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CONFIRMATION NO. 4188

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FILING RECEIPT

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Power of Attorney: None

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 61/064,618**

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Early Publication Request: No

**** SMALL ENTITY ****

Title

Transmission-guard for inductive power outlet

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. _____

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Additional inventors are being named on the _____ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max):

Transmission-Guard for Inductive Power Outlet

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number of CDs _____

☑ Drawing(s) *Number of Sheets* 4

☐ Other (specify) _____

☑ Specification (e.g. description of the invention) *Number of Pages* 12

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SIGNATURE /Yossi Azancot/ /Amir Ben Shalom/ /Arik Rofe/ /Oola Greenwald/ /Dov Rhodes/ Date 15th March 2008

TYPED or PRINTED NAME Yossi Azancot Amir Ben Shalom Arik Rofe Oola Greenwald Dov Rhodes REGISTRATION NO. _____ *(if appropriate)*

TELEPHONE +972 3 902 1057 Docket Number: 1052-29

Transmission-Guard for Inductive Power Outlet

Field of the Invention

The present invention is directed to inductive electrical power outlets. More specifically, the present invention relates to preventing power transmission from inductive power outlets in the absence of an electric load.

Background

Inductive power coupling allows energy to be transferred from a power supply to an electric load without connecting wires. A power supply is wired to a primary coil and an oscillating electric potential is applied across the primary coil, thereby inducing an oscillating magnetic field. The oscillating magnetic field may induce an oscillating electrical current in a secondary coil placed close to the primary coil. In this way, electrical energy may be transmitted from the primary coil to the secondary coil by electromagnetic induction without the two coils being conductively connected. When electrical energy is transferred from a primary coil to a secondary coil the coil pair are said to be inductively coupled. An electric load wired in series with such a secondary coil may draw energy from the power source wired to the primary coil when the secondary coil is inductively coupled thereto.

Induction type power outlets may be preferred to the more common conductive power sockets because they provide seamless power transmission and minimize the need for trailing wires.

Low power inductive electrical power transmission systems have been proposed. One such example is described in United States Patent No. 7,164,255 to Hui. In Hui's system a planar inductive battery charging arrangement is designed to enable electronic devices to be recharged. The system includes a planar charging module having a charging surface on which a device to be recharged is placed. Within the charging module, and parallel to the charging surface, at least one, and preferably an array of primary windings are provided. The primary windings inductively couple energy to secondary windings within the device to be recharged.

Such systems are adequate for charging batteries in that they typically provide a relatively low power inductive coupling. It will be appreciated however, that extended base units such as Hui's charging surface which transmit energy continuously, in a largely uniform manner over the whole area of the unit, are not

suitable for use with high energy systems, such as those required to power computers, light bulbs, televisions and the like.

Variable voltage in a high power primary coil produces a large oscillating magnetic field. Where a secondary coil is inductively coupled to the primary coil, the resulting flux linkage causes power to be drawn by the secondary coil. Where there is no secondary coil to draw the power, the oscillating magnetic field causes high energy electromagnetic waves to be radiated in all directions which may have undesired side affects, such as wiping credit cards and may be harmful to bystanders particularly to those with pacemakers. In addition whereas in low power systems such as Hui's charging surface excess heat may be readily dissipated, an uncoupled high power primary coil or its surroundings may become dangerously hot.

United States Patent No. 6,803,744, to Sabo, titled "Alignment independent and self aligning inductive power transfer system" describes an inductive power transfer device for recharging cordless appliances. Sabo's device includes a plurality of inductors which serve as the primary coil of a transformer. The secondary coil of the transformer is arranged within the appliance. When the appliance is positioned proximate to the power transfer device with the respective coils in alignment, power is inductively transferred from the device to the appliance via the transformer.

The inductors of Sabo's system are arranged in an array and connected to a power supply via switches which are selectively operable to activate the respective inductors. These selectively operable switches are provided to conserve power and to eliminate objectionable electromagnetic fields. '744 thus indicates the need for each primary coil to be energized from the power supply only when a secondary coil is within effective range. Nevertheless no mechanism is described by which such switches may be remotely operated.

The need remains therefore for a practical transmission-guard for preventing power transmission from inductive power outlets in the absence of an electric load.

Summary of the Invention

It is an aim of the invention to provide a transmission-guard for preventing an inductive power outlet from transmitting power in the absence of an electric load inductively coupled thereto, the inductive power outlet comprising at least one primary coil connectable to a power supply, for inductively coupling with a secondary coil wired to the electric load, the transmission-guard comprising at least one transmission-lock for preventing the primary coil from connecting to the power supply in the absence of a transmission-key.

Preferably, the transmission-lock comprises at least one magnetic switch and the transmission-key comprises at least one magnetic element associated with the secondary coil. In certain embodiments magnetic element comprises a ferrite flux guidance core. Optionally, the transmission-lock comprises an array of magnetic switches configured to connect the primary coil to the power supply only when activated by a matching configuration of magnetic elements. Typically, the magnetic switch comprises a magnetic sensor.

In certain embodments, the transmission-guard comprises: at least one emitter for emitting a release-signal; and at least one detector for detecting the release signal; the transmission-key comprises at least one bridge associated with the secondary coil for bridging between the at least one emitter and the at least one detector, such that when the secondary coil is brought into alignment with the primary coil the release signal is guided from the emitter to the detector. Optionally, the release-signal is an optical signal and the bridge comprises at least one optical wave-guide. Alternatively, the release-signal is a magnetic signal and the bridge comprises a magnetic flux guide. Alternatively, again, the release-signal is selected from the group comprising: mechanical signals, audio signals, ultra-sonic signals and microwaves.

In other embodiments, the transmission-key comprises a release-signal emitted by an emitter associated with the secondary coil. Optionally, the release-signal is an optical signal such as an infra-red pulse received by an optical detector configured to release the transmission-lock. Alternatively, the release-signal is a magnetic signal, such as may be emitted by the secondary coil. Alternatively, again, the release-signal is selected from the group comprising: mechanical signals, audio signals, ultra-sonic signals and microwaves.

In still other embodiments, a low-power power pulse transmitted by the primary coil, such that when the secondary coil is aligned to the primary coil the power pulse is transferred to the secondary coil and the transmission-key is triggered by the power pulse.

In preferred embodiments, the transmission-guard comprises: a first transmission-lock being released by a first transmission-key indicating the probable presence of a secondary coil and a second transmission-lock being released by a second transmission-key confirming the presence of the secondary coil. The first transmission-lock may initiate a power pulse transmitted from the primary coil, and the second transmission key may be triggered by the power pulse being received by the secondary coil.

It is a further aim of the invention is to provide a transmission-key for use in the transmission-guard. Another aim is to provide a transmission-lock for use in the transmission-guard.

Still another aim of the invention is to provide an inductive power outlet protected by the transmission-guard.

Another aspect of the invention is to teach a method for preventing an inductive power outlet from transmitting power in the absence of an electric load, by protecting the inductive power outlet with the transmission-guard.

Brief Description of the Figures

For a better understanding of the invention and to show how it may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings.

With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention; the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. In the accompanying drawings:

Fig. 1 is a block diagram representing the main components of a transmission-guard for an inductive power outlet according to a first embodiment of the present invention;

Fig. 2 is a schematic representation of an inductive power outlet protected by an exemplary transmission-guard according to a second embodiment of the present invention wherein a transmission-lock is released by a magnetic key;

Figs. 3a-c are schematic representations of a transmission-guard according to a third embodiment of the invention in which a transmission-lock is releasable by a passive optical transmission-key; and

Fig. 4 is a schematic representation of a transmission-guard according to a fourth embodiment of the invention in which a transmission-lock is releasable by an active optical transmission-key.

Description of the Preferred Embodiments

Reference is now made to Fig. 1 which shows a block diagram representing a transmission-guard 100 for preventing an inductive power outlet 200 from

transmitting power in the absence of a secondary unit 300 connected to an electric load 340, according to a first embodiment of the invention.

The inductive power outlet 200 consists of a primary coil 220, wired to a power supply 240, for inductively coupling with a secondary coil 320 wired to an electric load 340.

The primary coil 220 is typically wired to the power supply 240 via a driver 230 which provides the electronics necessary to drive the primary coil 220. Driving electronics may include a switching unit providing a high frequency oscillating voltage supply, for example. Where the power outlet 200 consists of more than one primary coil 220, the driver 230 may additionally consist of a selector for selecting which primary coil 220 is to be driven.

It is a particular feature of the present invention that a transmission-guard 100 is provided consisting of a transmission-lock 120 connected in series between the power supply 240 and the primary coil 220. The transmission-lock 120 is configured to prevent the primary coil 220 from connecting to the power supply 240 unless it is released by a transmission-key 140. The transmission-key 140 is associated with the secondary unit 300 and serves to indicate that the secondary coil 320 is aligned to the primary coil 220.

With reference to Fig. 2, a schematic representation is shown of an inductive power outlet 2200 protected by an exemplary magnetic transmission-guard 2100 according to a second embodiment of the present invention. Power may only be provided by the protected power outlet 2200 when an authenticated secondary unit 2300 is aligned thereto.

The protected power outlet 2200 includes a magnetic transmission-lock 2120 consisting of an array of magnetic switches 2122 electrically connected in series between the primary coil 2220 and the driver 2230. A magnetic transmission-key 2140 consisting of an array of magnetic elements 2142 is provided within the authenticated secondary unit 2300.

The configuration of magnetic elements 2142 in the transmission-key 2140 is selected to match the configuration of magnetic switches 2122 in the transmission-lock 2120. The authenticated secondary unit 2300 may be aligned with the protected induction outlet 2200 by aligning both the transmission-key 2140 with the

transmission-lock 2120 and the secondary coil 2320 with the primary coil 2220. Once correctly aligned, all the magnetic switches 2122 in the transmission-lock 2120 are closed and the driver 2230 is thereby connected to the primary coil 2220.

Various examples of magnetic switches 2122 are known in the art including for example reed switches, Hall-effect sensors or such like. Such magnetic switches 2122 may be sensitive to any magnetic elements 2142 such as either North or South poles of permanent magnets or electromagnetic coils for example. It is further noted that Hall-effect sensors may be configured to sense magnetic fields of predetermined strength.

According to certain embodiments, the magnetic transmission-key 2140 may consist of a permanent magnet and a ferrite element incorporated with in the secondary unit 300. The characteristics of the magnetic field produced by a transmission-key of this type depend upon the strength and position of the permanent magnetic as well as the dimensions and characteristics of the ferrite element. The magnetic transmission-lock 2120 may consist of an array of magnetic switches, such as unipolar Hall switches for example, which are strategically placed and orientated such that they connect the primary coil 2220 to the driver 2230 only when triggered by a particular combination of a permanent magnet and ferrite element.

It is noted that permanent magnets may commonly be provided to assist with alignment of the secondary coil 2320 to the primary coil 2220. Ferrite elements may also be commonly included in secondary units 300 for providing flux guidance from the primary coil 2220 to the secondary coil 2320. The magnetic transmission-lock 2120 may therefore be made sensitive to these components. Indeed a single magnetic transmission-lock 2120 may be provided which is configured to detect various secondary units and to selectively connect more than one primary coil 2220 depending on the secondary unit detected.

Referring back to Fig. 1, according to other embodiments of the transmission-guard 100, a power outlet 200 may be protected by a transmission-lock 120 which may be released when a release signal S_R is received by a detector 124. The release signal S_R may be actively emitted by the transmission-key 140 or alternatively the transmission-key may passively direct the release signal towards the detector 124.

One example of a passive transmission-key 3140 is shown in Figs. 3a-c which represent an optical transmission-guard 3100 according to a third embodiment of the invention.

The transmission-guard 3100 consists of an active optical transmission-lock 3120 incorporated within an inductive power outlet 3200 and a passive optical transmission-key 3140 incorporated within the secondary unit 3300.

With particular reference to Fig. 3a, the optical transmission-lock 3120 includes a switch 3122, an optical detector 3124, such as a photodiode, a phototransistor, a light dependent resistor or the like, and an optical emitter 3126 such as light emitting diode (LED). The switch 3122 is normally open but is configured to close when a release signal S_R is received by the optical detector 3124, thereby connecting a primary coil 3220 to a driver 3230. The optical emitter 3126 is configured to emit the optical release-signal S_R which is not directly detectable by the optical detector 3124.

Referring now to Fig. 3b, the optical transmission-key 3140 includes a bridging element 3142 such as an optical wave-guide, optical fiber, reflector or the like. The bridging element 3142 is configured to direct the optical release-signal S_R from the optical emitter 3124 towards the optical detector 3126, when a secondary coil 3320 is aligned with the primary coil 3220.

When the secondary unit 3300 is correctly aligned with the inductive power outlet 3200, as shown in Fig. 3c, the secondary coil 3320 aligns with the primary coil 3220 and the passive optical transmission-key 3140 aligns with the optical transmission-lock 3120. The optical release-signal S_R is thus detected by the optical detector 3126 and the switch 3122 is closed connecting the primary coil 3220 to the driver 3230.

It is noted that many materials are partially translucent to infra-red light. It has been found that relatively low intensity infra red signals from LEDs and the like, penetrate several hundred microns of common materials such as plastic, cardboard, Formica or paper sheet, to a sufficient degree that an optical detector 3124, such as a photodiode, a phototransistor, a light dependent resistor or the like, behind a sheet of from 0.1 mm to 2 mm of such materials, can receive and process the signal. For example a signal from an Avago HSDL-4420 LED transmitting at 850nm over 24

degrees, may be detected by an Everlight PD15-22C-TR8 NPN photodiode, from behind a 0.8 mm Formica sheet. For signaling purposes, a high degree of attenuation may be tolerated, and penetration of only a small fraction, say 0.1% of the transmitted signal intensity may be sufficient.

Although an optical transmission-key 3140 is described above, it will be appreciated that other passive transmission-keys may incorporate bridging elements configured to guide release-signals of other types. For example, a ferromagnetic bridge may be incorporated for transmitting magnetic release-signal from a magnetic element to a magnetic detector such as a Hall-effect sensor or the like. The magnetic emitter in such a case may be the primary coil itself.

Alternatively, audio signals through dense elements, or low power microwaves may be guided along microwave wave guides for example.

An example of an active optical transmission-key 4140 is shown in Fig. 4 representing a transmission-guard 4100 according to a fourth embodiment of the invention.

The transmission-guard 4100 of the fourth embodiment includes a transmission-lock 4120 incorporated within an inductive power outlet 4200 and an active optical transmission-key 4140 incorporated within secondary unit 4300.

The active optical transmission-key 4140 includes an optical emitter 4142, configured to emit an optical release-signal S_R, and the transmission-lock 4120 includes a switch 4122 and an optical detector 4124. The transmission-lock 4120 is configured to close the switch 4122 thereby connecting a primary coil 4220 to a driver 4230 when the optical detector 4124 receives the release-signal S_R.

When the secondary unit 4300 is aligned with the inductive power outlet 4200, the transmission-key 4140 emits an optical release-signal S_R which is received by the optical detector 4124 of the transmission-lock 4120 and this closes the switch 4122. Thus the inductive power outlet 4200 is enabled to transfer power to the secondary coil 4320.

It will be appreciated that a release signal S_R may be coded to provide a unique identifier . Coding may be by modulation of frequency, pulse frequency, amplitude or the like. The code may be used, for example, to identify the type or identity of the secondary unit for authentication. Other data may additionally be encoded into the

release-signal. This data may include required power transmission parameters, billing information or other information for the use of the power outlet.

Although an optical active transmission-key 4140 is described above, it will be appreciated that other active transmission-keys may emit other types of release-signals. For example, the secondary coil 4320 may be used to transmit a magnetic release-signal to a magnetic detector incorporated in the transmission-lock. This could be a Hall-effect sensor or the like or even the primary coil 4220 itself.

To actively emit a release-signal transmission-keys typically require a power source. In some cases, particularly where the secondary unit is incorporated into a portable electrical device, power may be provided by internal power cells with the secondary unit. Alternatively, power may be drawn from a power pulse transferred from the primary coil to the secondary coil.

In certain embodiments of the invention, the inductive power outlet transfers a periodic low energy power pulse, for example a pulse of a few milliseconds duration may be transmitted by the primary coil at a frequency of 1 hertz or so. When a secondary coil is brought into the vicinity of the primary coil the power may be transferred to the secondary coil and may be used to power an active transmission-key.

In other embodiments of the transmission-guard, a first transmission-lock (preferably a passive transmission-lock) associated with the secondary unit, releases a first transmission-lock thereby indicating the probable presence of a secondary coil. A low energy power pulse is then emitted by the primary coil to power an active second transmission-key which may release a second transmission-lock thereby connecting the primary coil to a driver.

The scope of the present invention is defined by the appended claims and includes both combinations and sub combinations of the various features described hereinabove as well as variations and modifications thereof, which would occur to persons skilled in the art upon reading the foregoing description.

In the claims, the word "comprise", and variations thereof such as "comprises", "comprising" and the like indicate that the components listed are included, but not generally to the exclusion of other components.

Claims

1. A transmission-guard for preventing an inductive power outlet from transmitting power in the absence of an electric load inductively coupled thereto, said inductive power outlet comprising at least one primary coil connectable to a power supply, for inductively coupling with a secondary coil wired to said electric load, said transmission-guard comprising at least one transmission-lock for preventing said primary coil from connecting to said power supply in the absence of a transmission-key.

2. The transmission-guard of claim 1 wherein said transmission-lock comprises at least one magnetic switch and said transmission-key comprises at least one magnetic element associated with said secondary coil.

3. The transmission-guard of claim 2 wherein said transmission-lock comprises an array of magnetic switches configured to connect said primary coil to said power supply only when activated by a matching configuration of magnetic elements.

4. The transmission-guard of claim 2 wherein said magnetic switch comprises a magnetic sensor.

5. The transmission-guard of claim 1 comprising: at least one emitter for emitting a release-signal; and at least one detector for detecting said release signal; said transmission-key comprises at least one bridge associated with said secondary coil for bridging between said at least one emitter and said at least one detector, such that when said secondary coil is brought into alignment with said primary coil said release signal is guided from said emitter to said detector.

6. The transmission-guard of claim 5 wherein said release-signal is an optical signal and said bridge comprises at least one optical wave-guide.

7. The transmission-guard of claim 5 wherein said release-signal is a magnetic signal and said bridge comprises a magnetic flux guide.

8. The transmission-guard of claim 1 wherein said transmission-key comprises a release-signal emitted by an emitter associated with said secondary coil.

9. The transmission-guard of claim 8 wherein said release-signal is an optical signal.

10. The transmission-guard of claim 9 wherein said optical signal is an infra-red pulse received by an optical detector configured to release said transmission-lock.

11. The transmission-guard of claim 8 wherein said release-signal is a magnetic signal.

12. The transmission-guard of claim 11 wherein said emitter is said secondary coil.

13. The transmission-guard of claim 1 comprising a low-power power pulse transmitted by said primary coil, such that when said secondary coil is aligned to said primary coil said power pulse is transferred to said secondary coil and said transmission-key is triggered by said power pulse.

14. The transmission-guard of claim 1 comprising: a first transmission-lock being released by a first transmission-key indicating the probable presence of a secondary coil and a second transmission-lock being released by a second transmission-key confirming the presence of said secondary coil.

15. The transmission-guard of claim 14, said first transmission-lock initiating a power pulse transmitted from said primary coil, and said second transmission key being triggered by said power pulse being received by said secondary coil.

16. A transmission-guard of claim 2 wherein said magnetic element comprises a ferrite flux guidance core.

17. A transmission-guard of claim 5 wherein said release-signal is selected from the group comprising: mechanical signals, audio signals, ultra-sonic signals and microwaves.

18. A transmission-guard of claim 8 wherein said release-signal is selected from the group comprising: mechanical signals, audio signals, ultra-sonic signals and microwaves.

19. A transmission-key for use in said transmission-guard of claim 1.

20. A transmission-lock for use in said transmission-guard of claim 1.

21. An inductive power outlet protected by said transmission-guard of claim 1.

22. A method for preventing an inductive power outlet from transmitting power in the absence of an electric load, by protecting said inductive power outlet with said transmission-guard of claim 1.

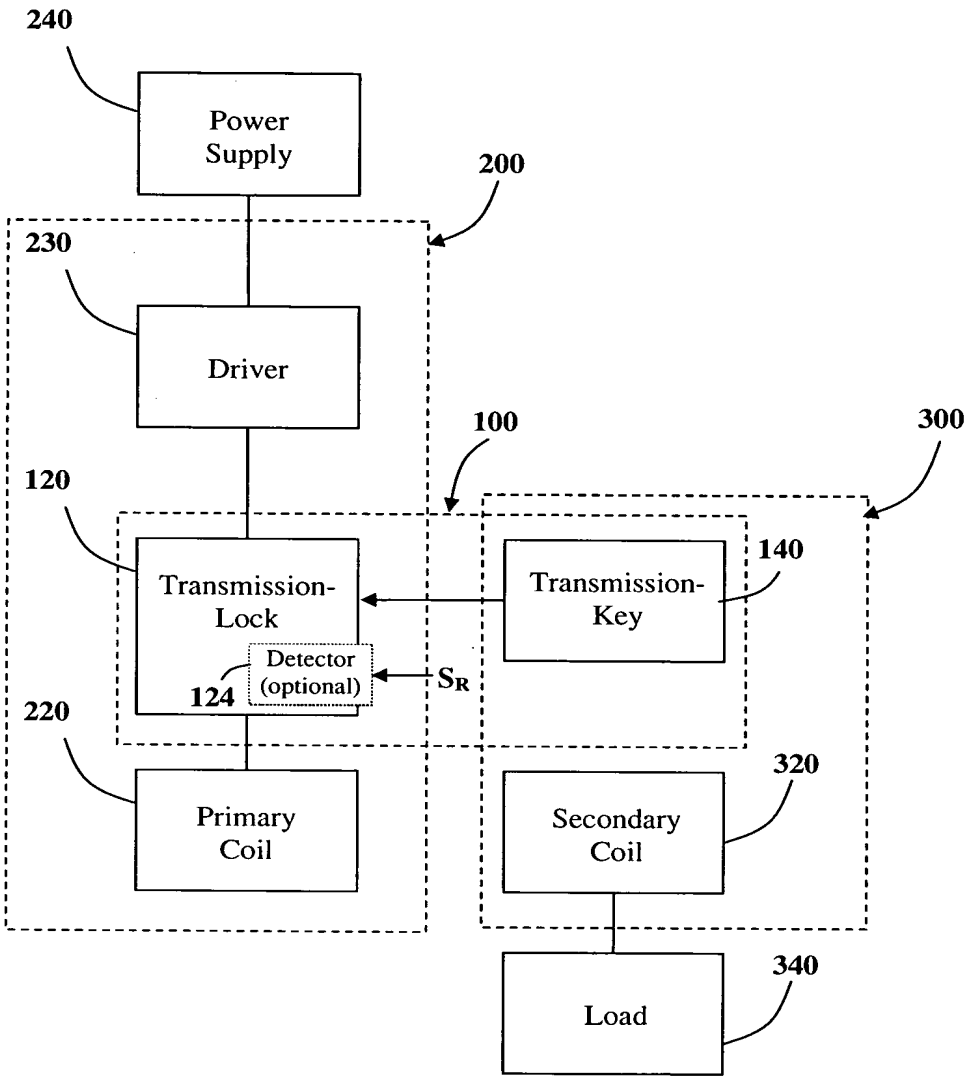

240
Power Supply
200
230
Driver
100
300
120
Transmission-Lock
140
Transmission-Key
Detector (optional)
124
S_R
220
Primary Coil
320
Secondary Coil
340
Load

Fig. 1

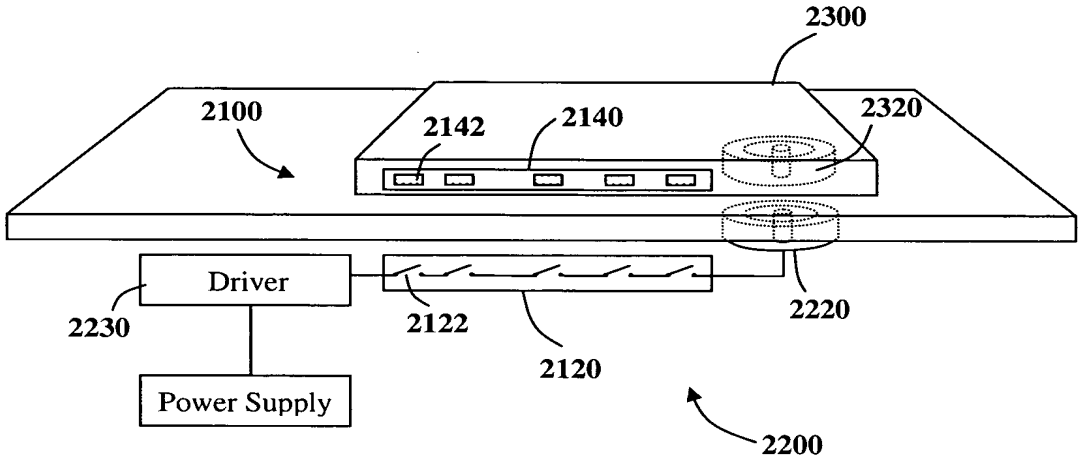

2300
2100
2142
2140
2320
Driver
2230
2122
2120
2220
Power Supply
2200

Fig. 2

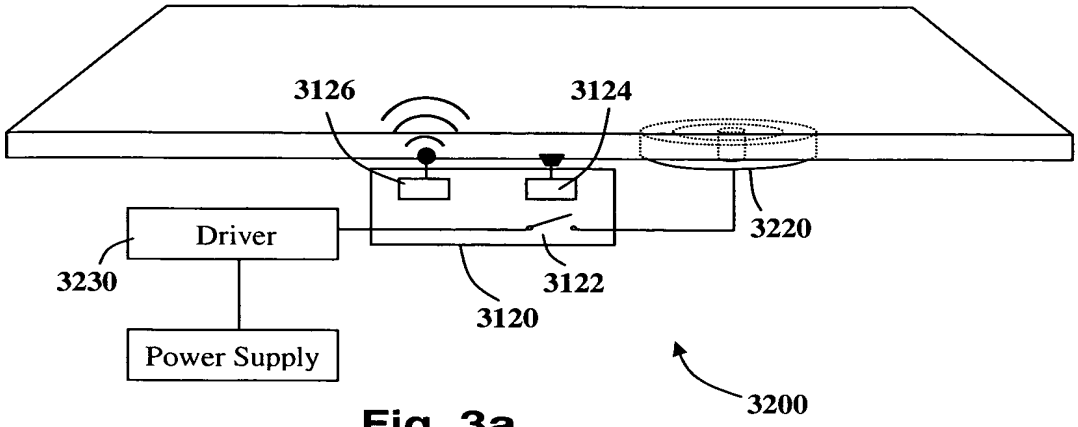


Fig. 3a

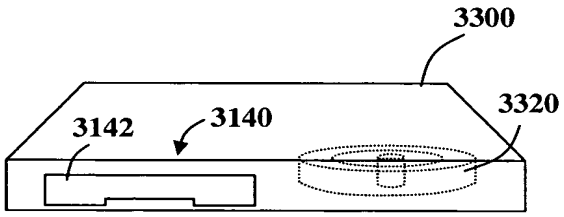


Fig. 3b

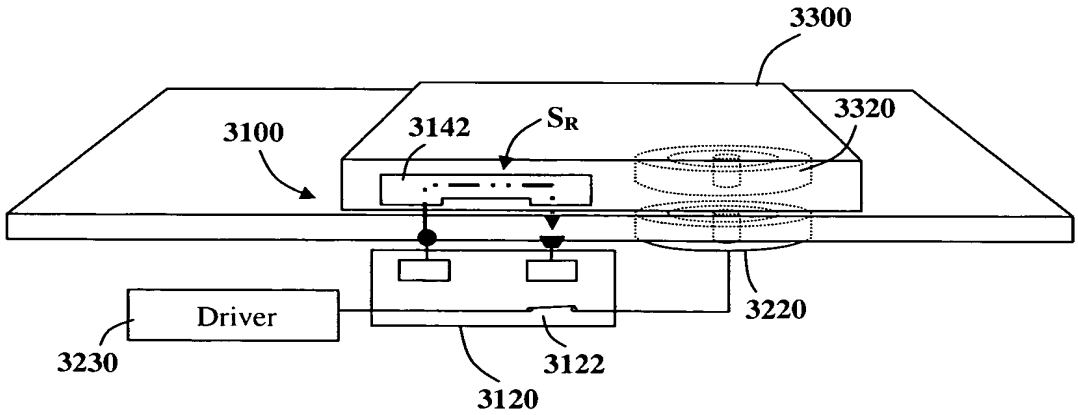


Fig. 3c

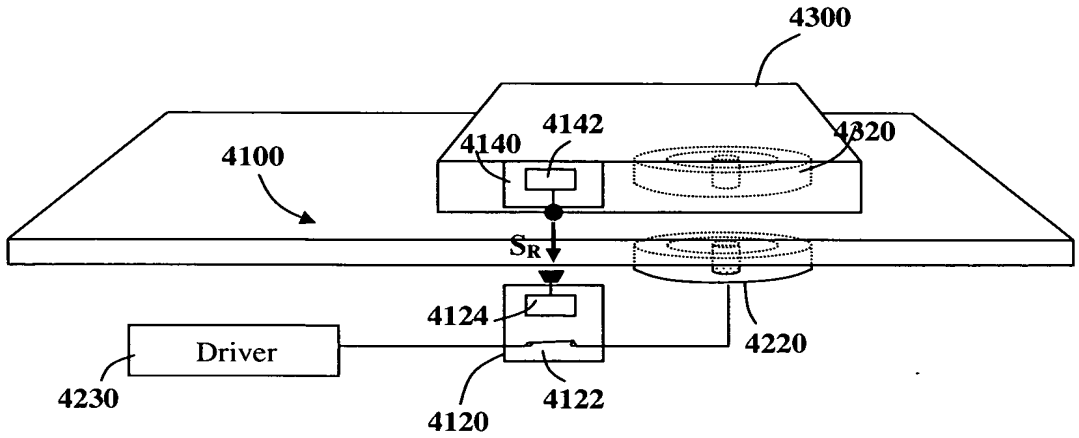


Fig. 4

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