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(54) Title: POWER FEED DEVICE OF INDUCTIVE CHARGING DEVICE

(57) Abstract: A power feed device (2) of an inductive charging device (1) is provided with: a power factor correction circuit (10) that converts an AC power source into DC, and that corrects the power factor; a smoothing capacitor (lb that is connected to the output terminal of the power factor correction circuit; an inverter circuit (20) that has a plurality of switching elements (21, 23, 26, 28), and that generates an AC signal using the voltage of the smoothing capacitor as the power source; a power feed unit (9) that feeds power based on the AC signal to a power-receiving device (50); and a control circuit (6) that synchronizes the duty factor of the switching elements in the inverter circuit with the AC power source and modulates the duty factor. The control circuit controls the plurality of switching elements so that width fluctuations related to the modulation of the duty factor are asymmetrical.

(57) ABSTRACT

A power supply device (2) of a non-contact charging device (1) that converts AC power source (3) to DC and includes a power factor improvement circuit (10), a smoothing capacitor (16) connected to the output end of the power factor improvement circuit, a plurality of switching elements (21, 23, 26, 28), an inverter circuit (20) that generates an AC signal with the voltage of the smoothing capacitor as a power source, a power supply unit (9) that supplies the AC signal to the power receiving device (50) based on the AC signal, and a control circuit that modulates the duty factor of each of the switching elements of the inverter circuit in synchronization with the AC power source and the control circuit controls the plurality of switching elements such that the increase/decrease range related to the modulation of the duty factor is asymmetrical.

SPECIFICATION

TITLE OF INVENTION: POWER SUPPLY DEVICE FOR NON-CONTACT CHARGING DEVICE

TECHNICAL FIELD

[0001]

The present disclosure relates to a non-contact charging device for non-contact charging of, for example, secondary batteries installed in electric propulsion vehicles (electric vehicles and hybrid vehicles).

CONVENTIONAL TECHNOLOGY

[0002]

Technologies that use magnetic, electric, radio waves, and the like have been developed for non-contact power transmission. This non-contact power transmission technology eliminates the need for wiring to connect the power supply device to the power receiving device, which saves time and effort for the user for making connection, and eliminates worries about electrical leakage and electric shock in rainy weather.

[0003]

However, with non-contact power transmission, for example, the positional relationship between the power supply device and the power receiving device is important for high efficiency. In order to address this problem, a technology has been proposed to reduce the constraint of the positional relationship between the power supply device and the power receiving device by equipping each of the power supply device and the power receiving device with a resonance part that generates resonance of an AC signal (see, for example, Patent Document 1).

[0004]

However, in the case of the technology described in Patent Document 1, harmonic components of the same frequency as that of the commercial power supply are superimposed on the power supply power output from the power supply device. As a result, current ripple or voltage ripple of harmonic components is generated in the output of the power supply device, and ripple is also generated in the output of the power receiving device, in other words, the output current to the battery.

[0005]

In addition, there is a conventional method of wired connection between the power source and the electric propulsion vehicle in order to charge such electric propulsion vehicles and the like. In the wired system, fast feedback control can be performed when a ripple in the output current to the battery is detected. However, in a non-contact charging method, when a ripple in the output current is detected, notification is provided to the power supply side via wireless communication, causing the problem of fast feedback control being difficult to perform.

[0006]
Therefore, three circuits (converters) each made up of four series-connected circuits are connected in parallel to enable sharing a plurality of smoothing capacitors where each circuit is driven so that the phase of each circuit is offset by 2/3 (rad) has also been proposed (for example, see Patent Document 2). With this technology, the charge and discharge current to the plurality of smoothing capacitors converges between the circuits enabling reducing voltage ripple.

PRIOR ART DOCUMENTS

Patent Documents

[0007]
Patent Document 1: Japanese Unexamined Patent Application 2009-296857
Patent Document 2: Japanese Unexamined Patent Application 2008-263715

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0008]
In the case of the configuration described in Patent Document 2, although the voltage ripple of the smoothing capacitor can be reduced, the number of parts in the power supply device is large due to the need for a plurality of circuits (converters) and this leads to increase in size and cost and also has the problem of increased power supply losses.

[0009]
In light of these points, the present disclosure addresses the problem of providing a non-contact charging device power supply device with reduced ripple on the output, enables size reduction and cost reduction, and suppresses power supply losses to the extent possible.

MEANS FOR SOLVING THE PROBLEM

[0010]
In order to resolve the problems described above, the following solutions have been achieved by the present disclosure. A power supply device for a non-contact charging device that supplies power to a power receiving device in a non-contact manner, comprising:

a power factor improvement circuit that converts an AC power source to DC to improve the power factor;

a smoothing capacitor connected to an output end of the power factor improvement circuit;

an inverter circuit that has a plurality of switching elements and generates an AC signal by switching each of the switching elements using the voltage of the smoothing capacitor as a power source;

a power supply unit that has a resonant capacitor and a first inductor connected to an output end of the inverter circuit, and supplies power generated between the first inductor and a second inductor provided in the power receiving device to the power receiving device based on the AC signal; and

a control circuit that modulates the duty factor of each switching element of the inverter circuit in synchronization with the AC power source, when power is supplied from the power supply unit to the power receiving device; wherein

the control circuit controls the plurality of switching elements such that the increase/decrease range related to the modulation of the duty factor is asymmetrical.

EFFECT OF THE INVENTION

[0011]

With the present disclosure, ripples generated in the output can be reduced, size and cost reduction are feasible, and power supply losses can be suppressed for the power supply device of the non-contact charging device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a circuit diagram illustrating the non-contact charging device according to embodiment 1.
FIG. 2 is a circuit diagram illustrating a configuration example of the input detecting part illustrated in FIG. 1.
FIG. 3 is a circuit diagram illustrating a configuration example of a synchronous signal generating part illustrated in FIG. 1.
FIG. 4 illustrates a waveform diagram of each part of a conventional power transfer system for comparison with the non-contact charging device in FIG. 1.
FIG. 5 illustrates a waveform diagram of each part in the non-contact charging device illustrated in FIG. 1, when the duty factor of the inverter circuit illustrated in FIG. 1 is changed.
FIG. 6 is a zoomed-in view of the operating waveform diagram of the inverter circuit at high input power.
FIG. 7 is a zoomed-in view of the operating waveform diagram of the inverter circuit at low input power.
FIG. 8 illustrates the relationship between the input current and the Δ duty factor of the power supply device illustrated in FIG. 1.
FIG. 9 illustrates the relationship between the input power and the duty factor of the power supply device illustrated in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS
[0013]
The present disclosure is a power supply device for a non-contact charging device that supplies power to a power receiving device in a non-contact manner, comprising:
a power factor improvement circuit that converts AC power source to DC to improve the power factor;
a smoothing capacitor connected to an output end of the power factor improvement circuit;
an inverter circuit that has a plurality of switching elements and generates an AC signal by switching each of the switching elements using the voltage of the smoothing capacitor as a power source;
a power supply unit that has a resonant capacitor and a first inductor connected to an output end of the inverter circuit, and supplies power generated between the first inductor and a second inductor provided in the power receiving device to the power receiving device based on the AC signal; and
a control circuit that modulates the duty factor of each switching element of the inverter circuit in synchronization with the AC power source, when power is supplied from the power supply unit to the power receiving device; wherein
the control circuit controls the plurality of switching elements such that the increase/decrease range related to the modulation of the duty factor is asymmetrical.

[0014]
In addition, the control circuit increases the modulation amount of the duty factor for the plurality of switching elements in conjunction with increase in input power from the AC power source to this power supply device.

[0015]
Furthermore, the control circuit ensures that the pattern for modulating the duty factor is an approximate sine wave with two times the frequency of the AC power source.

[0016]
With this configuration, output ripple of the power supply device can be reduced not only during feedback control where high detection accuracy is required but also with feedforward control. As a result, the ripple in the output of the power receiving device can be reduced, and components for detecting output of the first inductor and for detecting voltage of the smoothing capacitor are not needed in the power supply device. Thus the number of components in the power supply device is reduced enabling size reduction and cost reduction of the power supply device.

[0017]
Embodiments of the present disclosure will be described in detail below with reference to the drawings. However, the present disclosure is not limited by this embodiment.

[0018]
Embodiment 1FIG. 1 is a circuit diagram of the non-contact charging device according to embodiment 1.

[0019]
As illustrated in FIG. 1, a non-contact charging device 1 includes a power supply device 2 installed in, for example, a parking space, and a power receiving device 50 equipped on an electric propulsion vehicle. The power supply device 2 includes a commercial power supply 3, a first rectifier circuit 4, a synchronous signal generating part 5, a control circuit 6 on the power supply device 2 side (simply “control circuit 6” below), a power supply unit 9, a power factor improvement circuit 10, and an inverter circuit 20.

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