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Kanno

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(54) **WIRELESS POWER TRANSMISSION UNIT AND POWER GENERATOR WITH THE WIRELESS POWER TRANSMISSION UNIT**

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(73) Assignee: **Panasonic Corporation**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 365 days.

| | | | |
|----|-------------|----|---------|
| JP | 06-096300 | A | 4/1994 |
| JP | 08-037121 | A | 2/1996 |
| JP | 9-275644 | A | 10/1997 |
| JP | 10-014139 | A | 1/1998 |
| JP | 11-176676 | A | 7/1999 |
| JP | 2002-152997 | A | 5/2002 |
| JP | 2004-166323 | A | 6/2004 |
| JP | 2006-136045 | A | 5/2006 |
| JP | 2010-166693 | A | 7/2010 |
| WO | 2009/045847 | A2 | 4/2009 |
| WO | 2011/019088 | A2 | 2/2011 |

OTHER PUBLICATIONS

International Search Report for corresponding International Application No. PCT/JP2011/005631 mailed Jan. 17, 2012.
Form PCT/ISA/237 for corresponding International Application No. PCT/JP2011/005631 dated Jan. 17, 2012.
Co-Pending U.S. Appl. No. 12/853,351, filed Aug. 10, 2010.
Supplementary European Search Report for corresponding European Application No. EP 11 83 0387 dated Jan. 9, 2013.

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(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/391,274, filed on Oct. 8, 2010.

(51) **Int. Cl.**
H02J 3/38 (2006.01)

(52) **U.S. Cl.**
USPC 307/19; 307/18

(58) **Field of Classification Search**
USPC 307/18, 19
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | |
|--------------|----|---------|----------------|
| 6,008,622 | A | 12/1999 | Nakawatase |
| 2008/0278264 | A1 | 11/2008 | Karalis et al. |
| 2010/0033156 | A1 | 2/2010 | Abe et al. |

FOREIGN PATENT DOCUMENTS

| | | | |
|----|-----------------|----|--------|
| DE | 11 2006 002 299 | T5 | 6/2008 |
| EP | 2 211 438 | A1 | 7/2010 |

(57) **ABSTRACT**

A wireless power transmission unit includes oscillators that convert DC energy into RF energy with a frequency f_0 , power transmitting antennas, and power receiving antennas. Each power transmitting antenna is a series resonant circuit in which a power transmitting inductor and a first capacitor are connected in series. Each power receiving antenna is a parallel resonant circuit in which a power receiving inductor and a second capacitor are connected in parallel. If the oscillator has a voltage step-up ratio V_{oc} , the power transmitting inductor has an inductance L_1 , the power receiving inductor has an inductance L_2 , and the power transmitting and power receiving antennas have a coupling coefficient k , $(L_2/L_1) \geq 4(k/V_{oc})^2$ is satisfied. The absolute value of the phase difference θ_{res} between the respective resonant magnetic fields of first and second pairs of resonant antennas is set to fall within the range of 90 to 180 degrees.

32 Claims, 23 Drawing Sheets

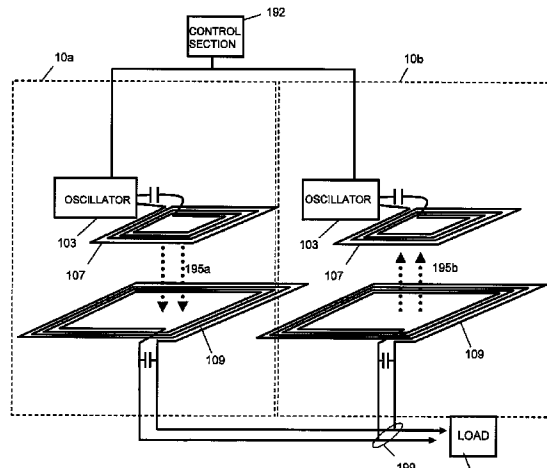


FIG. 1

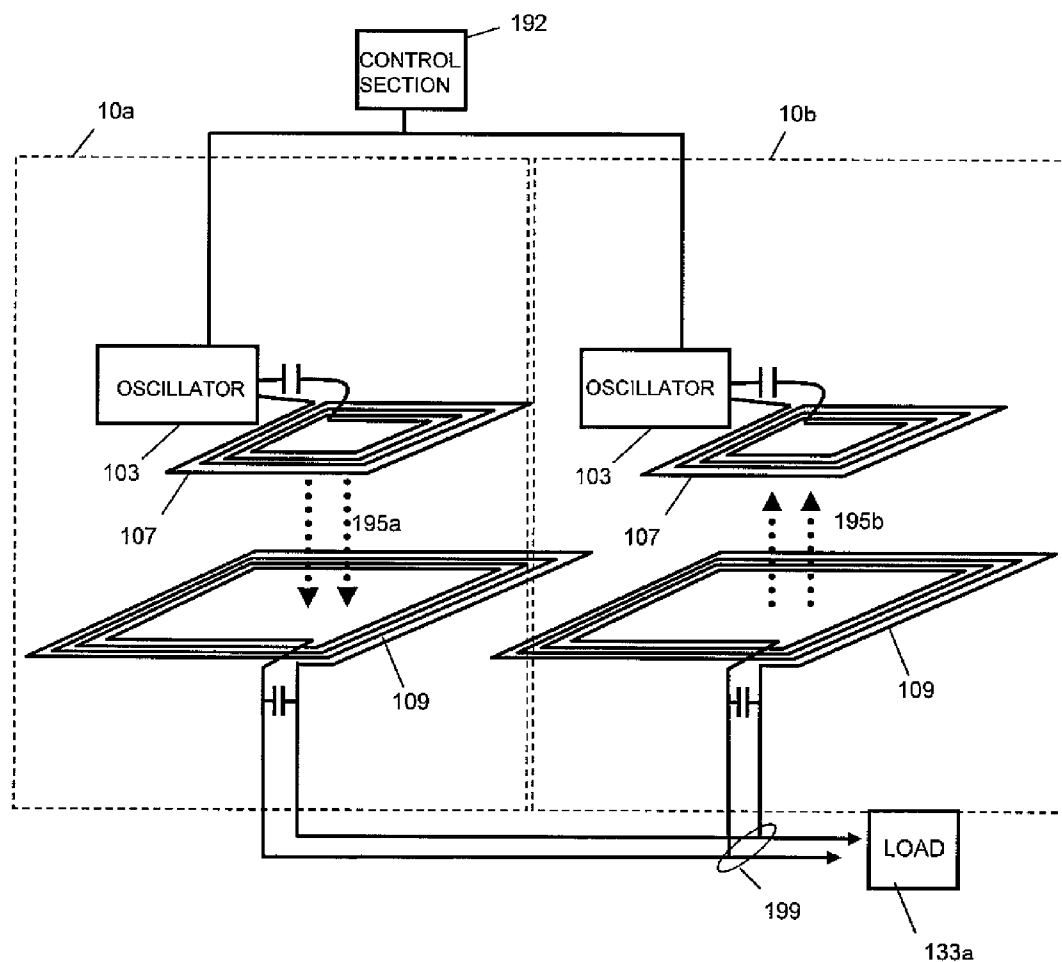


FIG. 2

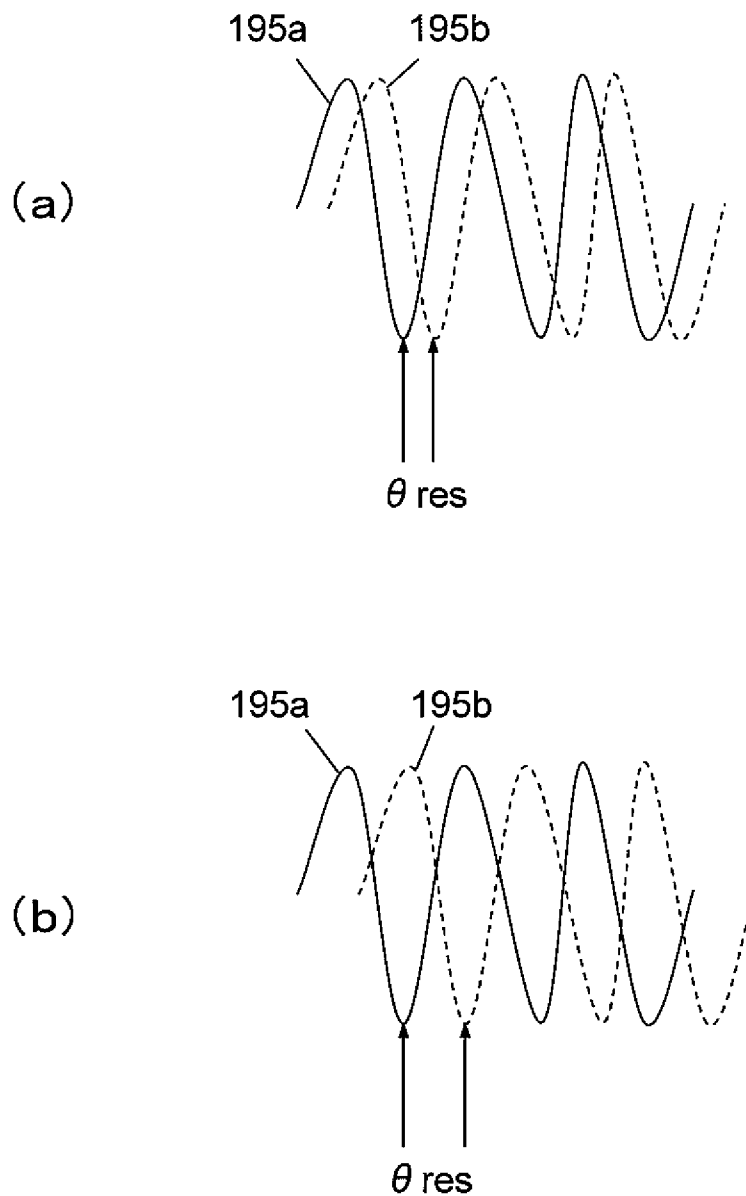


FIG. 3

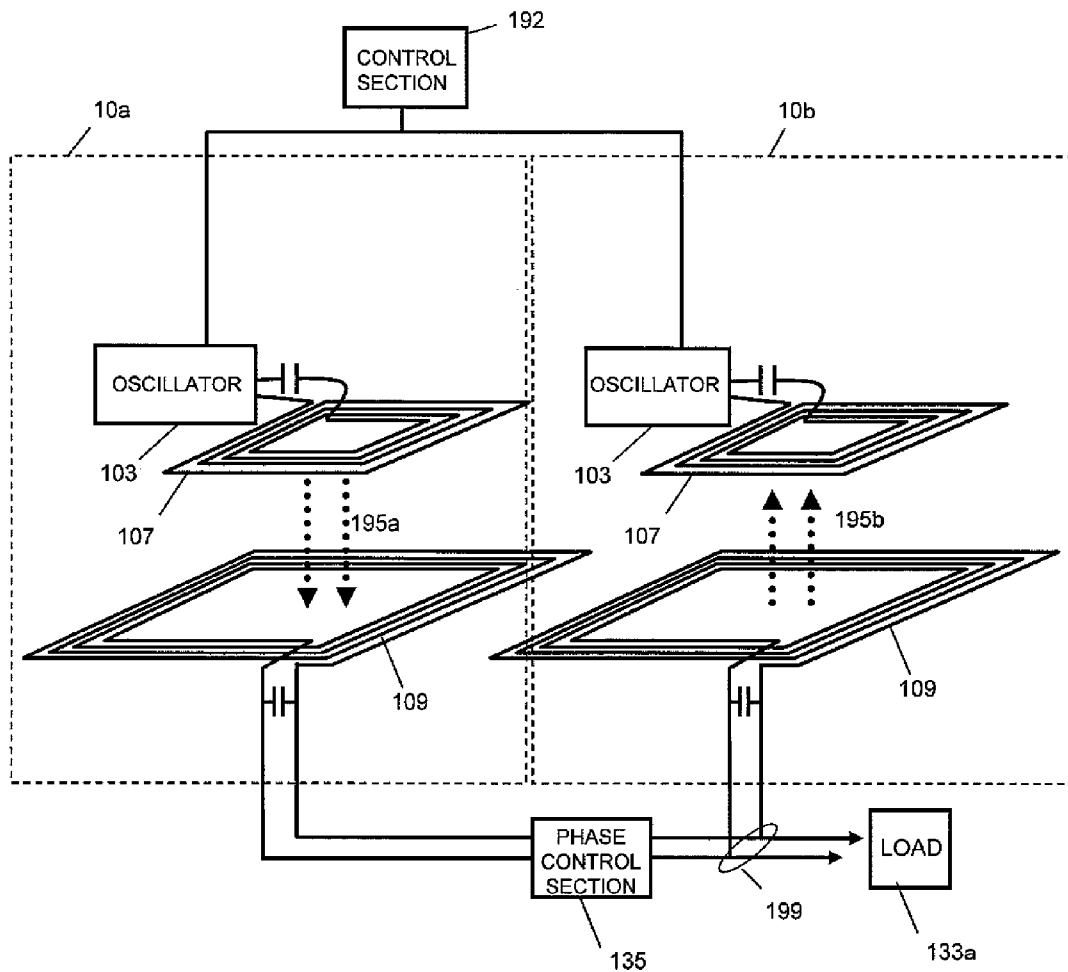
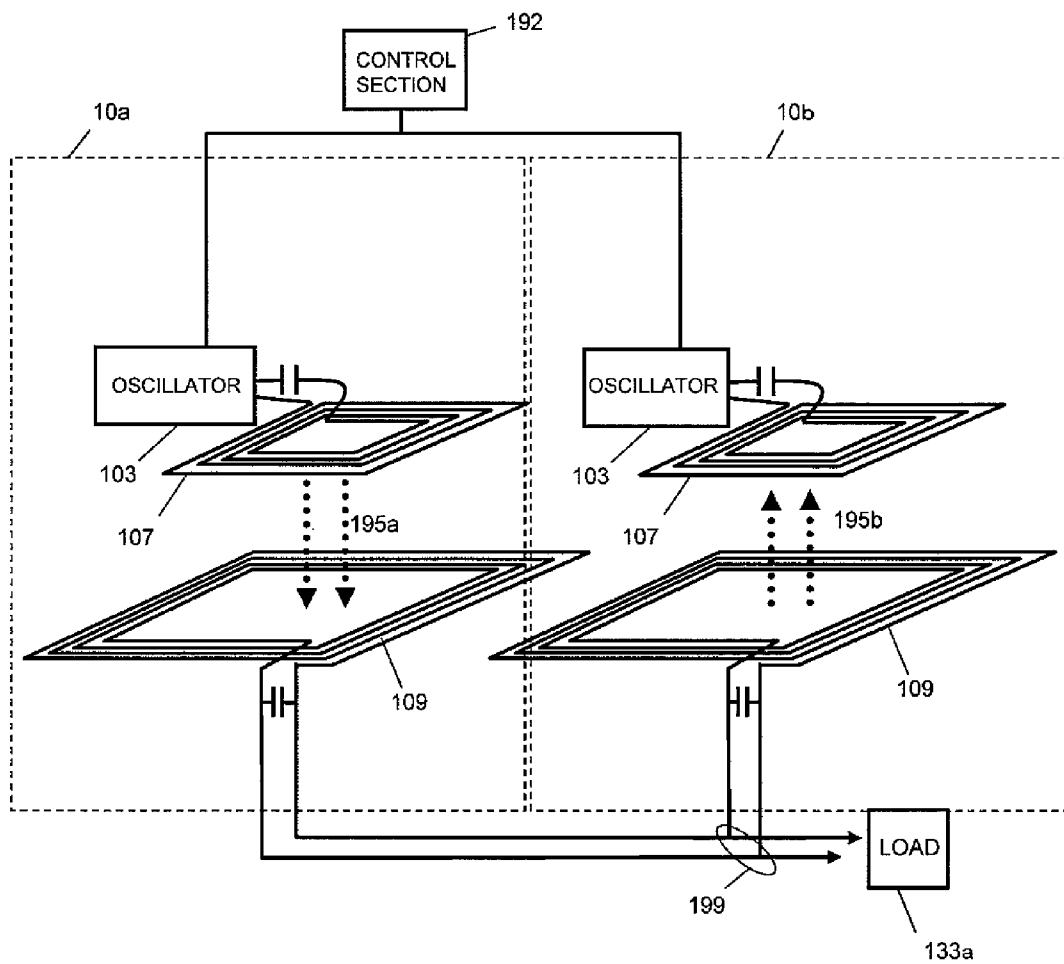


FIG. 4



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