CERTIFICATE OF TRANSLATION ACCURACY

I, Michael Fletcher, declare:

1. I am a native speaker of English and am well versed in both the Japanese and English languages and have over 18 years of experience translating Japanese technical documents into English on a full-time basis.

2. The following translation of the corresponding source text from Japanese into English is accurate and complete to the best of my knowledge.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and accurate.

Statements made herein are to the best of my knowledge true and are based on information that I believe to be true and further these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the patent application in the United States of America or any patent issuing thereon.

Executed this 10th day of February 2022, at Parowan, UT.

Michael Fletcher

(19) Japanese Patent Office (JP)

(12) Patent Publication Gazette (B2)

(11) Patent No. P3692541 (P3692541)

(45) **Date Issued: Sep 7, 2005**

(24) Registration date: Jul. 1, 2005

(51) Int. Cl	ID Number	JPO File Number	FI	Theme code (ref.)
H 02 J 17/00		H 02 J 17/00		B
H 02 J 7/00		H 02 J 7/00		301D

Number of Claims: 14 Total pages: 20

(21) Filed Appln. No.: H10-532727

(86) (22) Filed: Feb. 3, 1998

(86) International application number: PCT/JP1998/000441

(87) International publication number: W01998/034319

(87) International Filing Date: Aug. 6, 1998

Examination Request: Dec. 7, 2004

(31) Priority Claim number: H09-20739

(32) Priority Date: Feb. 3, 1997

(33) Priority claiming country: JP

(73) Patentee
Sony Corporation
7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

(74) *Agent, Attorney, or Firm*:
Patent Attorney TANABE, Keiki

(72) Inventor: NAGAI, Tamizi
c/o Sony Corporation 7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

(72) Inventor: TAKEI, Toshitaka
c/o Sony Corporation 7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

(72) Inventor: SUZUKI, Kuniharu
c/o Sony Corporation 7-35, Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

Continued on last page

(54) TITLE OF THE INVENTION

POWER TRANSFER DEVICE AND POWER TRANSFER METHOD

(57) What is claimed is:

[Claim 1]

A power transmission device designed to transmit power between a primary coil and a secondary coil, comprising:

signal generator means for generating and outputting an oscillation signal of a prescribed frequency;

current supply means for supplying current to be conducted on the primary coil;

drive means for driving and controlling conduction and interruption of the current supplied from the current supply means to the primary coil based on the frequency of the oscillation signal;

the primary coil, which generates time-varying magnetic flux based on the frequency of the oscillation signal by conduction and interruption of the current based on the drive control; and

the secondary coil, having a capacitance element connected in parallel, an induced electromotive force produced in accordance with the time varying magnetic flux interlinkage generated in the primary coil, and a higher resonant frequency than the frequency of the oscillation signal, and that together with the capacitance element, resonates the induced current generated based on the induced electromotive force; wherein

power is transferred from the primary coil to the secondary coil based on the time varying magnetic flux interlinkage generated in the primary coil generating the induced electromotive force in the secondary coil.

[Claim 2]

The power transfer device according to claim 1, wherein

the secondary coil rectifies and outputs the induced current generated by conduction and interruption of current in the primary coil.

[Claim 3]
The power transfer device according to claim 1, wherein
the primary coil and secondary coil are respectively wound around cores with a prescribed shape, and
the core with the primary coil wound thereon and the core with the secondary coil wound thereon are arranged in a position with the centers thereof mutually offset.

[Claim 4]
The power transfer device according to claim 3, wherein
the core with the primary coil wound thereon is formed with a larger cross-sectional area as compared to the core with the secondary coil wound thereon.

[Claim 5]
The power transfer device according to claim 1, comprising:
detection means for detecting predetermined parameter fluctuations occurring in the primary coil;
control means that outputs a first or second control signal based on the detection results;
intermittent oscillation means that supplies the oscillation signal intermittently to the drive means at a prescribed timing for a prescribed amount of time if the first control signal is supplied and supplies the oscillation signal to the drive means continuously if the second control signal is supplied.

[Claim 6]
The power transfer device according to claim 1, comprising:
a tertiary coil provided separately from the primary coil and secondary coil;
detection means for detecting prescribed parameter fluctuations occurring in the tertiary coil;
control means that outputs a first or second control signal based on the detection results;
intermittent oscillation means that supplies the oscillation signal intermittently to the drive means at a prescribed timing for a prescribed amount of time if the first control signal is supplied and supplies the oscillation signal to the drive means continuously if the second control signal is supplied.

[Claim 7]
The power transfer device according to claim 6, wherein
the tertiary coil is arranged in the vicinity of the secondary coil and in a position that interlinks with the magnetic flux generated in the primary coil.

[Claim 8]
The power transfer device according to claim 6 with the tertiary coil arranged in a position facing a prescribed metal member arranged in a prescribed position of an electronic device having the secondary coil, comprising:
second signal generating means that generates and outputs a second oscillation signal at a prescribed frequency;
second current supply means that supplies current conducted in the tertiary coil; and
second drive means that drives and controls the current supplied from the second power supply means conducted in the tertiary coil based on the frequency of the second oscillation signal.

[Claim 9]
A method of power transmission designed to transmit power between a primary coil and a secondary coil in an non-contact manner, comprising:
driving and controlling current conduction in the primary coil based on the oscillation signal with a prescribed frequency;
producing time-varying magnetic flux in the primary coil through conduction and interruption of the current based on the drive control at the frequency of the oscillation signal; and
resonating the current induced by the induced electromotive force of the secondary coil from interlinkage with magnetic flux generated in the primary coil for transferring power from the primary coil to the secondary coil and generated by the induced electromotive force at a frequency higher than the oscillation signal frequency.

[Claim 10]
The method of power transfer according to claim 9, wherein
the induced current generated in the secondary coil at the timing when current conduction in the primary coil is interrupted is rectified and output.

[Claim 11]
The method of power transfer according to claim 9, wherein
the primary coil and secondary coil consist of each being wound on a prescribed shaped core and the core centers thereof are arranged in mutually offset positions.

[Claim 12]
The method of power transfer according to claim 11, wherein
the cross-sectional area of the core on which the primary coil is wound is larger than the cross-sectional area of the core on which the secondary coil is wound.

[Claim 13]
The method of power transfer according to claim 9, comprising:
a detecting step of detecting prescribed parameter fluctuations that occur in the primary coil;
a controlling step of outputting a first or second control signal depending on the detection results; and
an intermittent oscillation switching step of driving and controlling intermittent conduction and interruption in the primary coil at prescribed timing if the first control signal is supplied and driving and controlling continuous conduction and interruption in the primary coil if the second control signal is supplied.

[Claim 14]
The method of power transfer according to claim 9, comprising:
a detecting step of detecting prescribed parameter fluctuations that occur in a tertiary coil provided separately from the primary coil and the secondary coil;
a controlling step of outputting a first or second control signal depending on the detection results; and
an intermittent oscillation switching step of driving and controlling intermittent conduction and interruption in the primary coil at prescribed timing if the first control signal is supplied and driving and controlling continuous conduction and interruption in the primary coil if the second control signal is supplied.

DETAILED DESCRIPTION OF THE INVENTION

TECHNICAL FIELD

The present invention relates to a power transfer device and a power transfer method, and is suitable for application to a power transfer device and a power transfer method used for a charging device that charges a secondary battery built into a small portable electronic device via a non-contact terminal, for example.

BACKGROUND ART

In recent years, the demand for small portable electronic devices such as headphone stereos, camera-integrated VTRs, and mobile communication terminal devices with reduced size has been increasing. These small portable electronic devices have a high-capacity rechargeable secondary battery built in as a power source, which is charged using a prescribed charging device.
One such charging device is a contact type. A contact-type charging device has a spring-type electrical contact, for example, and the electrical contact on the small portable electronic device is brought into contact with this contact to electrically connect the two, and the charging current is supplied to the secondary battery in the small portable electronic device through the electrical path thus formed.

However, in this type of charging device, the contact parts may become oxidized or contaminated over time. This manner of oxidation and contamination will cause poor contact between the two contact points, which will inhibit the supply of charging current to the secondary battery.
A charging device that uses a non-contact type charging method is considered to avoid this manner of problems. One possible non-contact charging method is to supply charge current from the charging device to the secondary battery using electromagnetic induction.

In other words, the primary coil is provided at the terminal on the charging device side, and the secondary coil is provided at the terminal on the small portable electronic device side, with the primary and secondary coils close together. When a current is applied to the primary coil under these conditions, the primary coil generates a magnetic flux. For example, if the current flowing in the primary coil is turned ON and OFF at regular intervals, the magnetic flux generated by the conduction of the current will vary with time. On the secondary coil side, the induced electromotive force is generated by electromagnetic induction due interlinkage of time-varying magnetic flux. The secondary coil uses the induced electromotive force as a power source to generate alternating current as AC current, with the direction of the current reversing according to the ON and OFF of the primary coil side conduction. The non-contact

In this manner, the primary coil on the charging device side and the secondary coil on the small portable electronic device side are brought into close proximity during charging, and power is transmitted from the primary coil side to the secondary coil side using a magnetic connection through electromagnetic induction. A non-contact charging device can be implemented in this manner.

In a charging device of this configuration, the primary and secondary coils are built into the charging device and electronic device, respectively, and power is transmitted from the primary coil to the secondary coil by electromagnetic induction enabling non-contact power transfer.

However, in such a case, the coupling coefficient between the primary and secondary coils becomes worse with increased space between the primary and secondary coils (for the specific magnetic permeability of air), and the amount of magnetic flux generated in the primary coil interlinked to the secondary coil is reduced. For this reason, compared to a general transformer, a high degree of coupling is difficult to achieve between the primary coil and the secondary coil in such a power transmission device.

This leads to the problem of low power transmission efficiency in power transmission devices as described above, due to power loss caused by low coupling.

DISCLOSURE OF THE INVENTION

The present invention came about in light of the points described above and proposes a power transfer device and power transfer method that improves the power transfer efficiency from the primary coil side to the secondary coil side.

In order to resolve the problems described above, the present invention is a power transmission device designed to transmit power between a primary coil and a secondary coil and includes:

signal generator means for generating and outputting an oscillation signal of a prescribed frequency;

current supply means for supplying current to be conducted in the primary coil;

drive means for driving and controlling conduction and interruption of the current supplied from the current supply means to the primary coil based on the frequency of the oscillation signal;

the primary coil, which generates time-varying magnetic flux based on the frequency of the oscillation signal by conduction and interruption of the current based on the drive control; and

the secondary coil, having a capacitance element connected in parallel, an induced electromotive force produced in accordance with the time varying magnetic flux interlinkage generated in the primary coil, and a higher resonant frequency than the frequency of the oscillation signal, and that together with the capacitance element, resonates the induced current generated based on the induced electromotive force; wherein

induced electromotive force is transferred to the secondary coil through interlinkage of the time-varying magnetic flux generated in the primary coil.

In this manner, the resonant frequency of the secondary coil side is set to a higher frequency than the frequency of the transmission signal of the primary coil side, which makes the apparent coupling coefficient between the primary and secondary coils higher by reducing capacitance and this enables increasing the power transfer efficiency from the primary coil to the secondary coil.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuit diagram illustrating a configuration of a charging device and an electronic device according to embodiment 1 of the present invention.

FIG. 2 is a circuit diagram illustrating the equivalent circuit of the electromagnetic induction part.

FIG. 3 is a chart describing the relationship between the drive frequency of the primary coil and the resonant frequency of the secondary coil.

FIG. 4 is a chart describing the drive voltage provided to the primary coil according to the drive frequency.

FIG. 5 is a chart describing the induced voltage generated in the secondary coil.

FIG. 6 is a circuit diagram illustrating a configuration of a charging device and an electronic device according to embodiment 2 of the present invention.

FIG. 7 is a chart describing the induced voltage generated in the secondary coil.

FIG. 8 is a schematic diagram illustrating a configuration of a charging device and an electronic device according to embodiment 3 of the present invention.

FIG. 9 is a block diagram illustrating a configuration of a charging device and an electronic device according to embodiment 4 of the present invention.

FIG. 10 is a chart illustrating control of induced voltage on the secondary coil side by varying the frequency of the primary coil side.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.