device compatible with the charging unit, has been placed within the predetermined distance from the charging unit.

4. The charging apparatus according to claim **3**, wherein the external device compatible with the charging unit is a device having a charging mechanism.

5. The charging apparatus according to claim **1**, wherein the control unit, during the contactless charging operation for the external device compatible with the charging unit, terminates the charging operation of the charging unit when the object that is determined by the determining unit not to be an external device compatible with the charging unit has been placed within the predetermined distance from the charging unit.

6. The charging apparatus according to claim **1**, further comprising:

a notification unit configured to notify a user that an object that is not an external device compatible with the charging unit has been placed when an object that is determined by the determining unit not to be an external device compatible with the charging unit, has been placed within the predetermined distance from the charging unit during the contactless charging operation for the external device compatible with the charging unit.

7. The charging apparatus according to claim **1**, further comprising:

a notification unit configured to notify a user that the control unit has restricted the charging operation of the charging unit.

8. A charging apparatus comprising:

a plurality of charging units configured to perform contactless charging operations for placed external devices;

a position detector configured to detect a position of a placed object;

a determining unit configured to determine whether the placed object is not an external device compatible with the charging units; and

a control unit configured to control the plurality of charging units, while a plurality of the charging units are performing contactless charging operations for external devices compatible with the charging units, such that when an object that is determined by the determining unit not to be an external device compatible with the charging units has been placed within a predetermined distance from either of the charging units performing the contactless charging operations, at least one of the charging operations for the external devices compatible with the charging units is restricted.

9. The charging apparatus according to claim **8**, wherein while a plurality of the charging units are performing contactless charging operations for external devices compatible with the charging units, the control unit, when an object that is determined by the determining unit not to be an external device compatible with the charging units has been placed within a predetermined distance from either of the charging units performing the contactless charging operations, terminates a charging operation of at least one of the charging units performing the charging operations that is located within the predetermined distance from the object determined not to be an external device compatible with the charging units.

10. The charging apparatus according to claim **8**, wherein while a plurality of the charging units are performing contactless charging operations for external devices compatible with the charging units, the control unit performs such control that, when an object that is determined by the determining unit not to be an external device compatible with the charging units has been placed within a predetermined distance from either of the charging units performing the contactless charging operations, the charging unit that is not located within the predetermined distance from the object determined not to be an external device compatible with the charging units, is controlled to intermittently charge the external devices compatible with the charging units.

11. The charging apparatus according to claim **8**, wherein while a plurality of the charging units are performing contactless charging operations for external devices compatible with the charging units, the control unit performs such control that, when an object that is determined by the determining unit not to be an external device compatible with the charging units has been placed within a predetermined distance from either of the charging units performing the contactless charging operations, the charging unit that is not located within the predetermined distance from the object determined not to be an external device compatible with the charging units, is controlled to lower a charging voltage applied to the external device compatible with the charging units.

12. The charging apparatus according to claim **11**, wherein the external device compatible with the charging units is a device having a charging mechanism.

13. The charging apparatus according to claim **8**, further comprising:

a notification unit configured to notify a user, while a plurality of the charging units are performing contactless charging operations for external devices compatible with the charging units, that an object that is not an external device compatible with the charging units has been placed, when an object that is determined by the determining unit not to be an external device compatible with the charging units, has been placed within a predetermined distance from the charging units performing the contactless charging operations.

14. The charging apparatus according to claim **8**, further comprising:

a notification unit configured to notify a user that the control unit has restricted at least one of the charging operations of the charging units.

15. The charging apparatus according to claim **9**, further comprising:

a notification unit configured to notify a user of a position of the charging unit whose charging operation has been terminated by the control unit.

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