Wireless Power Transfer by Resonant Inductive Coupling

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Contents

Types of wireless power transfer

Wireless power transfer can be broadly grouped depending on the effective range.

Near-field	**Far-Field**
Capacitive coupling	Microwaves
Inductive coupling	Lasers

Table: Types of wireless power transfer scheme

Review: Electromagnetic Induction

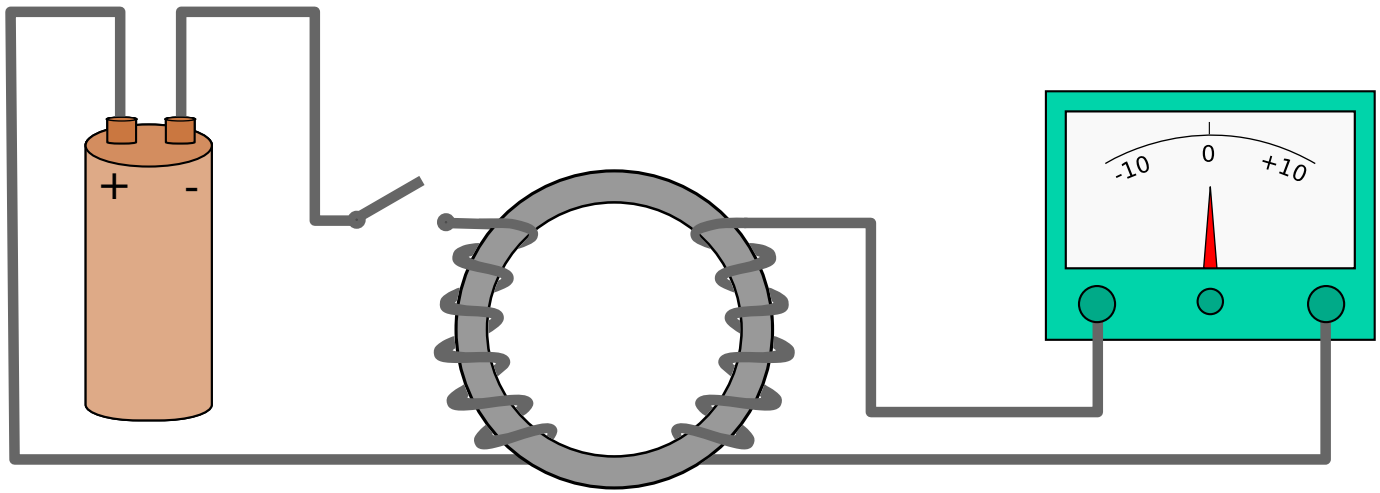

Figure: Diagram of Faraday's apparatus. Changes in the magnetic field of the left coil induces a current in the right coil. Nave, (*Hyperphysics: Selectivity and Q of a Circuit*)

Magnetic fields generated by a primary coil can induce a current in the secondary coil.
This was shown by Faraday in 1831.[1]

[1] Newcomb, *Memoir of Joseph Henry*.

Review: Resonant circuit

- A resonant circuit has a strong response to an oscillating voltage with frequency ω_0
- In the induction system, the voltage is induced by a magnetic field.

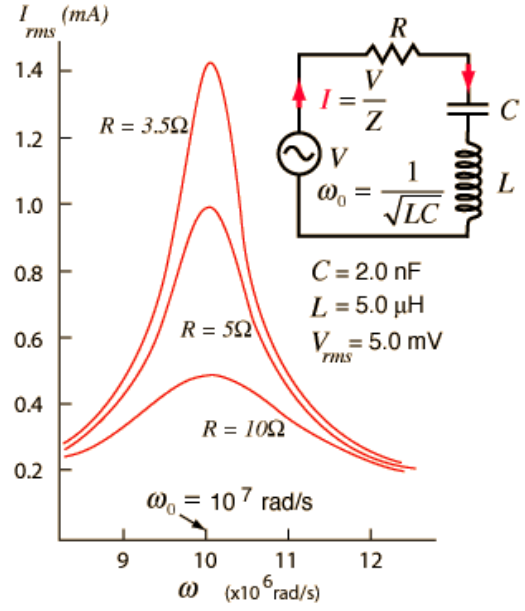

Figure: Diagram of an RLC circuit. The response to a driving oscillating voltage is shown. Nave, (*Hyperphysics: Selectivity and Q of a Circuit*)

Wireless Induction

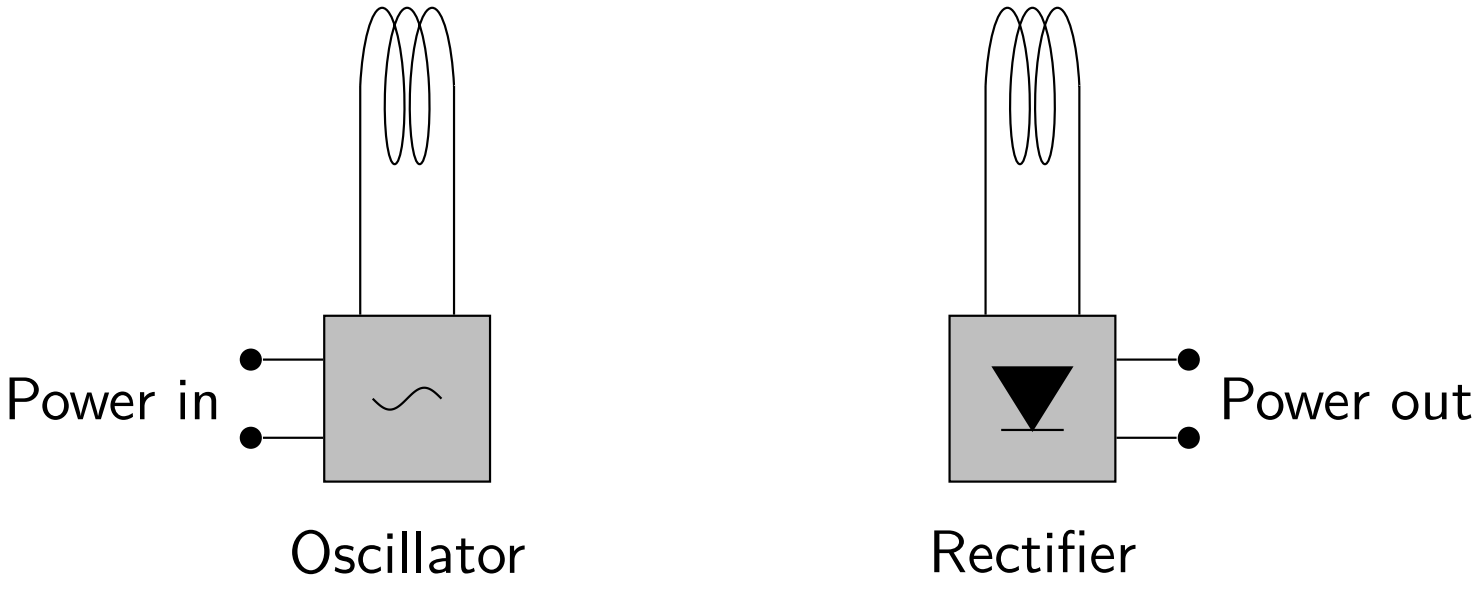

Figure: A simple induction apparatus to transmit power wirelessly.

- Remove the iron core.
- Main energy losses due to EM waves and electrical resistance.
- Efficient only if coils are adjacent.

Resonant inductive coupling

- The secondary resonant circuit strongly, producing a magnetic field.
- This responsive field couples the circuit together.
- Efficient transfer of energy is achieved.

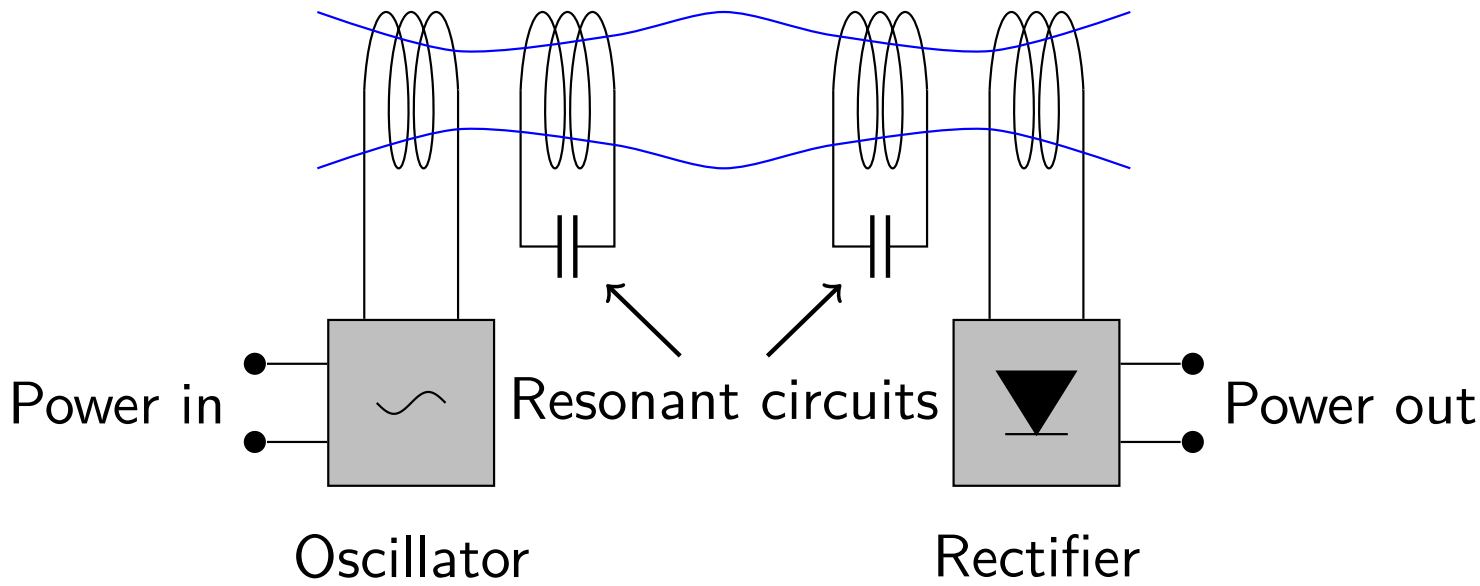

Figure: Diagram of an resonant inductive system. The blue line represents the magnetic field.

Efficiency

- Successfully transmitted 60 W over 2 meters with $\sim 40\%$ efficiency.[2]
- Efficiency can be affected by external objects placed within a few cm of coil.

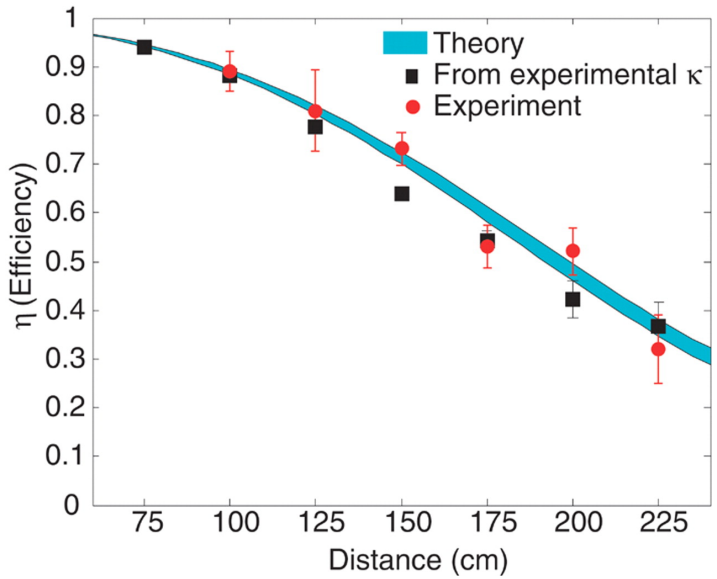

Figure: Efficiency data from experiments. A copper coil of radius 25cm was used in this experiment. Kurs et al., ("Wireless Power Transfer via Strongly Coupled Magnetic Resonances")

[2] Kurs et al., "Wireless Power Transfer via Strongly Coupled Magnetic Resonances".

Applications: Batteryless electronics

- The receiver circuit is cheaper than batteries.
- Batteries cause pollution during disposal.
- Low maintenance.[3]
- Usable in wet environments.

[3] Tan, *Energy Harvesting Autonomous Sensor Systems: Design, Analysis, and Practical Implementation*.

Applications: Smartcard

- Uses coil for power and communication.

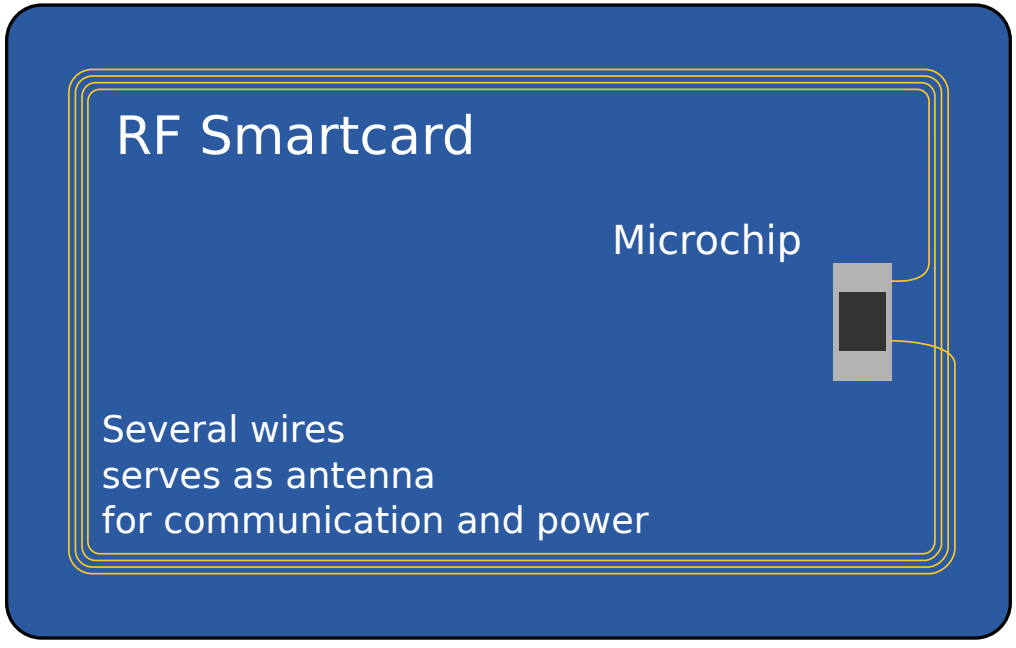

Figure: Diagram of the coil inside a smartcard. Wikipedia, (*Resonant Inductive Coupling*)

Conclusion

- Reviewed the principles of induction and resonance.
- Described how induction can be used to transmit energy wirelessly.
- Showed how efficiency and range can be improved with resonant coupling.
- Discussed applications of electromagnetic induction.

Any questions?