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DESIGN AND IMPLEMENTATION OF A REMOTE CONTROL BASED AUTOMATIC CHANGE OVER

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ABSTRACT

In this paper, an attempt is made to design and implement an automatic change over with remote control. The design and construction of an automatic changeover with remote control will ease the use of an electrical power generating system. This paper focuses on the design of an automatic changeover with timer system that will enhance user control over a power generating set. It is intended for use with a single phase power generating set operating at 220V ac. This research work is limited to the design of an automatic changeover with timer system that will enhance user control over a power generating set. It is intended for use with a single phase power generating set operating at 220V ac.

Keywords: **Switching, Relay, Generator, Motor, Public Power Supply and Transistor, Electronic Control Circuit.**

INTRODUCTION

Electrical power is a very important form of energy that is needed in homes, laboratories, schools, industries and the society at large. However, in Nigeria, it is not generated in adequate amounts and thus, making it one of the principal needs everybody in the society have to fulfill. Most people use small generating sets for this purpose, some use solar means, some use wind means while others combine all the different methods of self power generation to form a special power generating scheme and thus maintain 24 hours uninterrupted power supply.

In order to make self power generation enhanced, requiring less human control and more efficient, then modern automation and control systems needs to be installed on even the smallest power generation systems. Control and automation systems are electronic, electrical or electromechanical systems that can take future actions based on present and past actions or take an action based on input from another system. Present technological advancements have seen the evolution of special control systems into domestic equipments. These control systems include remote control systems, thermostats, temperature controllers and timers. Most control systems were originally reserved for industrial purposes due to cost implication of such systems. Control systems add more control functions to the devices and make them much easy to control. The control systems often found in consumer equipments function in one of two ways. Some control systems perform their functions by taking an action based on change in the immediate physical environment such as change in temperature, pressure, light intensity, etc. Examples of devices that use this type of control systems include; pressing iron, solar street lights, air conditioners and automatic emergency lights.

Other control systems perform their functions by taking an action when they receive data wirelessly or via wires from another device. Examples of such control systems are seen in remote controlled systems such as; television sets, DVD players, audio player systems, home theaters, remote controlled cars and micro wave timing systems. This type of control system is also found in mobile phones where an incoming call or text message will trigger the ringer system of a phone.

This project report describes the design and construction of an automatic change over with remote control which is a control system that serves two purposes; allows the user of a generator to be able to switch off the generator after working for a predefined period of time and also monitors whenever there is supply from PHCN, switch off the generator if it is running and switch the supply to PHCN automatically without human intervention.

MATERIALS AND METHOD

Design Concept

The design of the proposed system is made up of the following component parts:

i. The power supply stage
ii. The inverter stage
iii. The infra red receiver stage
iv. The mono stable stage
v. The switching relay and buzzer stage
vi. The power relay and PHCN indicator stage

The block diagram of the proposed system is shown in fig.1.1.

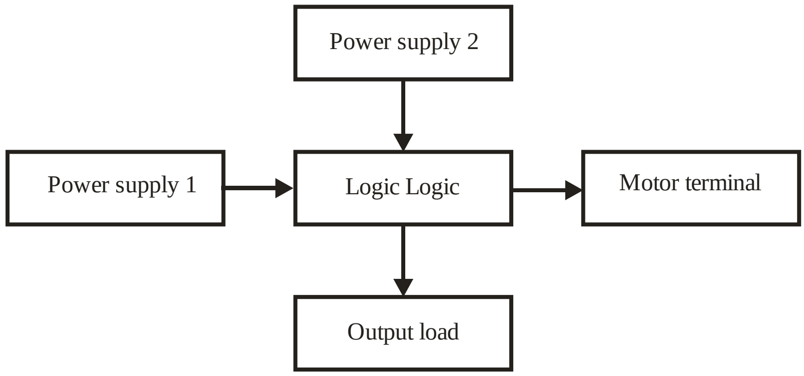


Fig.1.1: Block Diagram of the Proposed System

The Power Supply Stage

This stage is made up of two bridge rectifier circuits with voltage regulators to regulate their outputs. One of the bridge rectifier circuits is used to rectify input power from the generator and used to power the inverter stage, the infrared receiver stage, the mono stable stage and the switching relay and buzzer stage. The other bridge rectifier circuit is used to rectify input power from PHCN and the output is used to power the power relay stage. The output of this bridge rectifier also serve as an input to the inverter stage and such serves as an indicator for the availability of supply from PHCN to the circuit. The circuit diagram of the power stage is shown in fig.1.2.

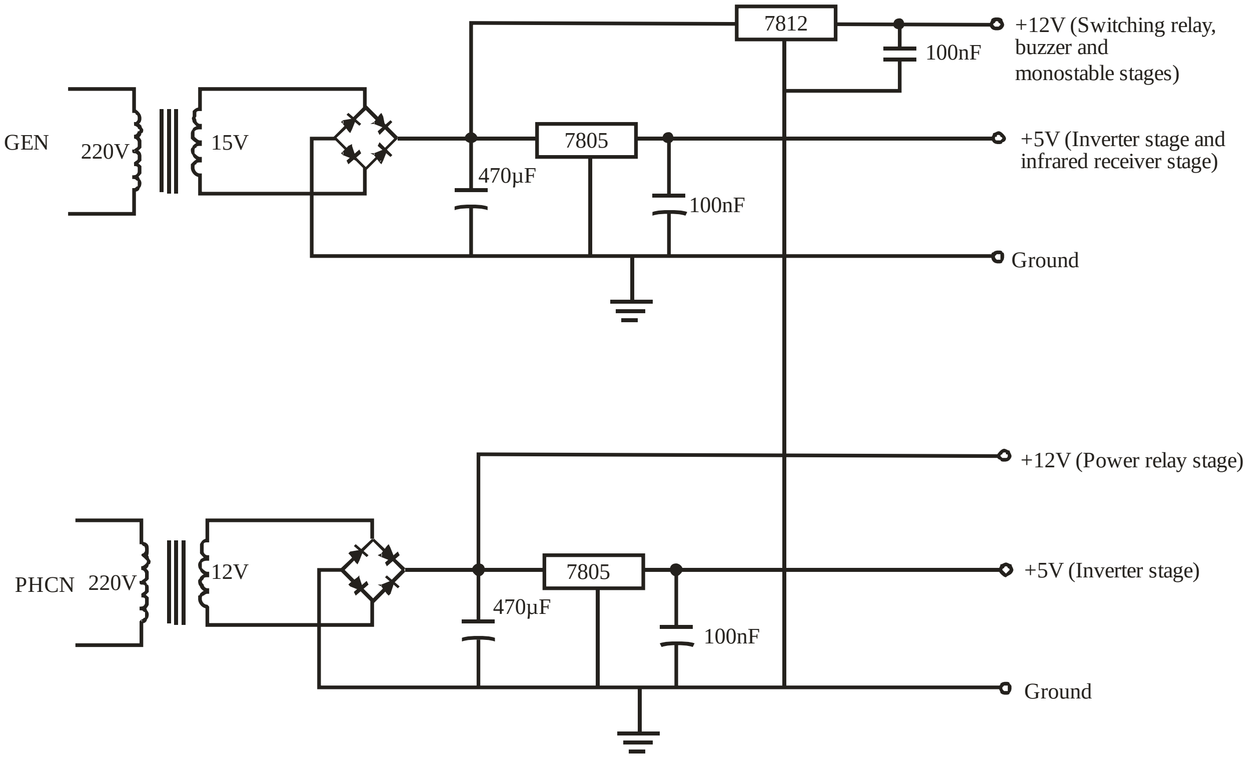


Fig. 1.2: The Power Supply Stage

The output of the bridge rectifier connected to the generator supply is filtered by the $470\mu F$ capacitor and fed to the inputs of two voltage regulators, the 7805 and 7812 voltage regulators. The 7805 regulator regulates the filtered output of the rectifier to $5V$ necessary to power the inverter circuit which is TTL logic gate IC and the 7812 regulates the rectifier output to $12V$ necessary to drive the switching relay and also power the mono stable circuit. The $0.1\mu F$ capacitors at the outputs of the regulators are to prevent the regulators from going into oscillation. The maximum input voltage for 78XX regulators is $24V$ and the input voltage must be greater than or equal to the expected output voltage.

For each cycle of conduction, two diodes are in operation. The output voltage of the rectifier can be calculated as follows:

$$V_{dc} = \frac{2V_m}{\pi} = \frac{2V_{rms}\sqrt{2}}{\pi} \qquad (1)$$

$$V_{dc} = \frac{2 \times 15 \times \sqrt{2}}{3.142} = 14.5V$$

Thus, both conditions for using the 78XX regulators are satisfied by the first part of the power circuit.

For the rectifier circuit connected to the supply from PHCN,

$$V_{dc} = \frac{2 \times 12 \times \sqrt{2}}{3.142} = 12V$$

This output is fed to the second 7805 voltage regulator which gives a $5V$ regulated output. The unregulated output is also used to directly drive the power relays.

The Inverter Stage

This stage is used to invert the power supplied by the bridge rectifier connected to the PHCN source and the output is used to trigger the mono stable stage. It is also used to invert the output of the mono stable stage and used to drive the switching relay appropriately. The IC used for the inverting is a 7400 NAND gate IC. This IC is powered by the $5V$ regulator connected to the bridge rectifier associated with the generator power source.

The Infrared Receiver Stage

This stage is used to detect the presence of remote control signals from a hand held remote controller. The circuit diagram of this stage is shown in fig.1.3.

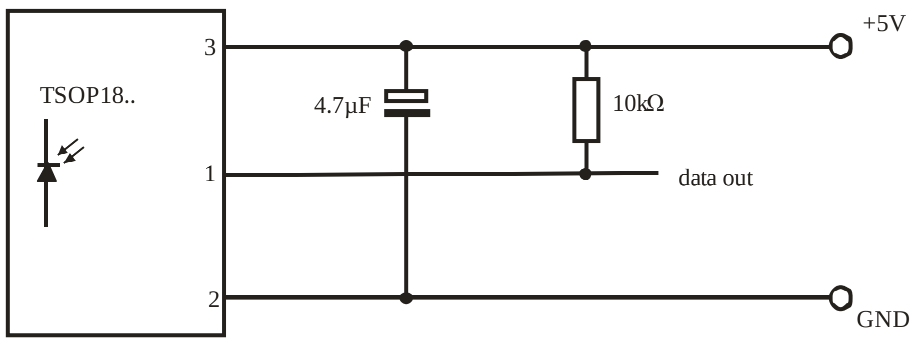


Fig. 1.3: The Infra Red Receiver Stage

The infra red detector is made up of TSOP1836; an infra red detector IC which is powered by the 5V supply provided by the rectifier and regulator circuit connected to the generator source. The IC has three pins. Pin 1 is data output, pin 2 is ground and pin 3 is supply pin. The data received from the transmitter is output directly at pin 1 of the IC. This data is then sent to the mono stable stage where it is interpreted. The 100Ω and 4.7μF capacitor between the main supply, the supply pin of the IC and ground is to reduce power supply disturbances while the 10kΩ resistor is to pull the output normally high.

The Mono Stable Stage

This stage serves as 11s short pulse generator which generates the control signals to switch off the generator whenever there is a triggering condition and also sounds the buzzer for a short period of time. When the generator is first switched on, it generates 11s pulse which sounds the buzzer and waits for the generator output to stabilize while allowing the infra red receiver stage to initialize properly. The trigger source of the mono stable stage comes from an OR gate which have inputs from the PHCN power source and the infra red receiver stage. The output of the mono stable stage is used to drive the buzzer and also fed to the inverter stage where it is inverted and used to drive the switching relay. The circuit diagram of the mono stable stage is shown in fig.1.4.

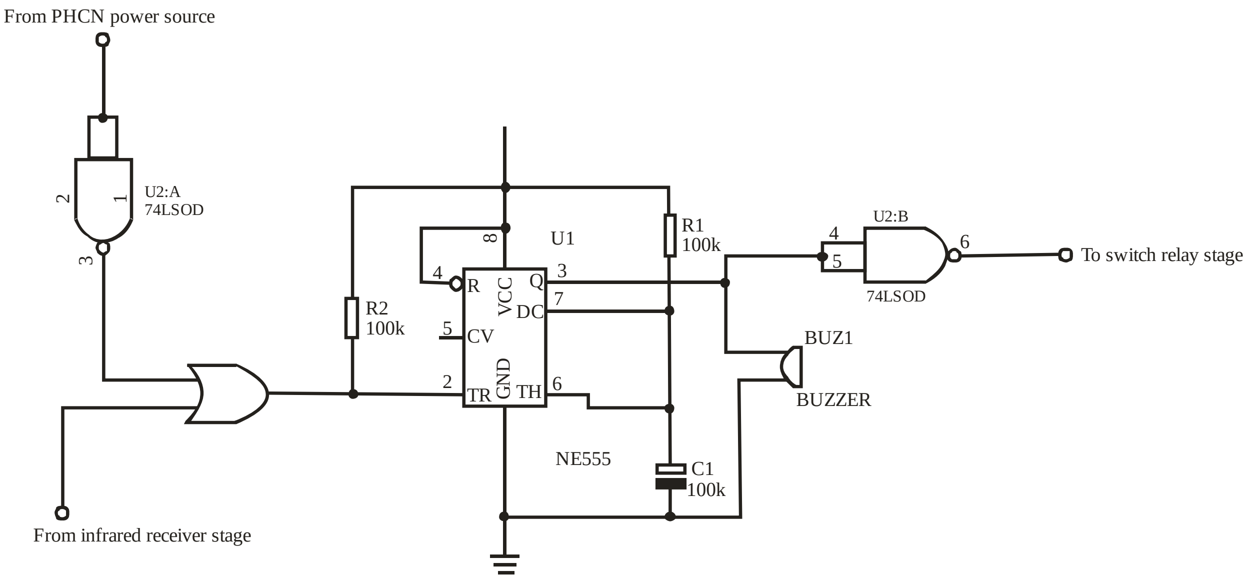


Fig. 1.4: The Mono Stable Stage

The mono stable is triggered when ever there is low going pulse on pin 2 which is held high by the 100kΩ resistor to prevent spurious triggering. The length of the output pulse that is generated whenever there is a trigger is determined by the values of capacitor C_1 and resistor R_1 and is given by the equation;

$t = 1.1R$ seconds

$$= 1.1\times 100\times 10^3\times 100\times 10^{-6}$$
$$= 11s \qquad (2)$$

The Switching Relay and Buzzer Stage

This stage is used to switch the generator off whenever there is a trigger at the mono stable stage and also used to sound a buzzer to indicate the condition. A $3-24V$ buzzer was used and is driven directly by the output of the mono stable stage. The switching relay is driven by the inverted output of the mono stable stage via a transistor. The following analysis describes the switching action that occurs in the switching stage.

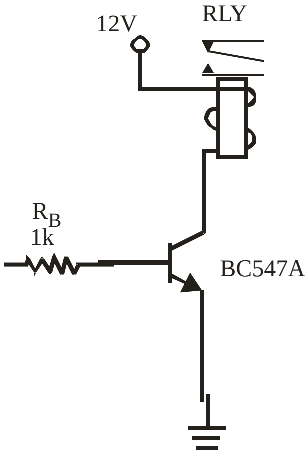


Fig. 1.5: The Switching Relay

Minimum voltage expected at the base of the transistor whenever there is a high output from the inverter stage, is assumed to be $3V$. Resistance in the base circuit, $R_b = 1$kΩ. The corresponding base current that flows in the circuit is given by,

$$R_b = \frac{V_b}{R_b}$$

$$= \frac{3}{1\times 10^3\Omega} 3mA \qquad (3)$$

Resistance of the relay in the collector circuit, $R_c = 330\Omega$. At saturation, current flowing in the collector circuit,

$$I_c = \frac{V_c - 0.2}{R_c}$$

$$= \frac{12 - 0.2}{330} = 35.7mA \quad (4)$$

Minimum hfe for the transistor (BC547) is 110

Therefore, the base current required to cause saturation is,

$$I_{breq} = \frac{I_c}{hfe}$$

$$\frac{35.7}{110} = 0.32mA \quad (5)$$

Since the actual current that is flowing through the base of the transistor is higher than that required to cause saturation, the relay will be latched on whenever the inverter stage gives a high output on the pin connected to the base of the transistor.

The Power Relay and PHCN Indicator Stage

This is the stage in which the actual switching of power from Generator to PHCN and vice versa is done. It consists of two relays that are powered by the part of the power source connected to the PHCN supply. By default, the output of this stage is connected to the generator supply. When there is supply from PHCN, the output is switched away from the generator source to the PHCN source. The circuit diagram of this stage is shown in fig.1.6.

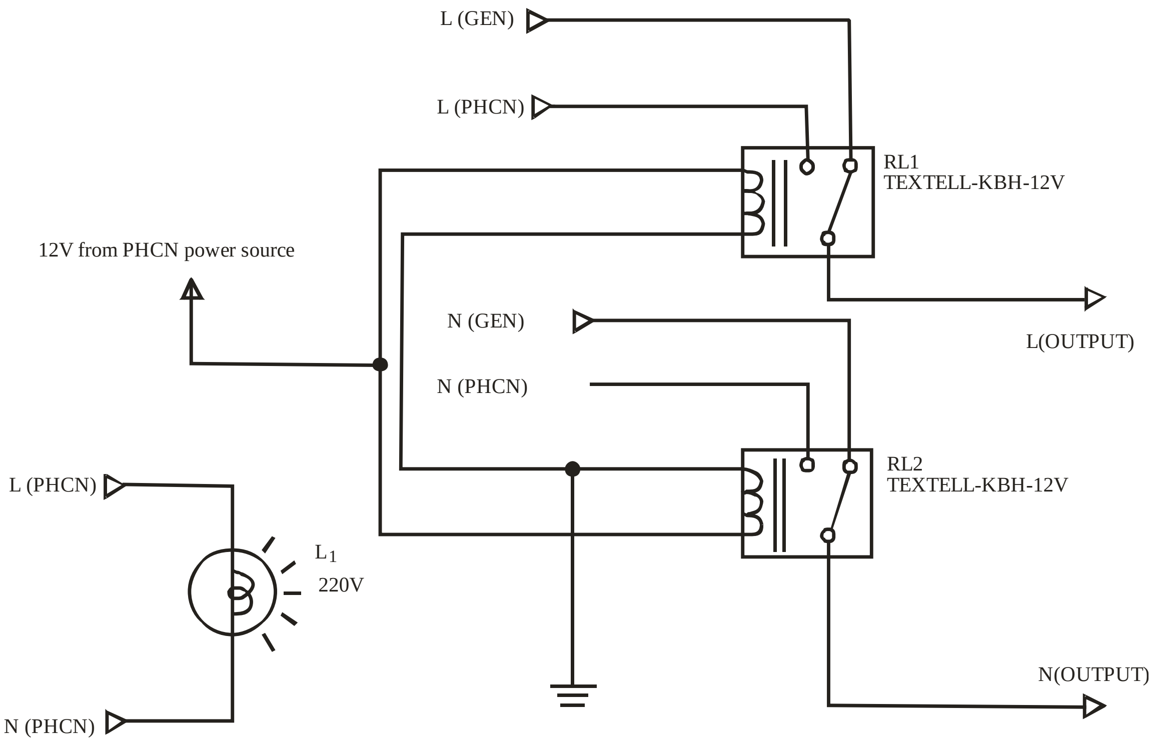


Fig. 1.6: Power Relay and PHCN Indicator Stage

The complete circuit diagram for the design is shown in fig.1.7

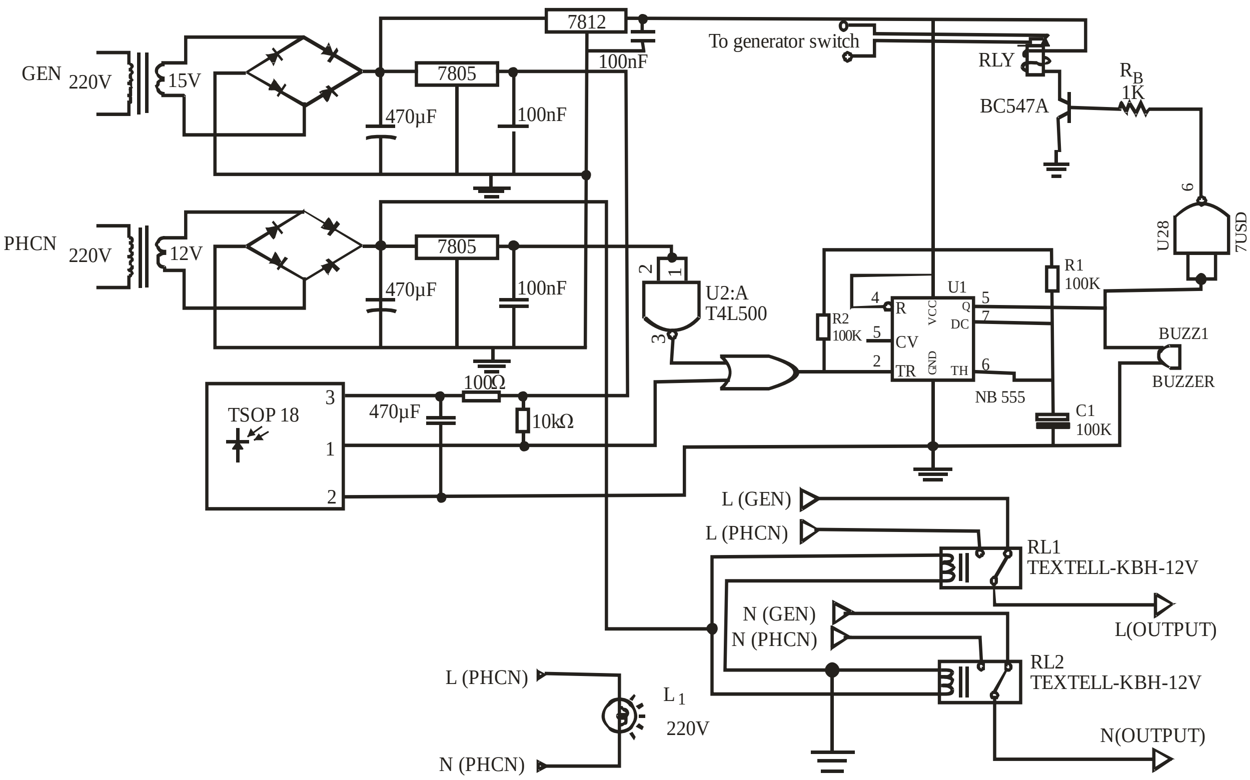


Fig. 1.7: Complete Circuit Diagram of the Design

RESULT AND DISCUSSION

Construction

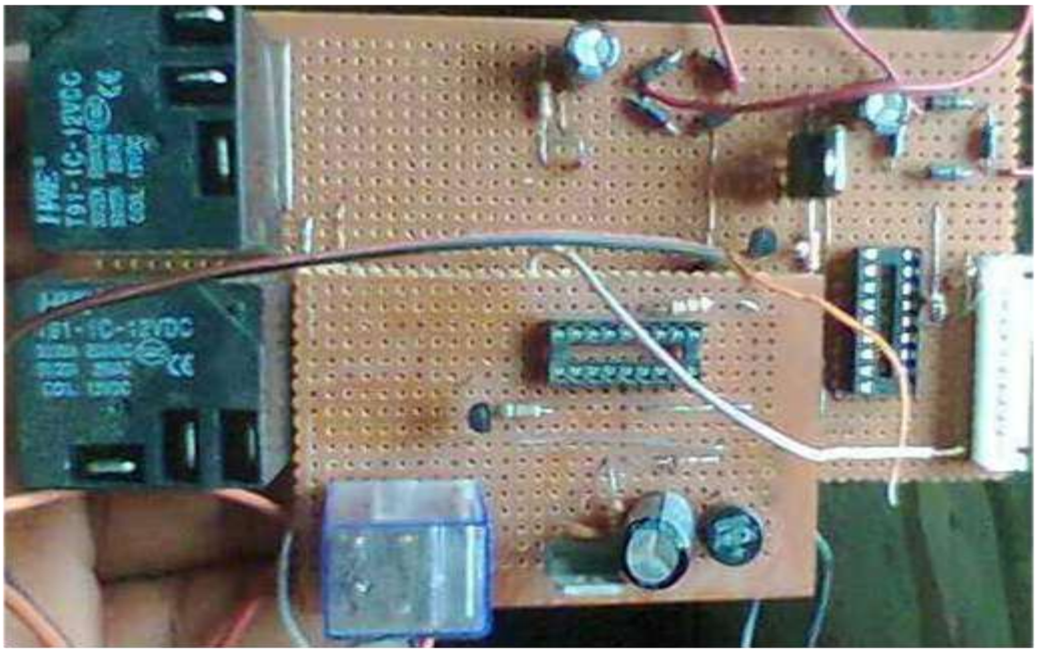
The construction of this project refers to the techniques by which the circuit in this project is designed and the way the final project is cased. Thus, construction of the device in this project work is divided into two; the soldering stage and the packaging stage.

Packaging

The whole project is packed in a metallic container. The container is a commercially available adaptable box often used by electrical engineers for complex installation works and this justifies why it was used. The container was drilled where necessary to allow rooms for indicators, switches, buzzers and other required devices. The circuit was fitted into the box and held tightly in place with the aid of screws and nuts. The transformers to be used in the power circuit were also held tightly in place with the aid of screws and nuts.

Testing

The first set of testing was done after the soldering of each stage. The second testing was done after the whole circuit has been soldered appropriately. The final testing was done after the whole devices had been packaged. The final circuit of the proposed system is shown in fig.1.8.



CONCLUSION

This paper has presented the development of a remote control based automatic change over. Several components were integrated to achieve the proposed system. The proposed system eases the use of an electrical power generating system. The system is applicable to a single phase power generating set operating at $220V$ ac.

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