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Efficient Wireless Phone Charging Using Mutual Induction

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***Abstract*— The mobile phones or wireless handsets are part of our life. It is the easiest as well as the fastest medium of communication. As far as developing technologies are concerned, it has taken the top most priority. With the wireless handsets becoming very important and a basic part of life, the recharging of a battery of the cell mobile phone has always been a complication and an issue. The battery life of wireless handsets has always been an issue for the manufacturers. The wireless charging which basically depends on inductive charging is the most convenient way to charge the battery of the cell phone. The wireless chargers work on the principle of mutual induction which basically emit current which is alternating in nature through transmitting coil, this induces the voltage in the other half i.e. within the receiver coil. This receiver coil is then used to charge the battery of the cell phone or the smart phone. In this project, the DC energy is converted to AC energy with the help of oscillation circuit and then it is transmitted via transmitter coil which induces the voltage in the receiver coil. The project design provides the 5V output which is used to charge the battery. It is totally based on coupling magnetic field. This project is divided into two sections; transmitter section and the receiver section. The transmitter coil transmits the coupling magnetic field to the receiver coil by passing very high frequency. This system is totally safe for the users and to the other electronic devices also. The efficiency of this wireless phone charger is very high as it can charge the cell phone or smart phone very efficiently.**

***Index Terms*— Power Transfer, Wireless, Transmitter, Mutual Induction, 555 Timer IC.**

I. INTRODUCTION

In today's world of technological advancement, electricity has become the most important part of our life. Due to the emergence of the wireless and digital technologies, the life has become more comfortable. We cannot think of life without electricity. Wires are the conventional form through which we get electricity. After a lot of research works and experiments, we are able to get the electricity without wires that are wireless [2]. This is a real breakthrough in this field. This process is known as Inductive charging.

The world has seen a drastic change because of small but significant discoveries. The discoveries of the bulb by Thomson, steam engine by Watt and gravitational law by Newton are all very important discoveries which changed the world. But the era of wireless technology came into existence with the discovery of Electromagnetic waves by James Clerk Maxwell. Nowadays everything is tending to become wireless and it is common in our daily life. Wireless mouse, wireless keyboard, cell phone, cordless headphones, satellite communication and wireless internet services like Wi-Fi etc. are such examples in our day-to-day life that world is tending to get wireless. Wireless or cordless devices are more sophisticated as compared to the wired devices and this has raised the living standards. Earlier it was Nikola Tesla who did several experiments and finally was able to transfer power wirelessly. But most part of the power is lost in radioactive mode due to which it has less efficiency. The principle of Inductive charging was devised by Dave Gerding in the year 2005 and this principle is now widely used by many researchers and several experiments is going on to reduce the loss of power to make this concept more efficient [3].

The concept of wireless power transmission has become a reality only because of the several experiments that were done on inductive coupling by the researchers at MIT and in many other research places. Intel has also worked on wireless power transmission in the year 2008. Now it is efficiently used by the users within a number of electronics devices. This field has attracted many researchers and engineers as this is the future and a lot of work is yet to be done so as to reduce the power loss during the wireless power transmission to make it more efficient [1].

In this paper, a circuit design is presented which demonstrates the notion of wireless phone charging system. This system can be used to charge the mobile phone wirelessly without plugging any wired adaptor. The concept of inductive coupling is utilized to transfer the power wirelessly. Firstly, the mains input 230V AC is converted to 30V AC using a step-down transformer and then the bridge rectifier converts 30V AC into 30V DC. This 30V DC is then converted to alternating AC using the oscillator circuit and then it is transmitted using the transmitter coil. At a distance of about 2.3inches, the receiver coil receives alternating 18V to 20V which is then converted to 5V DC and is provided to the mobile phone. In this way, the mobile phone is charged wirelessly without plugging the adaptor. This can further be enhanced by integrating the receiver part into the mobile phone only so that it can be charged by placing the mobile phone on the charging pad which consists of the transmitter part.

II. WORKING PRINCIPLE

The principle of the electrical transformer is used in inductive charging. With the help of inductively coupled coils, the electrical transformer transfers the electrical energy from one circuit to the other circuit. The varying current in the primary winding creates magnetic flux which is also varying in nature and then magnetic field within the secondary winding. A varying EMF (electromotive force) is then induced in the secondary coil. This phenomenon is known as "*Mutual Induction*". Several other devices which work on the principle

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of mutual induction are induction cookers, electric toothbrushes etc. The disadvantage of induction is the short range that is why the receiver should be placed close to the transmitter coil.

III. Block Diagram of Operation

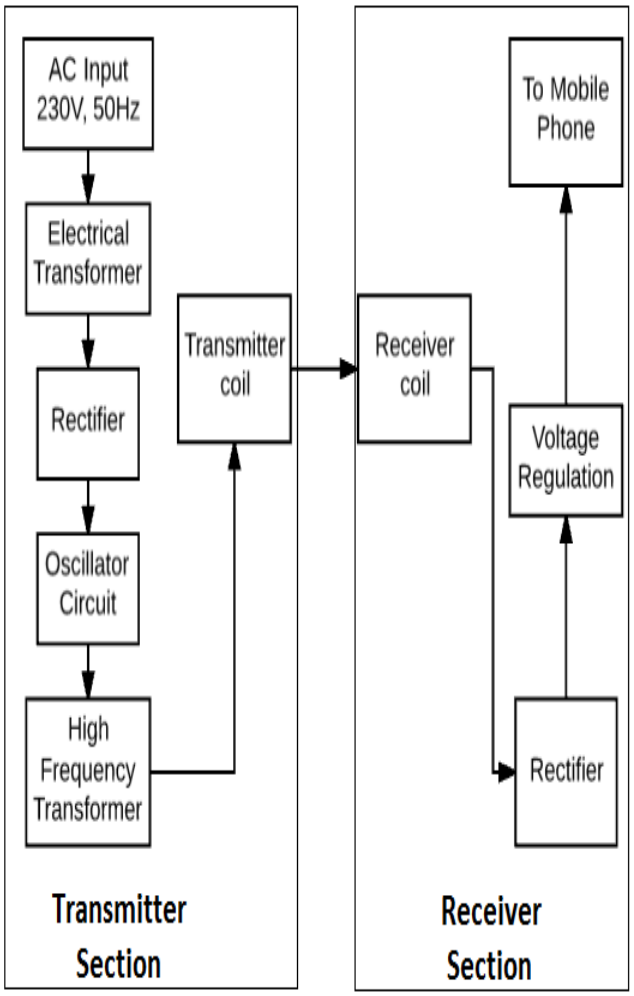

Fig.1. Block Diagram

The different sections of the block diagram are explained below:-

1. AC mains input is provided which is equivalent to 230V, 50Hz AC (Alternating Current).
2. The step-down electrical transformer converts the 230V, 50Hz AC into 30V, 50Hz AC.
3. The rectifier converts the AC into DC (Direct Current).
4. This 30V DC is then converted to high frequency alternating pulse using the high frequency transformer. The oscillator circuit is used to generate the high frequency pulse using 555 Timer IC.
5. The output of the high - frequency transformer is then transmitted using the transmitter coil which further induces varying electromotive force or voltage in the receiver coil.
6. This voltage is filtered and rectified using the rectifier i.e. converted into DC.
7. The voltage regulator is used to regulate the voltage to 5V which is then provided to the mobile phone for charging the battery.

IV. Circuit of Transmitter Section

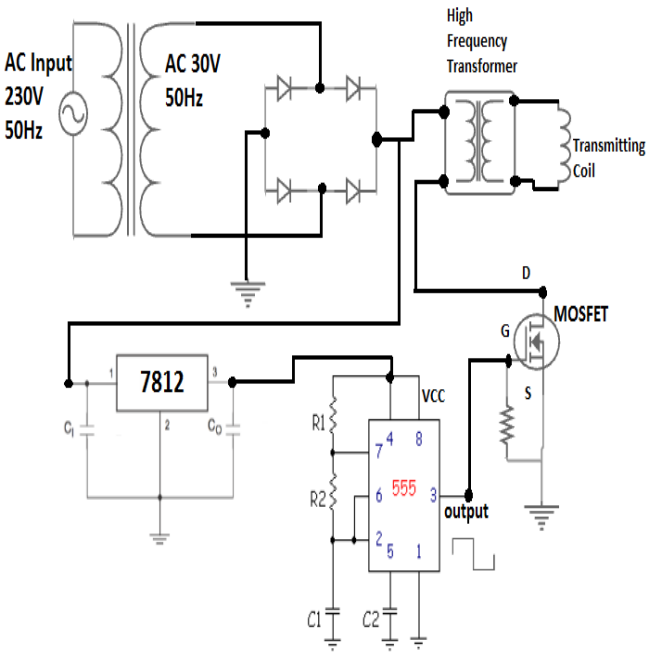

Fig.2. Transmitter Section

The NE555 Timer IC is configured in astable mode and is used to generate the very high frequency pulse of 90 KHz [4]. The values of other parameters are as follows:-

1. R_1 = 1.335 ohms (Ω)
2. R_2 = 1.603 ohms (Ω)
3. C_1 = 4.8 microfarad (μF)
4. Frequency = 90 KHz
5. Duty Cycle = 52%
6. Time High = 7.64 microseconds (μs)
7. Time Low = 5.1 microseconds (μs)

This pulse is then provided to the gate terminal of the power MOSFET to switch the MOSFET at a very high frequency which then converts the 30V DC into alternating pulse of very high frequency and this alternating pulse is transmitted through the transmitter coil to generate varying magnetic flux which further incorporates magnetic field and induces the voltage in the receiver coil. The voltage regulator IC (Integrated Circuit) LM7812 is used to provide +12V to the VCC terminal of the NE555 Timer IC.

V. Circuit of Receiver Section

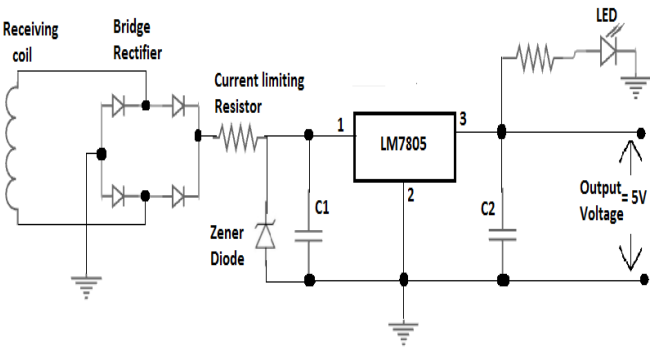

Fig.3. Receiver Section

The receiver circuit receives the induced voltage within the receiving coil which is also varying or alternating in nature. This voltage or induced emf (electromotive force) is then rectified with the help of bridge rectifier which is nothing but the combination of four diodes; this converts the AC voltage into the DC voltage. The voltage regulator circuit firstly includes the zener diode which is used to regulate the voltage in combination with a current limiting resistor. Further, the voltage regulator IC (Integrated Circuit) LM7805 is used to get the output equivalent to 5V. This voltage is used to charge the mobile phones.

VI. Experimental Setup

The experimental setup shown in fig.4 shows the transmitter as well as the receiver sections along with a mobile phone connected to the output of the receiver section.

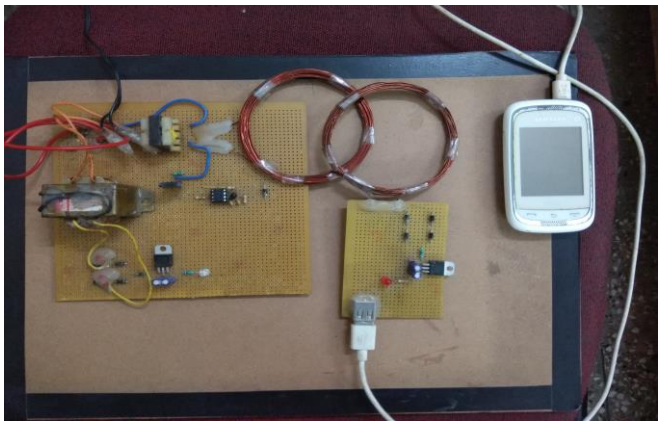

Fig.4. Experimental Setup

VII. Future Development

This circuit design can be implemented by replacing the electronic components with the other components of high standards. Several experiments can be done so as to reduce the loss in the process of wireless power transfer which will definitely enhance the efficiency of the system. The methodology of inductive coupling can be replaced with the microwave technology or with some other methods so as to increase the output and reduce the loss. This will increase the efficiency of the wireless phone charging system. The receiver coil can be integrated within the mobile phone only so that the mobile phone can directly be charged by just keeping it on the charging pad, which is the transmitter section.

VIII. . Conclusion

In this paper, the wireless energy transfer through inductive coupling is described. In this circuit design, when the distance between the transmitter and the receiver sections is 2.3inches, 9V output is received at the receiver end which is then regulated to 5V and is provided to the battery of the smartphone or cell phone. The 555 Timer IC is used to generate a pulse of 90 KHz and duty cycle of about 52%, which is then provided to the gate terminal of the MOSFET so as to convert the DC energy into alternating AC energy with the help of high - frequency transformer. This AC energy is then provided to the transmitter coil which induces the voltage in the receiver section. It can also be enhanced by changing some components.

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