WIRELESS POWER TRANSFER

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OVERVIEW

- INTRODUCTION
- HISTORY OF WPT
- TYPES OF WPT
- ADVANTAGES AND DISADVANTAGES
- APPLICATIONS
- CONCLUSION
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WHAT IS WIRELESS POWER TRANSFER?

- It is the transmission of electrical energy from a power source to an electrical load without interconnecting wires. This can be used for applications where conventional wires are unaffordable, inconvenient, hazardous, unwanted or impossible.

HISTORY

- Nikola Tesla in late 1890s
- His vision was to create a “WORLD WIRELESS SYSTEM”
- A 187 feet tall tower to broadcast energy from which people could access free energy
- Due to shortage of funds, tower did not operate

HISTORY (CONTD….)

- Tesla was able to transfer energy from one coil to another coil
- He managed to light 200 lamps from a distance of 48Km
- The idea of Tesla is taken in to research after 100 years by a team led by Marin Soljacic from MIT. The project is named as ‘WiTricity’.

Types and Technologies of WPT

- Near-field techniques

1. Inductive coupling
2. Resonant inductive coupling
3. Air ionization

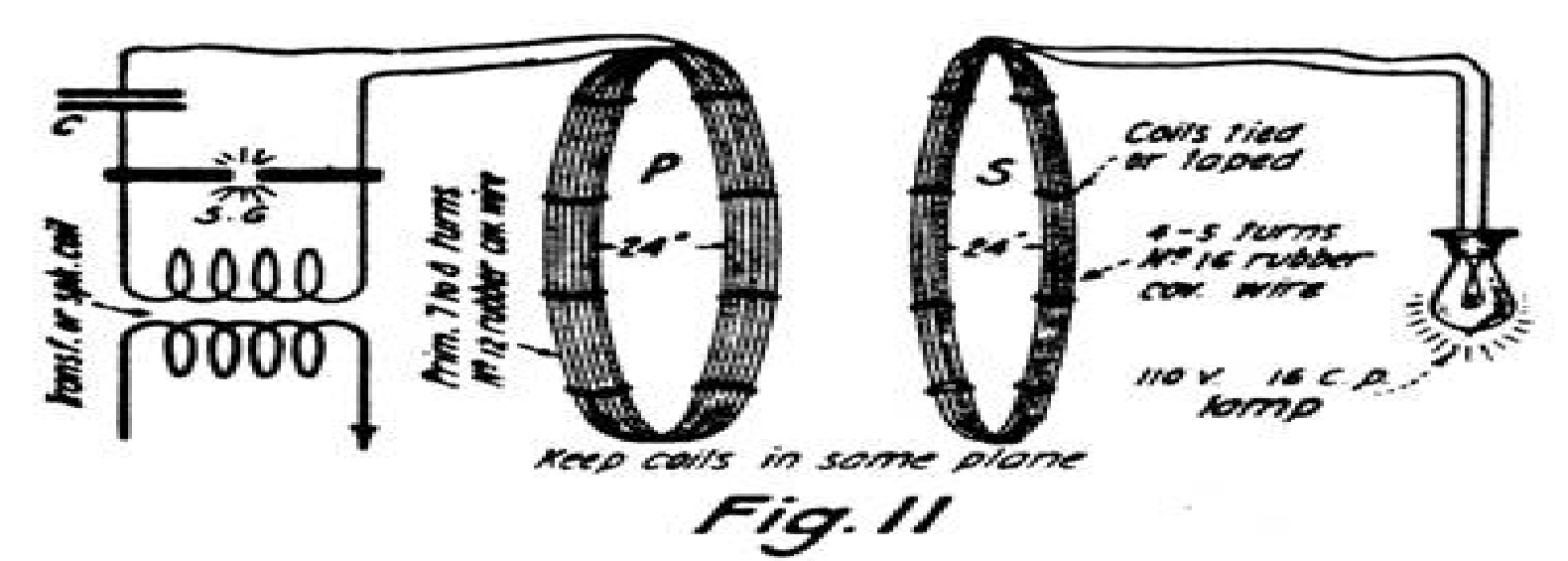
Contd…..

- Far-field techniques

1. Microwave power transmission
2. LASER power transmission

Inductive Coupling

- Primary and secondary coils are not connected with wires
- Energy transfer is due to mutual induction



- Wireless Charging Pad (WCP) is an example
- On a WCP (primary coil), the devices (Secondary coil) are to be kept ,battery will be automatically charged.

Resonance Inductive Coupling (RIC)

- Combination of inductive coupling and resonance
- Resonance improves the efficiency by tunneling the magnetic field to a receiver coil which resonates at the same frequency
- When resonant coupling is used the two inductors are tuned to a mutual frequency and the input current is modified from sinusoidal to non sinusoidal rectangular or transient waveform so as to drive the system more aggressively.

WiTricity

- Based on RIC
- Led by MIT's Marin Soljacic
- Energy was transfererred wirelessly for a distance just more than 2m.
- Coils were helical in shape
- Efficiency achieved was around 40%
- Used frequencies ranging from 1MHz to 10MHz

WiTricity (Contd..)

Air Ionization

- Toughest technique under near-field energy transfer techniques
- Air ionizes only when there is a high field
- Needed field is 2.11MV/m
- Natural example : Lightening
- Not feasible for practical implementation

Advantages of near-field techniques

- No wires
- Efficient energy transfer using RIC
- Harmless, if field strengths under safety levels
- Maintenance cost is less

Disadvantages

- Distance constraint
- Field strengths have to be under safety levels
- Initial cost is high
- In RIC , tuning is difficult
- High frequency signals must be the supply
- Air ionization technique is not feasible

Far-field energy transfer

- Radiative
- Needs line of sight
- LASER or MICROWAVE
- Aims at high power transfer

Microwave Power Transfer (MPT)

- Transfers high power from one place to another. Two places being in the line of sight.
- STEPS

1. Electrical energy to microwave energy
2. Capturing microwaves using rectenna
3. Microwave energy to electrical energy

MPT (contd…)

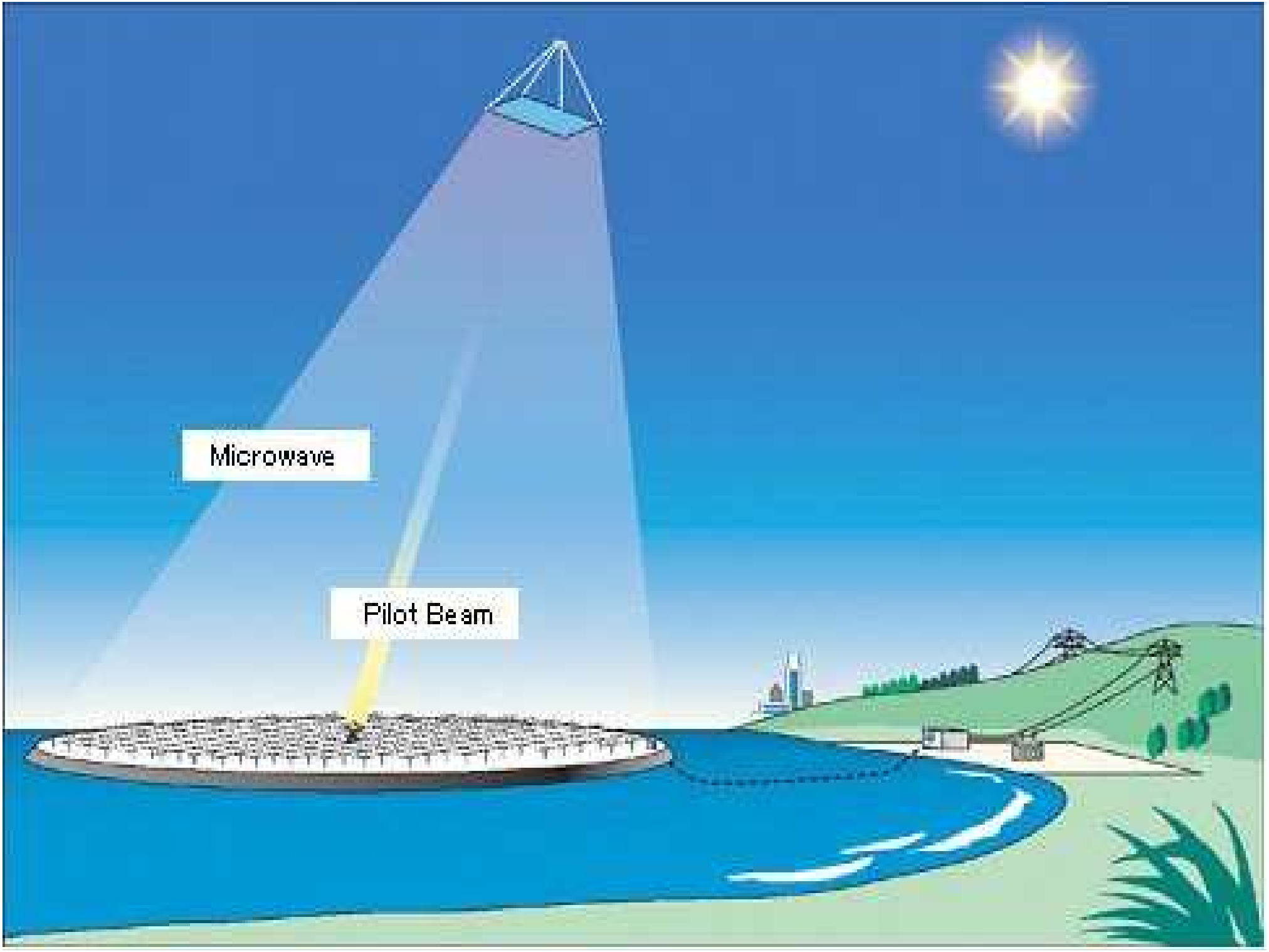
- AC can not be directly converted to microwave energy
- AC is converted to DC first
- DC is converted to microwaves using magnetron
- Transmitted waves are received at rectenna which gives DC as the output
- DC is converted back to AC

LASER

- LASER is highly directional and coherent
- Not dispersed for very long
- But, gets attenuated when it propagates through atmosphere
- Simple receiver-Photovoltaic cell
- Cost efficient

Solar Power Satellites (SPS)

- To efficiently make use of renewable energy i.e. solar energy
- SPS are proposed to be placed in geostationary orbits
- Solar energy is captured using photocells
- Each SPS may have 400 million photocells
- Transmitted to earth in the form of microwaves/LASER
- Using rectenna/photovoltaic cell, the energy is received and converted to electrical energy
- Efficiency exceeds 95% if microwave is used.


Microwave
Pilot Beam

Rectenna

- Stands for rectifying antenna
- Consists of mesh of dipoles and diodes
- Converts microwave to its DC equivalent

Advantages of far-field energy transfer

- Efficient
- Need for grids, substation etc are eliminated
- Low maintenance cost
- More effective when the transmitting and receiving points are along a line of sight
- Can reach the places which are remote

Disadvantages

- Radiative
- Needs line of sight
- Initial cost is high
- When LASERs are used,

1. Conversion is inefficient
2. Absorption loss is high

- When microwave are used,

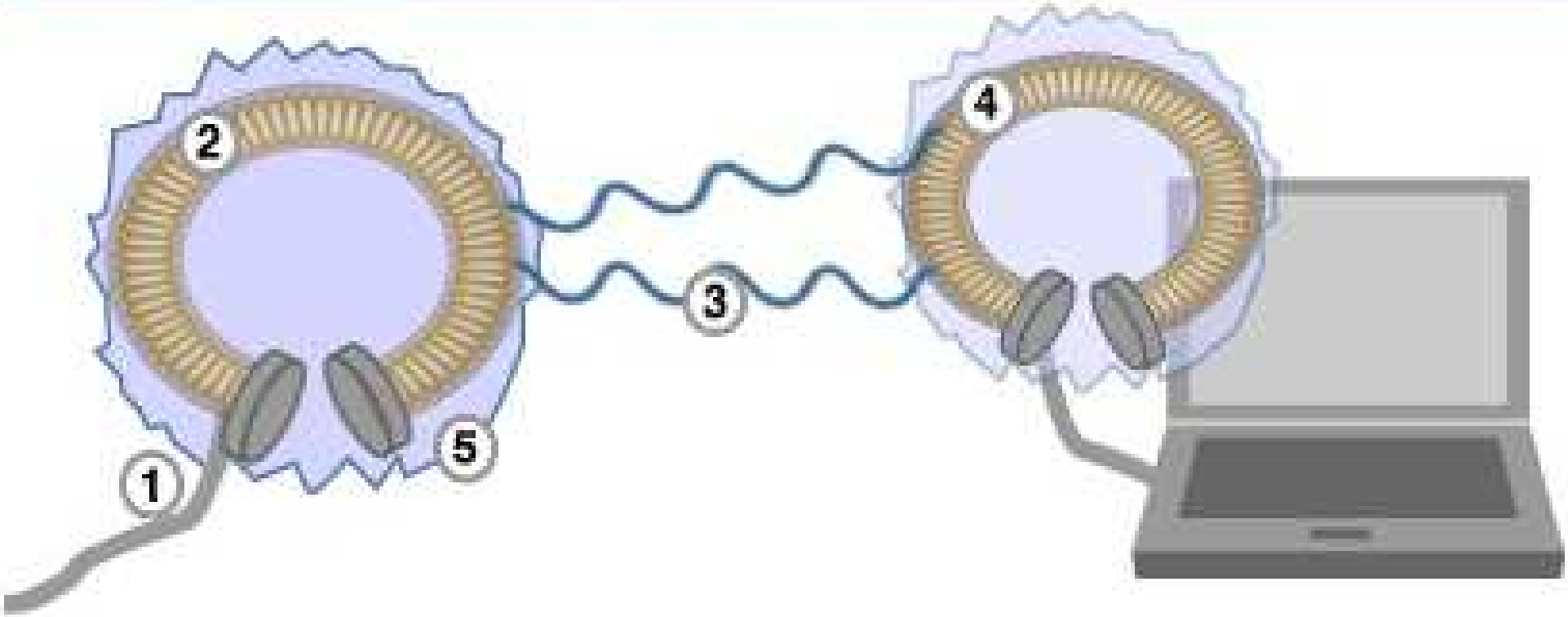
1. Interference may arise
2. FRIED BIRD effect

APPLICATIONS

- Near-field energy transfer

1. Portable Consumer electronics
2. Industrial, military and household robots
3. Far-field energy transfer
4. Solar power satellites
5. Energy to remote areas
6. Can broadcast energy globally in future

HOW WIRELESS POWER COULD WORK



- **1)** Power from mains to antenna, which is made of copper
- **2)** Antenna resonates at a frequency of about 10MHz, producing electromagnetic waves
- **3)** 'Tails' of energy from antenna 'tunnel' up to 2m (6.5ft)
- **4)** Electricity picked up by laptop's antenna, which must also be resonating at 10MHz. Energy used to re-charge device
- **5)** Energy not transferred to laptop re-absorbed by source antenna. People/other objects not affected as not resonating at 10MHz

CONCLUSION

- Transmission without wires –a reality
- Efficient
- Low maintenance cost. But high initial cost
- Better than conventional wired transfer
- Energy crisis can be decreased
- Low loss

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THANK YOU!