Academic Science

Wireless Mobile Charger

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Abstract - The main objective of Wireless Charger System is to charge the mobile battery by using wireless charger. The technology will replace cables and standardize on one interface, potentially being able to charge 1000mAh battery. This is done using charging a resonant coil from AC and then transmitting subsequent power to the resistive load. The project is meant to charge a low power device quickly and efficiently by inductive coupling without the help of wires. Wireless charging system described by using the method of inductive coupling. In this project, oscillation circuit converts DC energy to AC energy (transmitter coil) to transmit magnetic field by passing frequency and then induce the receiver coil. The properties of Induction coupling are wave (magnetic field-wideband), range (very short~cm), efficiency (height) and operation frequency. The project shows as a small charging for 5V battery of phone in this method. The system bases on coupling magnetic field, then designed and constructed as two parts. There are transmitter part and receiver part. The Ampere's law, Biot-Savart's law and Faraday law are used to calculate the inductive coupling between the transmitter coil and the receiver coil. The calculation of this law shows how many power transfer in receiver part when how many distance between the transmitter coil and the receiver coil. The system is safe for users and neighboring electronic devices. To get more accurate wireless charging system, it needs to change the design of the few keywords. Research was conducted to investigate the current and future applications of wireless power transmission. To understand the fundamental theory, progressive innovations, and detrimental effects of this technology within the environment and society, a comprehensive literature review was formed. Electronic questionnaires were distributed, and personal interviews were vi conducted to obtain detailed descriptions of modern implementation methods within different industries.

Keywords- *Wireless Mobile Charging Vehicle, Optimization, Routing path, Adaptive Decision System, Scalability, Wireless energy transfer, Wireless Sensor Network.*

1. INTRODUCTION

Wireless charging technology enables wireless power transfer from a power source such as charger to a load such as a mobile device conveniently across an air gap by eliminating the bunch of wire. Wireless power transmission involves the exchange of power without the need for physical connections. The development of this technology started in the late 19th and early 20th centuries, when a number of important innovations in electromagnetic research were made. These advancements established the basic principles that served as the foundation for modern electrical power transport. During the past 20 years, improvements in wireless technologies have led to a revival of related research. Public interest in wireless power has also increased with the application of Nikola Tesla ideas and inventions [1]. As a result of this, the feasibility of technological implementation merits examination.

Various scientists and inventors contributed to the development of wireless power. Examining their backgrounds reveals the sources of their motivation and the methods by which they conducted research. The inventions developed during this time were more advanced than anything that had been seen before, solving challenging problems and developing the basic theories that yielded modern technology. These inventors' patents, papers, and experiments effectively describe the practicality and utility of wireless power propagation.

Three prominent forms of power transmission are conduction, induction, and radiation. There are various formulas that explain how electrical power can be transmitted without the use of a physical conductor. Each mode of power transport has theories that govern how the electromagnetic waves carry power from a transmitter to a receiver.

2. Basic Concept

Electromagnetic Induction is a process where a conductor placed in a changing magnetic field (or a conductor moving through a stationary magnetic field) causes the production of a voltage across the

conductor. This process of electromagnetic induction, in turn, causes an electrical current-it is said to induce the current.

2.1. Discovery of Electromagnetic Induction

Michael Faraday is given credit for the discovery of electromagnetic induction in 1831, though some others had noted similar behavior in the years prior to this. The formal name for the physics equation that defines the behavior of an induced electromagnetic field from the magnetic flux (change in a magnetic field) is Faraday's law of electromagnetic induction. The process of electromagnetic induction works in reverse as well, so that a moving electrical charge generates a magnetic field. In fact, a traditional magnet is the result of the individual motion of the electrons within the individual atoms of the magnet, aligned so that the generated magnetic field is in a uniform direction.

2.2. Principle of Electromagnetic Induction

Faraday explained electromagnetic induction using a concept he called lines of force. Coils of wire in the base station (the charging plate) create a magnetic field as the current passes through. This field can induce an electrical current in an adjacent coil of wire without actually touching it. Inductive charging uses an electromagnetic field to transfer energy between two objects. This is usually done with a charging station. Energy is sent through an inductive coupling to an electrical device, which can then use that energy to charge batteries or run the device.
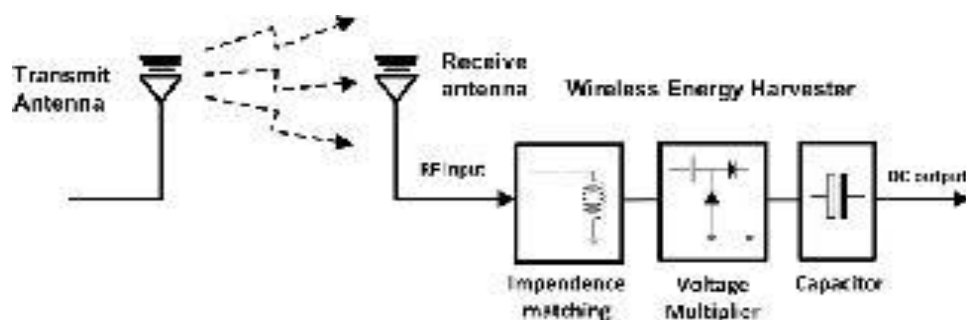
2.2.1. Wireless Techniques:

Three major techniques for wireless charging are magnetic inductive coupling, magnetic resonance coupling, and microwave radiation. The magnetic inductive and magnetic resonance coupling work on near field, where the generated electromagnetic field dominates the region close to the transmitter or scattering object. The near-field power is attenuated according to the cube of the reciprocal of the distance. Alternatively, the microwave radiation works on far field at a greater distance. The far-field power decreases according to the reciprocal of the distance. Moreover, for the far-field technique, the absorption of radiation does not affect the transmitter. By contrast, for the near-field techniques, the absorption of radiation influences the load on the transmitter.
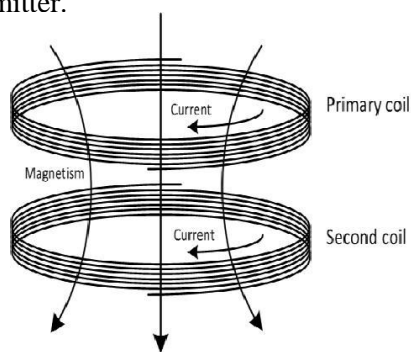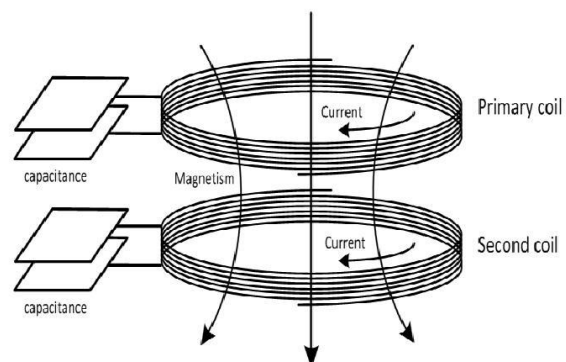
(a) Induction Coupling   (b) Magnetic Resonance Coupling

(c)Far Field Wireless Charging

Fig. 1 Wireless Charging Techniques

2.2.2. Magnetic Inductive Coupling:

Magnetic inductive coupling [19] is based on magnetic field induction that delivers electrical energy between two coils. Figure 1a shows the reference model. Magnetic inductive coupling happens when a primary coil of an energy transmitter generates predominant varying magnetic field across the secondary coil of the energy receiver within the field, generally less than the wavelength. The near-field power then induces voltage/current across the secondary coil of the energy receiver within the field. This voltage can be used by a wireless device. The energy efficiency depends on the tightness of coupling between two coils and their quality factor. The tightness of coupling is determined by the alignment and distance, the ratio of diameters, and the shape of two coils. The quality factor mainly depends on the materials, given the shape and size of the coils as well as the operating frequency. The advantages of magnetic inductive coupling include ease of implementation, convenient operation, high efficiency in close distance (typically less than a coil diameter) and safety. Therefore, it is applicable and popular for mobile devices. Very recently, MIT scientists have announced the invention of a novel wireless charging technology, called MagMIMO which manages to charge a wireless device approximately 30 centimeters away. It is claimed that MagMIMO can detect and cast a cone of energy towards a phone, even when the phone is put inside the pocket.

2.2.3. Magnetic Resonant Coupling:

Magnetic resonance coupling [21], as shown in Fig. 1b, is based one vane scent wave coupling which generates and transfers electrical energy between two resonant coils through varying or oscillating magnetic fields. As the resonant coils, operating at the same resonant frequency, are strongly coupled, high energy transfer efficiency can be achieved with small leakage to non-resonant externalities. This property also provides the advantage of immunity to neighboring environment and line-of-sight transfer requirement. Compared to magnetic inductive coupling, another advantage of magnetic resonance charging is longer effective charging distance. Additionally, magnetic resonant coupling can be applied between one transmitting resonator and many receiving resonators, which enables concurrent charging of multiple devices.

In 2007, MIT scientists proposed a high-efficient mid-range wireless power transfer technology, i.e. Witricity, based on strongly coupled magnetic resonance. It was reported that wireless power transmission can light a 60W bulb in more than two meters with transmission efficiency around 40% [22]. The efficiency increased up to 90% when the transmission distance is one meter. However, it is difficult to reduce the size of a Witricity receiver because it requires a distributed capacitive of coil to operate. This Posses big challenge in implementing

Witricity technology in portable devices. Resonant magnetic coupling can charge multiple devices concurrently by tuning coupled resonators of multiple receiving coils [23]. This has been shown to achieve improved overall efficiency. However, mutual coupling of receiving coils. Resulting interference, and thus proper tuning is required.

2.2.4. Microwave Radiation:

Microwave radiation [24] utilizes microwave as a medium to carry radiant energy. Microwaves propagate over space at the speed of light, normally in line-of-sight. Figure 1.1c shows the architecture of a microwave power transmission system. The power transmission starts with the AC to DC conversion, followed by a DC-to-RF conversion through magnetron at the transmitter side. After propagated through the air, the microwaves captured by the receiver rectenna are rectified into electricity again. The typical frequency of microwaves ranges from 300MHz to 300GHz. The energy transfer can use other electromagnetic waves such as infrared and X-rays. However, due to safety issue, they are not Widely used. The microwave energy can be radiated isotropically or towards some direction through beamforming. The former is more suitable for broadcast applications. For point-to-point transmission, beamforming transmit electromagnetic waves, referred to as power beam forming [36], can improve the power transmission efficiency. A beam can be generated through an antenna array (or aperture antenna). The sharpness of power beamforming improves with the number of transmit antennas. The use of massive antenna arrays can increase the sharpness. The recent development has also brought commercial products into the market. For example, the Power caster transmitter and Power harvester receiver [25] allow 1W or 3W isotropic wireless power transfer.

Besides longer transmission distance, microwave radiation offers the advantage of compatibility with existing communication system. Microwaves have been advocated to deliver energy and transfer information at the same time. The amplitude and phase of microwave are used to modulate information, while the radiation and vibration of microwaves are used to carry energy. This concept is referred to as simultaneous wireless information and power transfer (SWIPT). However, due to health concern of RF radiations, the power beacons are constrained by the Federal Communications Commission (FCC) regulation, which allows up to 4 watts for effective isotropic radiated power, i.e., 1 watt device output power plus 6dBi of antenna gain. Therefore, dense deployment of power beacons is required to power hand-held cellular mobiles with lower power and shorter distance. The microwave energy harvesting. Efficiency is significantly dependent on the power density at receive antenna

3. WORKING PRINCIPLE AND HARDWARE DESCRIPTION

3.1 Working Principle
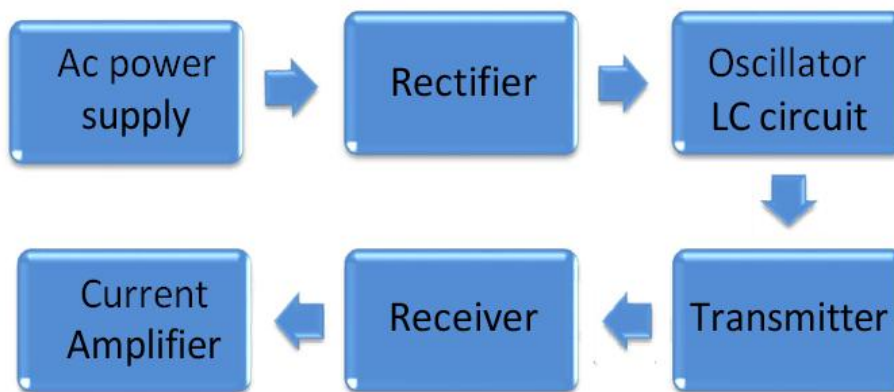
Fig. 2 Block Diagram of Wireless Charger

The block diagram of wireless charger consists of Ac power supplier, rectifier, LC oscillator circuit, transmitter, receiver and current amplifier, which is shown in fig. 2. In the first step AC supply of 220V is given to the circuit, then transformer is connected which convert this 220V to 18V supply. This converted 18V is of AC nature and for further process this supply needs to convert into DC supply. For conversion, bridge rectifier is used. The conversion process of AC to DC gives ripples in output. For removing ripples a filter circuit is needed which consist of capacitor and resistor. After this smooth DC is obtained which is supplied to oscillator circuit consist of inductor and capacitor. Oscillators convert a DC input (the supply voltage) into an AC output (the waveform), which can have a wide range of different wave shapes and frequencies that can be either complicated in nature or simple sine waves depending upon the application. Then this signal is given to transmitter which transmits the signal. Then it is receive by receiver. The mobile phones are not charged at AC so we need to convert it again in DC output. Which is of low value therefore a current amplifier is needed for the circuit. Electric power is distributed as alternating current because AC voltage may be increased or decreased with a transformer. This allows the power to be transmitted through power lines efficiently at high voltage, which reduces the power lost as heat due to resistance of the wire, and transformed to a lower, safer, voltage for use.

3.2 Transmitter Coil:

Power supply is given to the transmitter. Copper coil is wound into number of turns as per the requirement. When the power is supplied to transmitter the coil energizes and results in the magnetic coupling. Hence the power is transferred. The transmitter coil is of diameter 10cm and no. of turns of the coil is 150.

Fig 3 Transmitter coil

3.3 Receiver coil:

The secondary receiver coils are similar designs to the primary sending coils. Running the secondary at the same resonant frequency as the primary ensures that the secondary has low impedance at the transmitter's frequency and that the energy is optimally absorbed. To remove energy from the secondary coil, different methods can be used, the AC can be used directly rectified and a regulator circuit can be used to generate DC voltage. The receiver coil is shown in fig. 4.The receiver coil is of same diameter as transmitter coil but the no. of turns is 200.
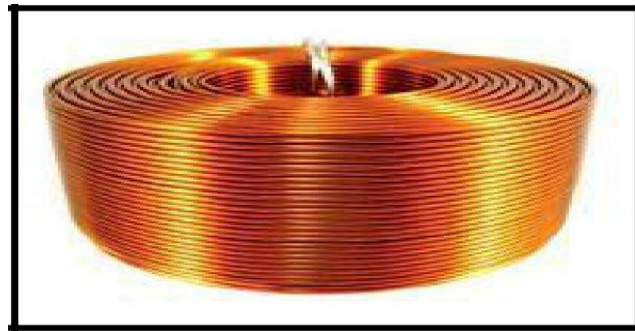
**Fig. 4 Receiver coil**

3.4 AC to DC converter
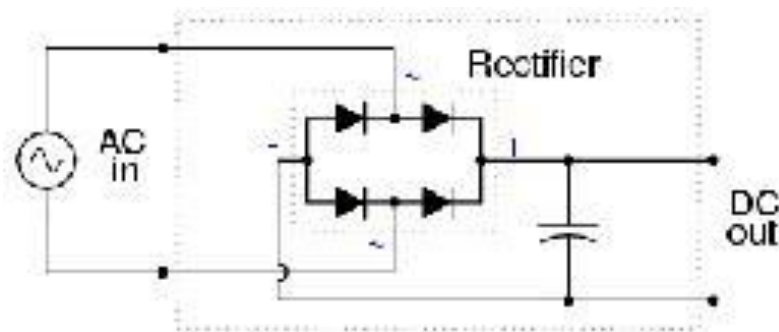
Fig. 5 Rectifier circuit

A Rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification. We use full wave rectifier for this. The average (DC) output voltage is higher than for half wave, the output of the full wave rectifier ha much less ripple than that of the half wave rectifier producing a smoother output waveform. In the first half of the AC cycle, D2 and D4 conduct because they're forward biased. Positive voltage is on the anode of D2 and negative voltage is on the cathode of D4. Thus, these two diodes work together to pass the first half of the signal through. In the second half of the AC cycle, D1 and D3 conduct because they're

forward biased: Positive voltage is on the anode of D1 and negative voltage is on the cathode of D3. The net effect of the bridge rectifier is that both halves of the AC sine wave are allowed to pass through, but the negative half of the wave is inverted so that it becomes positive.

3.5 Oscillator Tank Circuit
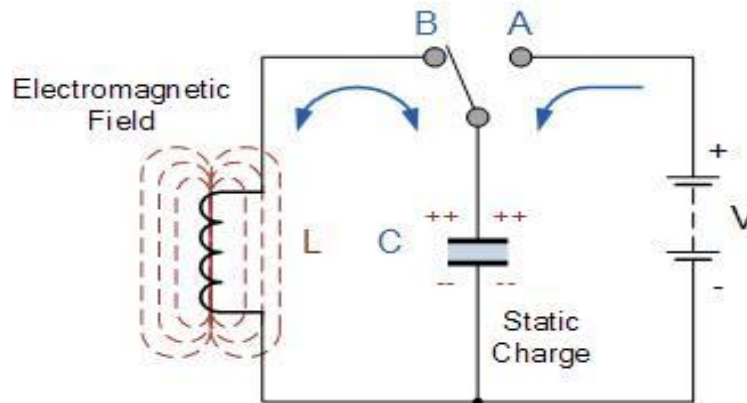
Fig. 6 Basic oscillator tank circuit

An oscillator is an electronics device for generating an Ac signal voltage. The basic oscillator circuit is shown in fig. 6. The frequency of the generated signal depends on the circuit constants. Oscillators are used in radio and TV receivers, in radar in all transmitting equipment's and in military and industrial electronics. Oscillators any generate sinusoidal non sinusoidal or waveforms, from very low frequencies up to very high frequencies. The local oscillator in most present day broadcast band AM super heterodynes will cover a range of frequencies from 1000 through 2100 KHz. An oscillator is a back and forth motion. In mechanics a pendulum or swing illustrates the principle of 24 oscillation. Once a pendulum is started, it would continue swinging indefinitely if it were not for the energy lost in overcoming friction. It is necessary to add energy periodically to offset this loss and keep the pendulum moving. In a parallel LC circuit, electronics oscillate when the circuit is excited.

3.6 Current Amplifier
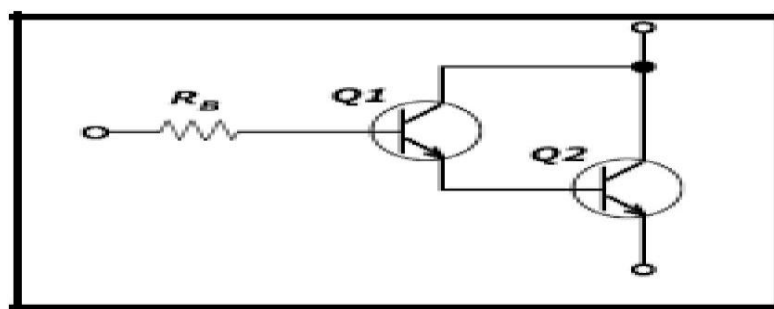
Fig. 7 Darlington Pair

Where, Q1- BC 547, Q2- TIP 122 and RB- 1K. Current Amplifier consists of two Darlington pairs because we have to amplify the current from 40mA to 450mA. Darlington pair is used as a current amplifier. The Darlington transistor (often called a Darlington pair shown in fig. 7) is a compound structure consisting of two bipolar transistors (either integrated or separated devices) connected in such a way that the current amplified by the first transistor is amplified further by the second one. This configuration gives a much higher current gain than each transistor taken separately and, in the case of integrated devices, can take less space than two individual transistors because they can use a shared collector. Integrated Darlington pairs come packaged singly in transistor-like packages or as an array of devices (usually eight) in an integrated circuit. Darlington pair has two transistors one is BC-547 and another one is TIP-122. TIP 122 has maximum Collector to Emitter

and Collector to Base voltage 100V and maximum voltage at Emitter to Base is 5V. Maximum collector current is 5A and the maximum power dissipation is 65W.
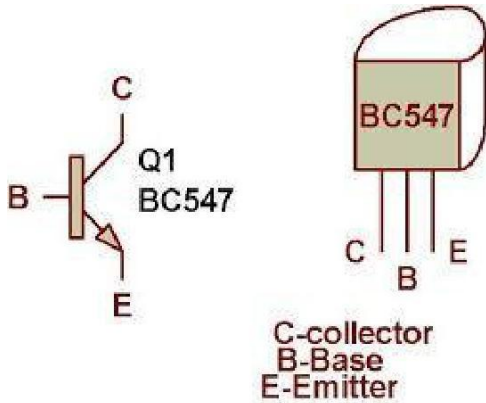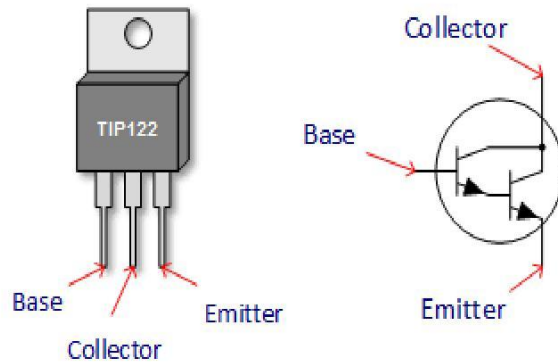

Fig. 8 BC-547 IC   **Fig. 9 TIP-122 IC**

Darlington Pair is not as fast as a single transistor. This is because the first transistor cannot actively shut off the base current of the second transistor. In turn this makes the overall device or circuit configuration slow to reduce the current flow or switch off. To address this problem, the second transistor often has a resistor connected between the base and emitter. This resistor also helps prevent any leakage current from the input transistor from turning the output transistor on. This leakage current can be of the order of Nano-amps for a small signal transistor or up to a few hundred micro-amps for a power transistor. The value of the base emitter resistor is chosen so that it does not sink a large proportion of the current intended to pass through the base of the output transistor, while not allowing the leakage current to develop a voltage equal to the turn on voltage of the output transistor to be developed. Typical values for the resistor may be a few hundred ohms for power applications for the circuit or a few thousand ohms for a small signal version.7809 is used for voltage regulation input voltage of 7809 can be up to 23V but under my experience, it is wise to avoid input over 15V. The 7809 is a 9 Volt voltage regulator IC with features such as internal current limit, safe area protection, thermal protection etc. A 16 V transformer brings down the 230V mains, 1A bridge rectifier rectifies it and capacitor C1 filters it and 7809 regulates it to produce a steady 9V DC output.7809 is claimed to output 9V and almost 1.5A current but again, I have experienced that we should not put a load over 9V and 1A on it. Since we are using it in power supply, the transfer of power will result in heat output. We will need to use a heat sink with 7809 otherwise this heat can damage it. It is advised to use a 1A fuse on the output side of 7809 and a 1.5A fuse on the input side of 7809 to avoid damage in case of short circuit.
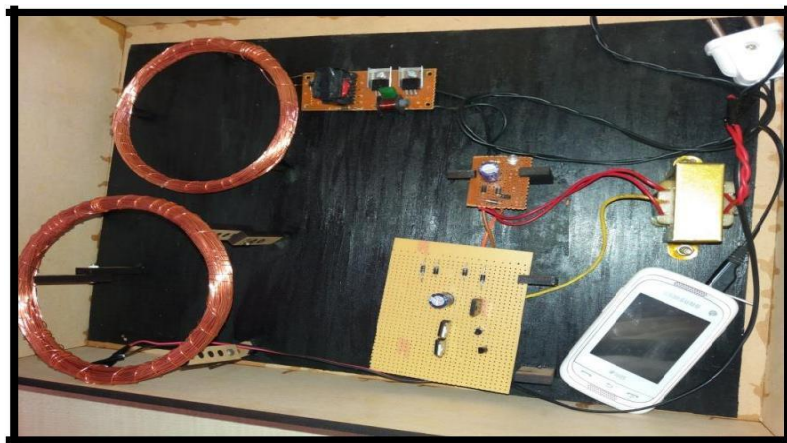
3.7 Wireless charger

Fig. 10 Wireless Charger

This wireless charger consists of two coils transmitter coil and receiver coil, rectifier, oscillator tank circuit and shown in fig 10. Distance between the transmitter and receiver coil is 6cm. By using inductive charging it can charge the 1000mAh battery phone in just 30 min.

4. CONCLUSION

Wireless charging can be as efficient as a wired charging. Based on the reviewed literature and collected data, suggests that wireless power transmission could be feasible. Modern science has now made it possible to use electricity without having to plug in any wires for charging. There are three techniques for wireless power transfer. Inductive charging has lower efficiency and increased resistive heating in comparison to direct contact. Implementations using lower frequencies or older drive technologies charge more slowly and generate heat within most portable electronics. Magnetic microwave has also some limitations Signal absorption by the atmosphere. Microwaves suffer from attenuation due to atmospheric conditions and towers are expensive to build. Researchers developed inductive charging using resonance where energy is transmitted between two copper coils that resonate at the same frequency. Of these two coils, one is the power transmitter and the other, the receiver. This is more feasible than other techniques and is safer than wired charging system. In this project, wireless charging of 1050mAh battery has been focused. The circuit for this purpose has been designed, fabricated, implemented and tested. This circuit consists of transformer, rectifier, oscillator tank circuit, transmitter coil, receiver coil, current amplifier. Initially, output current is 13mA so there is a need to amplify current by using a transistor based current amplifier whose gain is 0.93. Thereafter the output current found to be 450mA at 5V dc and it charges 100% battery in 30mins within the range of 6cms.Wireless power transmission has been the subject of many studies in the past, and will continue to be so in the future.

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