DESIGN AND CONSTRUCTION OF A SINGLE PHASE AUTOMATIC CHANGE OVER SWITCH

BY

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2001/12015EE

A thesis submitted to department of electrical and computer engineering

School of engineering and engineering technology,

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Niger state

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DEDICATION

This project is dedicated to almighty GOD. The most beneficent and the most merciful and sustainers of my life to him all thanks and praise belongs. This project is as well dedicated to my beloved parents Rev (Dr.) Paul E. Kine and Deaconess Helen W. Kine

DECLARATION.

I, KINE SAMUEL N. declares that this work was done by me and has never been presented else where for the award of a degree. I also hereby relinquish the copyright to the federal university of technology, Minna.

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ACKNOWLEDGEMENT.

I am grateful to the Almighty God who made it possible for me to carry out this project work successfully. My profound gratitude goes to my supervisor Mr. Abraham Usman for his moral and technical support, construction criticism and time given to me during my project work. My profound gratitude goes to my parents Rev(Dr) Paul E. Kine and Deaconess Helen W.Kine for the good upbringing and their dedicated effort to see me through my academic pursuit from primary school till date, I prayed that the Almighty God should let them live long and enjoy the fruits of their labours.

My sincerely appreciation goes to the entire staff and lecturers of Electrical / Computer Engineering Department for the knowledge imparted in me.

My special gratitude goes to all member of my family, Bro. Emmanuel L. Kine, Sis. Bariwere S. Kine, Bro Daniel L.Kine, Sis. Beauty T. Kine, Bro Tambari S. Kine.Sis.Lezorgia L. Kine and late Bro.Hon.Barika S. Kine. I say thank you all for you are there for me when the road was rough. I am also indebted to my friends, Simeon Nnadi, Ihezukwu Michael (Biggie), Seni (Snell), Henry Nwosu, Samaila, Emeka, Fetus, Gigals brothers to mention but a few. The entire family of Rev. B.T. Nwiwure, and the family of Barr. C.N. James for their assistant rendered to me.

ABSTRACT.

It is very obvious that light plays a very important role in all aspect of human life. A single phase automatic change over switch for a standby generator when there is power outage from PHCN was designed and constructed. The switching was efficient and effective. This project is mostly useful in places like industries, broadcasting stations, and hospitals in order to save life from danger during operation. This project is fully automatic since it changes from PHCN to generator and vice versa by the change over relays concerned. It is realised using available discrete components.

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CHAPTER ONE

1.0 INTRODUCTION

Today's residential, commercial and industrial requirements for electricity are growing at a faster rate than ever. Our dependency on electricity is increasing more and more, ranging from our everyday needs and comforts, jobs, entertainment and medical requirements to discoveries yet to come. As the need for electricity grows, so does the need for a distribution system that can safely and efficiently deliver the power required.

It is important that the electrical power produced at the source and delivered to the load be adequate and uninterrupted.[1]

Electricity is modern man's most convenient and useful form of energy. Without it the present social infra-structure would not at all be feasible. The increasing per capital consumption of electricity throughout the world reflects a growing standard of living of the people. The optimum utilization by the society of this form of energy can be ensured by an effective distribution system.[2]

The need for an automatic change over switch system cannot be over emphasized due to the fact that in the third world countries (or developing countries) like Nigeria, electricity supply is not always regular. Thus, it is extremely important to have an automatic change over switch in area or places which have some sensitivity in case the normal supply (mains supply) fails at odd times.

In the field of technology, Nigeria in particular is left behind and the dream of constant power supply is yet to become a reality. Meanwhile, power outages are common in many parts of the country, some of the time due to lack of power from the main station that is used to supply power (PHCN). In other areas they are becoming more common on the power network struggle to keep up with the ever increasing electricity demands by keeping a stand by generator.

In the light of this problem, a simple step has been taken to design and construct single – phase automatic change over switch. This helps a lot during power outages in such places like hospitals, established large companies (e.g. telecommunication companies) and some of the government establishment.

The operation of the relay is the heart of this project work, because when P.H.C.N. is in supply, the relay concern for the changing over from P.H.C.N. line would the change over immediately from generator to P.H.C.N. mains, the output will be the one coming from P.H.C.N. this process repeats immediately the P.H.C.N. supply goes off, by changing over from P.H.C.N. line to generator line and the output will be supply from the generator.

It can be noted from the title of the project work, called an automatic change over switch that generator will only be on when P.H.C.N. failed, but when P.H.C.N. is restored, immediately the generator will be off automatically by the action of the relay concern.

Broadly speaking the project uses a step down transformer, bridge rectifier, a voltage regulator. The generator starts immediately P.H.C.N. supply goes off and the supply from the generator line then passed to the output by the work of change over relays concerned.[3]

1.1.0 PROJECT MOTIVATION

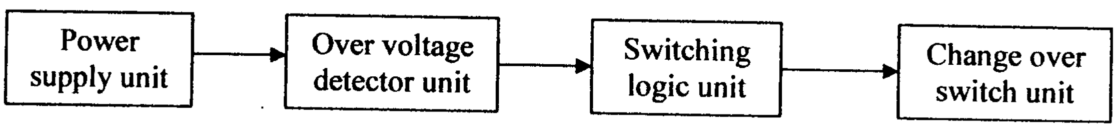
The design and construction of the single phase automatic change over switch for medium size generator is made cost effective and portable. However as a result of the cost implication in acquiring highly sophisticated and heavily designed automatic change over switch. This project is therefore aim at serving the needs of the less privilege in the society.

Despite its simplicity and little cost implication, it is quite effective and address the problem of erratic power supply from the P.H.C.N. by making the supply to individuals constant at all times.

1.1.1 METHODOLOGY

The method employed in this project is to carry out the design of individual modules which are then coupled into a single to satisfy the overall objective of this project.

The sub – circuits are



The design methodology follows the block diagram basically. The design considered the availability of suitable components at reasonable cost.

1.1.2 AIMS AND OBJECTIVES

The objectives of this project are to improve the availability and the efficiency of electric energy consumption in such a way that the design device delivers a normal output voltage continuously.

1.1.3 SCOPE OF PROJECT

The scope of this project is to design an electrical circuit that will enable the user to minimize change over time and also prevent dangers associated with manual change over switches. The study carried out on this project has been limited to voltage range of 180V to 270V.

CHAPTER TWO

2.0 LITERATURE REVIEW

Electricity was discovered by Micheal Faraday (1791 - 1867) when he discovered that the movement of a magnet in coil of wire produces an electric current in that wire. Although no one can see electricity, there is evidence of its presence everywhere. Electric power is very much abundant and easy to use. It can be seen in our everyday life for purposes such as industrial processes, commercial purpose, domestic use, communication and transportation purposes. [4]

The outstanding advantage of electricity compared to other power sources are its mobility and flexibility. Electrical can be moved to any point along a pair of wires and depending on the user requirement converted to light, heat, motion or other forms. One of the early problems associated with the use of electricity was efficient transmission to the consumer. Voltage drop and loses in resistance on the low voltage distribution circuit where the first limiting factors encountered. The problem of voltage regulation became more pronounced due to the distance between the generating station and the consumer end. The voltage regulator came into use soon after the 19th century breakthrough by Thomas Edison. It is useful in the variation of transmission voltages. [5]

The first attempt to create an automatic voltage regulator employed the use of a motorized system controlled by a control circuit to change the taps on the secondary of an autotransformer so as to step up when the input voltage is low or to step down when the input voltage is high. Some of its disadvantages are that it was bulky, costly and the mechanical parts wear away which resulted in improper contact between the contacts terminals. [6]

Another type of automatic voltage regulator was the resonance circuit voltage regulator. It involves far components, inductance of the transformer coupled with a parallel inductance and capacitance resonance. When the line voltage falls below the rated values, less current is drawn by the inductance and parallel circuit combination becomes capacitive. The capacitive current drawn through the transformer raises the output. If line voltage is raised above the rated value, the parallel circuit combinations become less capacitive and the output voltage falls below the line value. The disadvantage of this approach is that it is bulky, heavy and frequency dependent.

An improvement on the motorized voltage control is the automatic voltage regulator. This comprises of a Schmitt trigger which act as a comparative circuit, a driver and an autotransformer. The Schmitt trigger circuit is biased to compare the DC value of the incoming AC voltage with a self reference DC voltage and energizing the driver circuit which does the switching between the task of the auto relay either to increase the load voltage when the AC value dropped below a line value or decrease when the AC voltage input goes high beyond a set value. This advent of the AVR brought about the use of a driver circuit than the motorized unit used to change the taps on the secondary of the autotransformer. Though the system could be heavy depending on the power rating, but is not as bulky as the motorized voltage control system. The contact devices, electronic relays are more reliable and cheaper to construct. The present technological dispensation has changed voltage stabilization technique greatly. The AC in version approach which uses the principle of switch mode power supplies. The system output is a square wave AC voltage which could be filtered to obtain a pure signal. This system is not heavy but more expensive and more complex than earlier ones.

Another approach was the phase control automatic voltage regulator. The system is connected in series with the voltage controlling device which is usually a silicon controlled rectifier (SCR) and transistor. This method is very fast in response to voltage fluctuation at the input. The system is not heavy and also not expensive but its output waveform is distorted.

This entire automatic voltage regulator has a common disadvantage of raising the output voltage at normal undesired value when certain under voltage occur at P.H.C.N. supply voltage due mainly to over loading.

This approach uses a Schmitt trigger to dictate to the relays connected to the single line of P.H.C.N. supply and generator to switch on the contact to the high voltage supply. The beauty of this approach is that it relatively cheaper, size reduced, light weight, flexible and better response compare to previous project.

A manual change over switch consists of manual change over switch box, switch gear box and the connector fuse or cut out fuse. This change over switch box separate the source between the generator and P.H.C.N. and when there is power supply outages, from P.H.C.N. somebody has to go and change the line from P.H.C.N. source to generator thus when P.H.C.N. power supply is restored somebody has to go and put off the generator and then change the source line from generator to P.H.C.N.

The switch is used to protect the equipment of the generator as well as that of the building. This shows that if there is high voltage from P.H.C.N. when supply, the fuse inside the switchgear will cut off, this separates the supply from the load. This also does the same when there is high voltage from the generator. The cut – out fuse is an additional protector of any high voltage between P.H.C.N. a source and switchgear.

In view of the above manual change over switch that involves manpower by using one's energy in starting the generator and switching over from over P.H.C.N. to generator and vice – versa when the P.H.C.N. supply is being restored; the urgency attached to cases of operation in hospital in order to save life from danger by getting the supply from generator as fast as possible. Gave the zeal to design and construct a single phase automatic change over switch which would solve the problem of manpower and the danger likely to be encountered during operations in hospitals.

2.1 THEORETICAL BACKGROUND OF THE PROJECT

The theoretical background of this project is based on the principles of a regulated power supply, a relay operating principle.

As shown in the figure below, a regulated power supply make use of a step down transformer, rectifying circuit, filter and a voltage regulator.

The transformer steps down the AC supply voltage to suit the requirement of the electronic devices and circuits fed by the DC power supply. It also provides isolation from the supply line an important safety consideration. The rectifying circuit (bridge type) employs (4) diodes to convert AC voltage into pulsating (called ripples) present in the output voltage supplied by the rectifier of course, no filter can practice, gives an output voltage as ripple free as that of a DC but it so closely that the power supply performs as well. The voltage regulator keeps the terminal voltage of the DC supply constant even AC input voltage. [7]

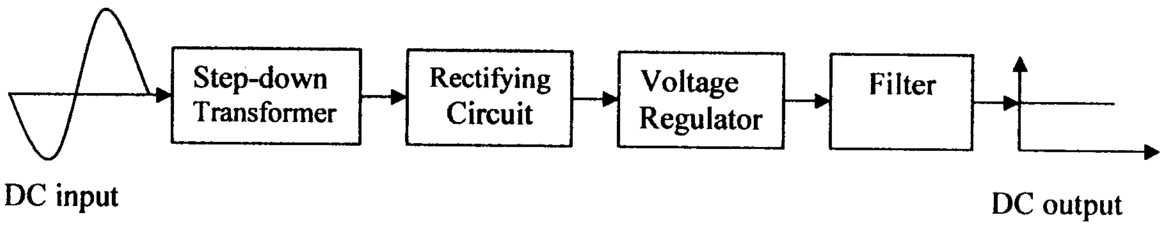


Fig.2.0 lock diagram of the Regulated Power Supply.

The relay operating of the project section operates based on the principle of electromagnetic induction. However, a general purpose relay (used) is basically a mechanical switch operated by a magnetic coil similar to that of the figure below, the general purpose relay employed here is a DC type. These relays are available with coils that can operate or close the contacts from mill volts to the hundred volt range. Relays with a 6, 12, 24, 18, 115, and 230volts design are the most common. Today designs offer a number of general purpose relays that require as little as 4milliamp at 12v DC making them IC compatible to TTL and CMOS logic design (gates). These relays are available in a volt range of switching configuration [2, 3, 4, 5, 6, and 7].

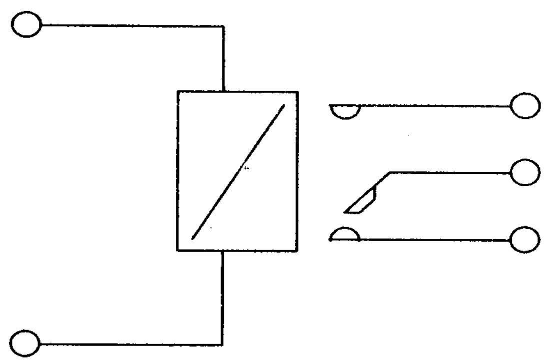


Fig 2.1 Electromechanical Relay

The current needed to separate a relay is called the pull – in current and drop – out current is the current the coil when the relay just stops working. If the coil resistance is R and its operating voltage is V, the pull-in current,

$$I = \frac{V}{R}$$

The primary purpose of the DC voltage source is to supply power for lighting the LED and ignition of the generator. The LED converts electrical energy into light energy (as a transducer). It is used as an indicator. The resistor in series with the LED limits the current through the LED by directing and controlling current, making changing currents produce changing voltage and obtaining variable voltages from fixed ones. The value of the external resistor in series with the LED is calculated as follows:

$$R = \frac{Vs - Vf}{If}$$

Where: R is the use of the resistor

Vs is the supply voltage

Vf is the forward voltage of the diode

If is the forward current of the diode

The arrangement of the capacitor and the relays is used to ensure the ignition time of the generator using the voltage supply from the secondary. This ignition time is the transient time or time constant of a capacitor as it charges or discharges through a resistor (i.e. the resistance of the relay). This can be calculated or determined using this relationship that follows: $T = CR$,

Where: T is the time constant of the capacity

C is the capacitance of the capacitor

R is the resistance of the relay

Note: $Vs = \frac{2V}{3}$ after time T

Vc is the capacitor voltage

V is the supply voltage of the secondary.

CHAPTER THREE

3.0 DESIGN AND IMPLEMENTATION

The automated P.H.C.N. generator changeover system comprises the following subsystem:

1. Power supply
2. Over voltage detector
3. Changeover logic
4. AC power switch

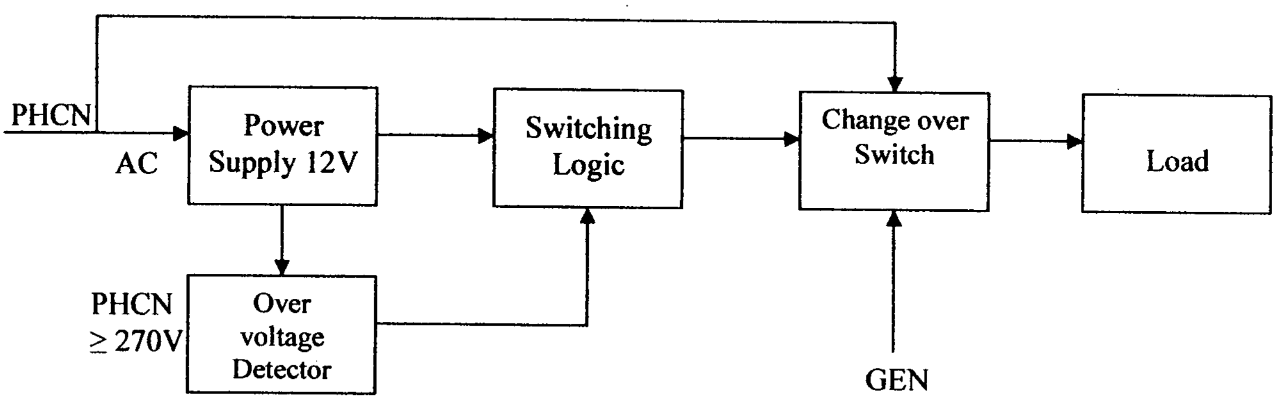


Fig 3.0 Block diagram of a Single Phase Automatic Change over Switch

3.1 POWER SUPPLY

The power supply was constructed using a 15V, 1A step down transformer wired to a full wave bridge rectifier and smoothened by a 25V, 2200uf capacitor.

The power supply was carefully chosen to provide the required system voltages over the operational input AC voltage range of 140V – 270Volts.

The power supply is shown below;

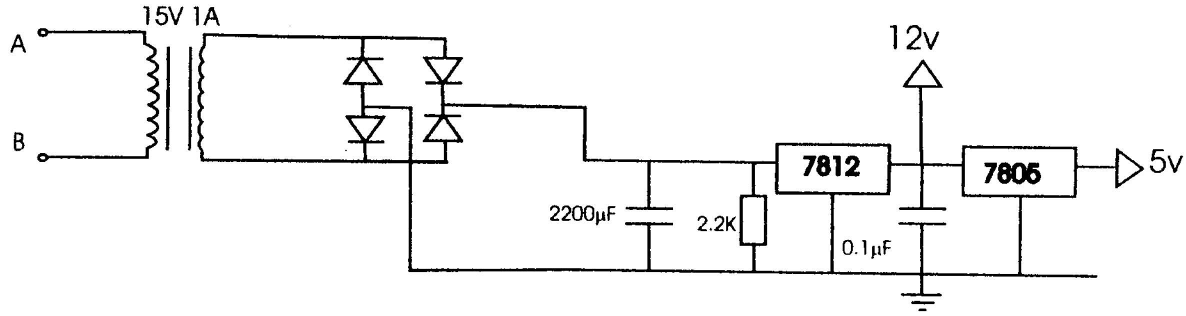


Fig 3.1 Power Supply.

Two system supplies were used; a +12V supply that powered the logic / detector subsystem, and a 15V controlling the relays.

The 15V (at 240VAC input voltage) was converted to a DC voltage with peak amplitude of

$(Vrms\sqrt{2}) - 1.4 = 15\sqrt{2} - 1.4 = 19.8V$

The value of the voltage was smoothened by an R-C combination consisting of a 2.2kΩ resistance and 2200uf capacitance.

The DC voltage across the capacitor is given by the expression

$$Vdc = \frac{Vpeak}{1 + \frac{1}{4\,FCRl}}$$

$Rl = 2.2k\Omega$

C = 2200uf

F = 50Hz

$$Vdc = \frac{(15\sqrt{2}) - 1.4}{1 + \frac{1}{4 \times 50 \times 2200 \times 10^{-6} \times 2200}}$$

$$Vdc = \frac{19.8}{1} = 19.8V$$

A 2.2V Ω discharge resistor was placed across the capacitor to provide fast response to input voltage variations on the AC line. The discharge time construction is given by

$$T = RC$$

$$= [2200 \times 2200 \times 10^{-6}]\ s$$

$$= 4.84 seconds$$

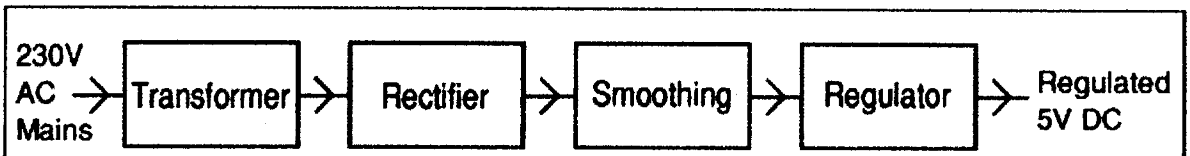
This is the approximate time the unit takes to respond to variations in the input line voltage affecting the switching logic.

Using a low time constant will cause transient response and too large a time constant result in a slow system.

The (19.8V) DC voltage was regulated down to +12V by a 7812, 12volt, 1amp regulator. A +5V supply was also derived from this regulated input. The +12V establishes the switching thresholds for the changeover logic control circuit.

3.1.1 TYPES OF POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. For example a 5V regulated supply:



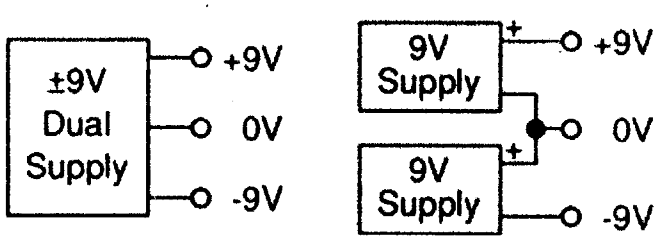
Block Diagram of a Regulated Power Supply System

Each of the blocks is described in more detail below:

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, but the DC output is varying.
- Smoothing - smoothes the DC from varying greatly to a small ripple.
- Regulator - eliminates ripple by setting DC output to a fixed voltage.

Power supplies made from these blocks are described below with a circuit diagram and a graph of their output:

- Transformer only
- Transformer + Rectifier
- Transformer + Rectifier + Smoothing
- Transformer + Rectifier + Smoothing + Regulator

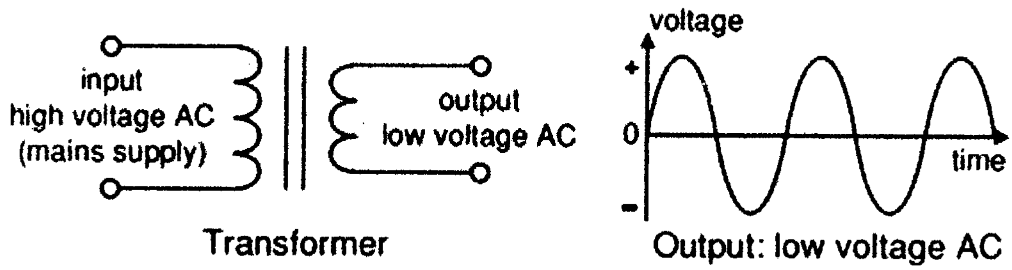


3.1.2 Dual Supplies

Some electronic circuits require a power supply with positive and negative outputs as well as zero volts (0V). This is called a 'dual supply' because it is like two ordinary supplies connected together as shown in the diagram.

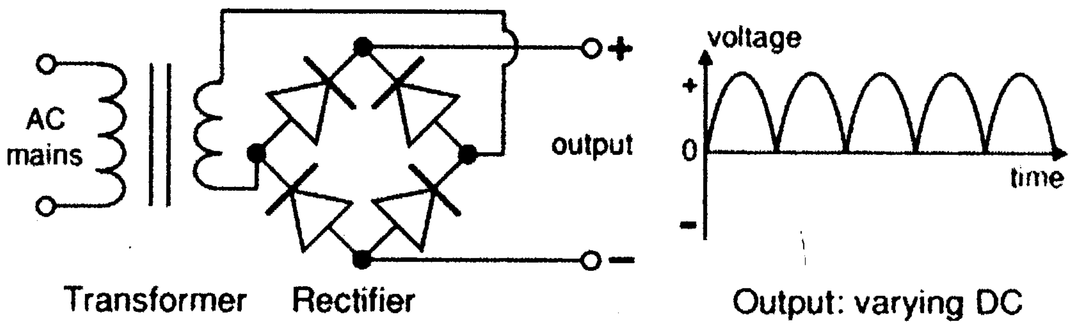
Dual supplies have three outputs, for example a ±9V supply has +9V, 0V and -9V outputs.

Transformer only



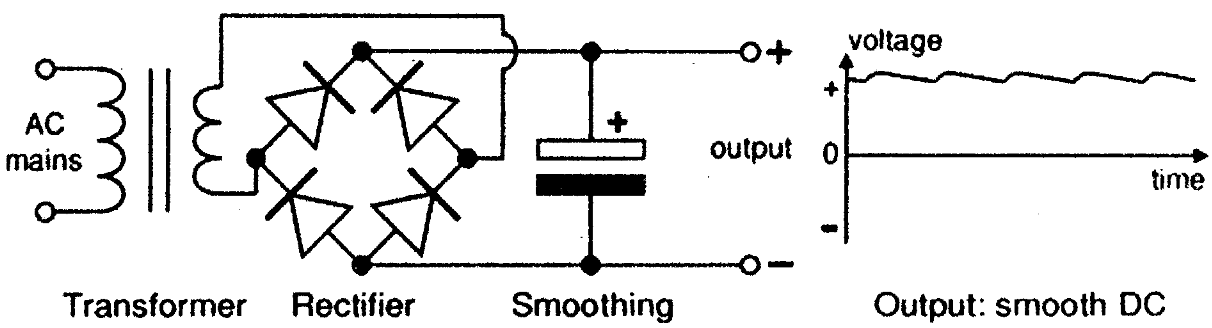
The low voltage AC output is suitable for lamps, heaters and special AC motors. It is **not** suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

Transformer + Rectifier



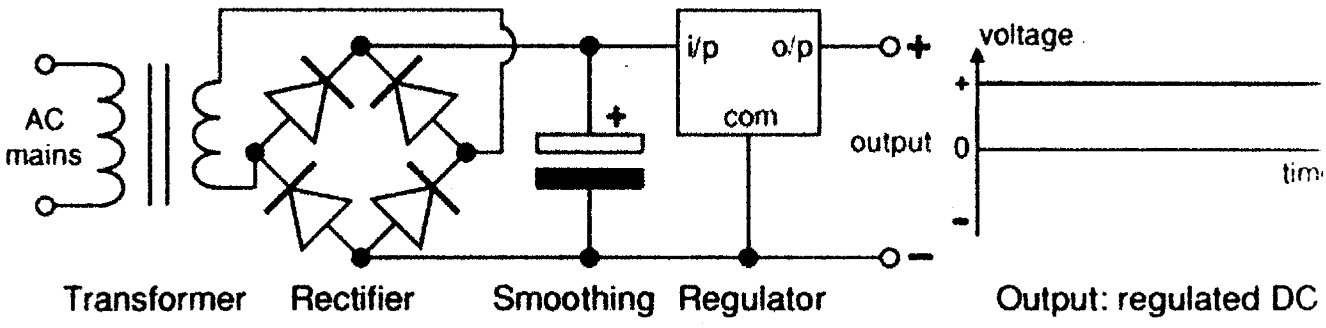
The varying DC output is suitable for lamps, heaters and standard motors. It is **not** suitable for electronic circuits unless they include a smoothing capacitor.

Transformer + Rectifier + Smoothing



The smooth DC output has a small ripple. It is suitable for most electronic circuits.

Transformer + Rectifier + Smoothing + Regulator



The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

Transformer

Transformers convert AC electricity from one voltage to another with little loss of power.

Transformers work only with AC and this is one of the reasons why mains electricity is AC.

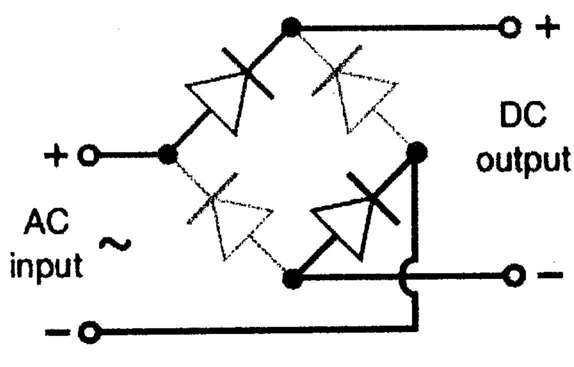
Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage. The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils, instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up. The ratio of the number of turns on each coil, called the turns ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

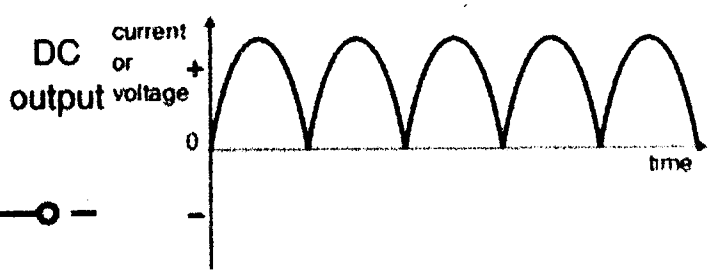
3.1.3 Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces **full-wave** varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce **half-wave** varying DC.

3.1.3.1 Bridge rectifier

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages).



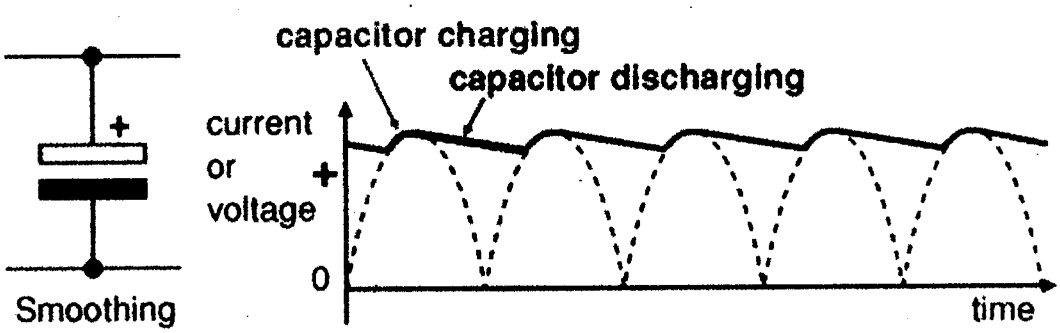


Bridge Rectifier

Output waveform

3.1.4 Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.



Smoothing significantly increases the average DC voltage to almost the peak value (1.4 × RMS value). For example 6V RMS AC is rectified to full wave DC of about 4.6V RMS (1.4V is lost in the bridge rectifier), with smoothing this increases to almost the peak value giving 1.4 × 4.6 = 6.4V smooth DC.

Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small ripple voltage. For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor. A larger capacitor will give less ripple. The capacitor value must be doubled when smoothing half-wave DC.

3.1.5 Regulator

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulators ICs have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heatsink if necessary.

3.1.5.1 Zener diode regulator

For low current power supplies a simple voltage regulator can be made with a resistor and a zener diode connected in reverse as shown in the diagram. Zener diodes are rated by their breakdown voltage Vz and maximum power Pz (typically 400mW or 1.3W).

The resistor limits the current (like an LED resistor). The current through the resistor is constant, so when there is no output current all the current flows through the zener diode and its power rating Pz must be large enough to withstand this.[8]

3.1.6 CHANGEOVER LOGIC

The changeover logic was designed around a Schmitt trigger. A Schmitt trigger is a modified DC comparator with well defined switching thresholds. Schmitt triggers prevent switching around a point that is problematic of simple comparators.

A representative design is indicated in the figure 3.2 below

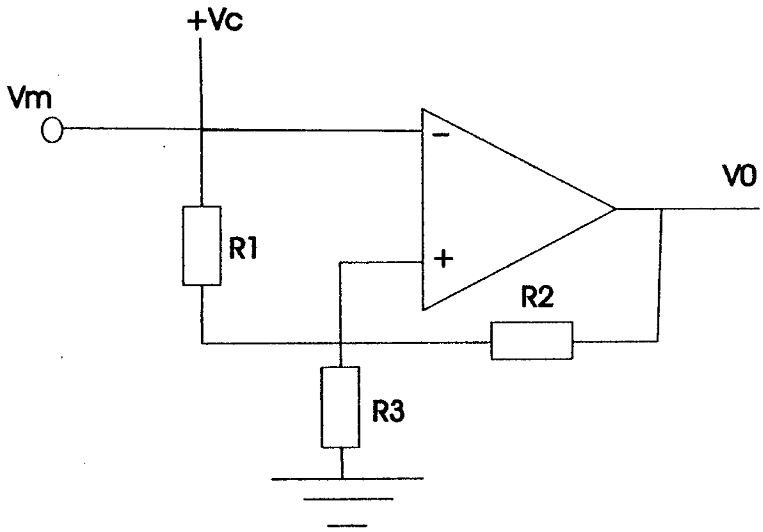


Fig 3.2 Schmitt trigger circuit

The Schmitt trigger circuit has two switching thresholds defined by the values of the circuit resistances. Assuming initially the Vo is high,

$$V_{+(1)} = \frac{Vcc \times R3}{(R1 // R2) + R3} \text{ ---------------------------(a)}$$

When Vo is low,

$$V_{+(2)} = \frac{Vcc \times (R2 // R3)}{R1 + (R2 // R3)} \text{ ---------------------------(b)}$$

The two thresholds defined when the trigger changes state. If V(-) (i.e. the input) is higher than the $V_{+(1)}$, the output switches low, and stays low until the input voltage falls below $V_{+(2)}$ at which point the output switches high again.

The difference in the switching threshold is the hysterisis and is responsible for conferring stability on the circuit operation. A Schmitt trigger internal to an MS555 timer was used, with the values of $R1 = R2 = R3 = 5k\Omega$

For equal values of R, it is seen that

$V_{+(1)} = \frac{2}{3}$ Vcc and $V_{+(2)}$ $\frac{1}{3}$ Vcc.

For a wide control input range, a Vcc of 12V was chosen, putting $V_{+(1)}$ at 8Vand $V_{+(1)}$ at 4V.

The 555 Schmitt trigger is shown in the fig 3.3 below

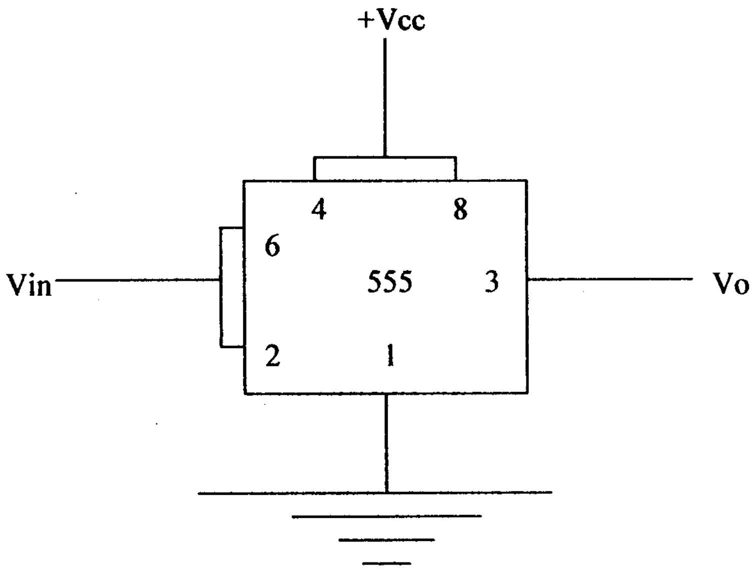


Fig 3.3 555 Schmitt Trigger.

The trigger is configured for Schmitt trigger operation by connecting pins 6 and 2 together and making them common inputs for the input voltage.

For the 555, When

$V_{(6,2)} > \frac{2}{3}$ Vcc, Vo = Low (0V)

$V_{(6,2)} > \frac{1}{3}$ Vcc, Vo = High (Vcc)

The voltage to the input pins 6 and 2 was derived from the zener – resistor network shown below.

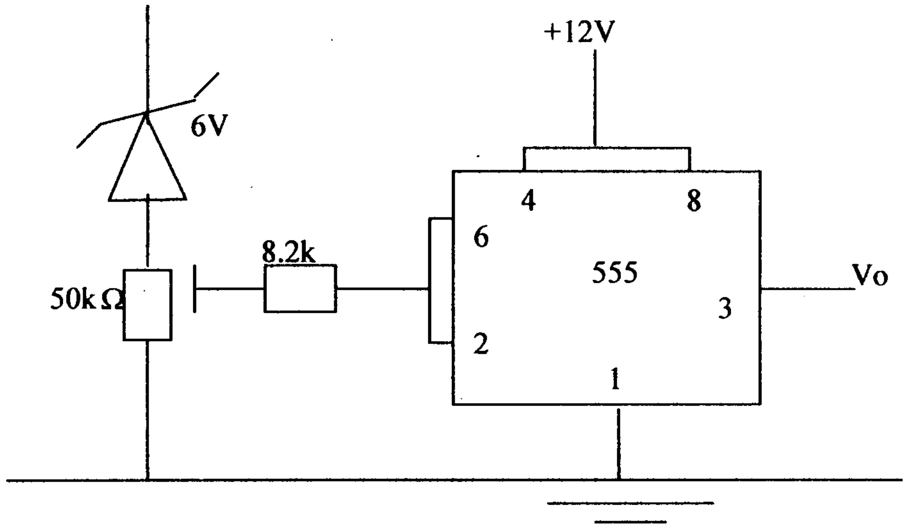


Fig 3.4 Voltage Detector Circuit

The network was adjusted to turn off pin 3 at an input voltage of 180V AC or high, and remains ON until the input voltage falls below 150V.

3.1.7 OVER VOLTAGE DETECTOR

Over voltage detection occurs at any presettable voltage set by the wiper position of a 50kΩ resistance shown below

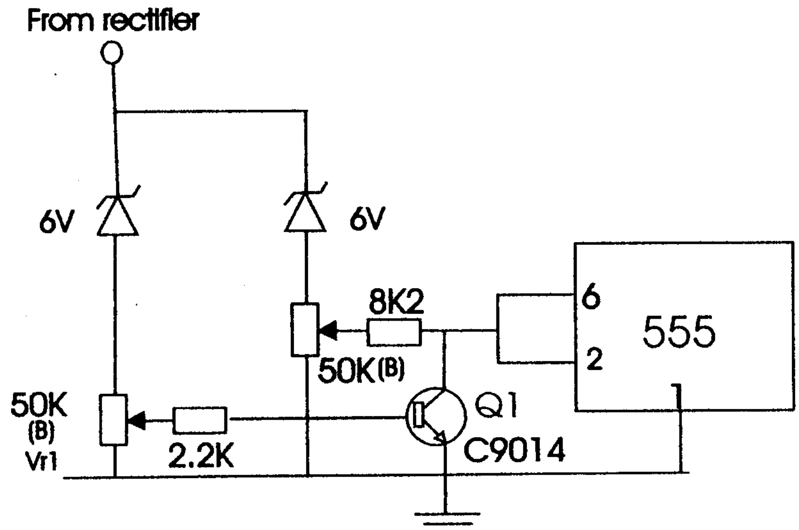


Fig 3.5 Over voltage Detector

VR1 is the over voltage level setting. At over voltage, Q1 switches ON, forcing the input on pins 6 and 2 Low, taking pin 3 high. Pin 3 is wired to the circuit shown below;

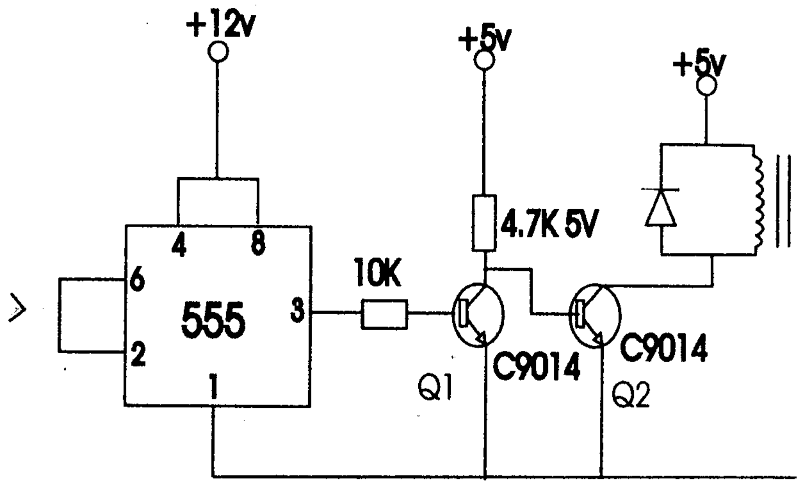


Fig 3.6(a) Change Over Control Logic

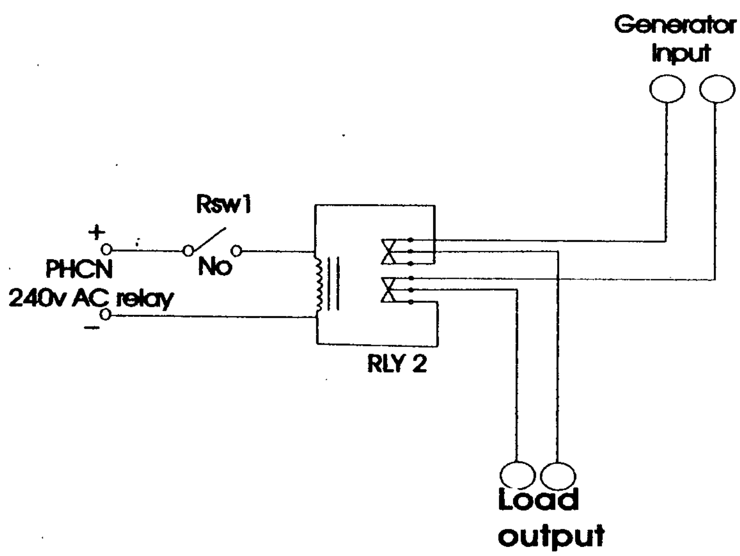


Fig 3.6(b) Change Over Control Logic

Q1 and Q2 form the relay control switches. When pin 3 of the 555 is high Q1 saturates, cutting off Q2 and de – energizing RLY1. With RLY1 de – energized, RSW1 opens and RLY2 de – energizes, transferring the load to the generator input. With pin 3 of the 555 Low, Q1 is cut off and Q2 turns ON, everything RLY1.

RSW1 closes, energizing RLY2. The load is thus transferred to the P.H.C.N inputs as indicated in the fig 3.6 R_B for Q1 was calculated from

$$R_b = \frac{Vb - Vbe}{Ib}$$

RLY1 is a 400Ω, 5v relay, requiring a normal coil current of ($^5/_{400}$) Ω μ = 12.mA.

$Ic_{(Q2)} = Icoil = 12.5mA$

β for Q1 and Q2 = 200

$$I_{B(Q2)} = \frac{Ic}{\beta} = \frac{12.5 \times 10^{-3}}{200}$$

$$= 62.5\mu A$$

$$R_{B(Q2)} = \frac{5 - 0.7}{62.5 \times 10^{-6}} = 69k\Omega$$

Allowing for overdrive in Q2, R_b was reduced to 4.7kΩ.

To turn off Q2, $V_{CE(Q1)} < \frac{1}{3} V_{BE(Q2)}$.

$V_{CE(Q1)}$ is typically made 0V

$V_{CE(Q1)} = Vcc - IcRc$

$0 = 5 - IcRc$

$IcRc = 5$

$Ic = {}^5/_{4700} = 1mA$

$I_B = \frac{Ic}{\beta} = 5.3\mu A$

$$R_{B(Q2)} = \frac{Vb_{(Q1)} - Vbe_{(Q1)}}{Ib_{(Q1)}}$$

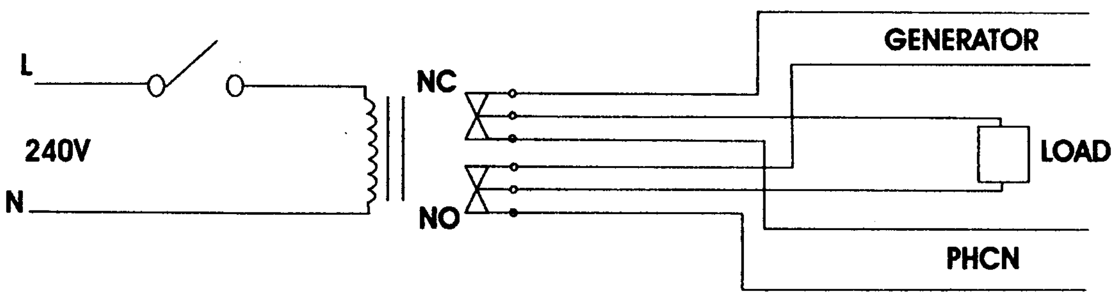
$$= \frac{12 - 0.7}{5.3 \times 10^{-6}}$$

$$= 2m\Omega$$

When this value was used, appreciable heating was noticed in Q1 due to non saturation. R_B was reduced to 10kΩ to guarantee saturation at all operating conditions.

3.1.8 TRANSFER SWITCH

The transfer switch was based on a 4 pole – 8way AC relay. It was connected as shown below.



RLY2 Fig 3.7 Transfer Switch

The complete schematic diagram of a transfer switch is shown in figure 3.7 above.

The complete schematic diagram is shown in fig.3.8

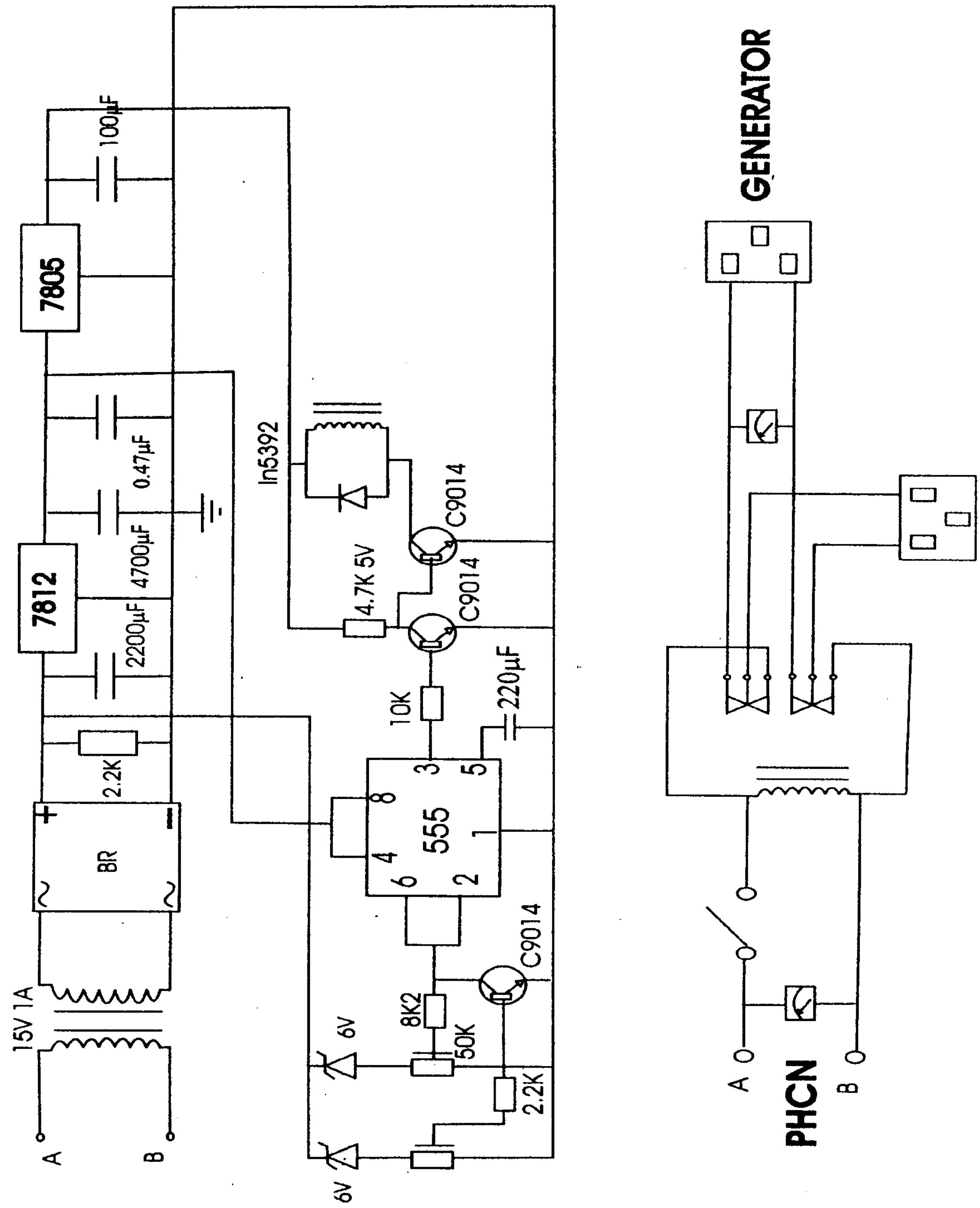


Fig 3.8 Complete Schematic Diagram

CHAPTER FOUR

4.0 TESTS, RESULTS AND DISCUSSION

4.1 CONSTRUCTION TOOLS AND MATERIALS

Some of the tools for the construction are, side cutter, precision set, screw driver, tester, blade, needle-like driller and some of the materials used include; vero board (Electronic board), connectors, connecting wires, lamp holder and one electric bulb, 6V DC relays (two), two 2200µf capacitors, two light emitting diodes, a transformer, a voltage regulator of 12V, two cables each of 1.5mm diameter, two electrical socket, two resistors, and eight diodes, plywood, nails, silver point, soldering iron and lead.

4.2 CONSTRUCTION DETAILS

4.2.1 TESTING OF CONNECTION

The unit was designed and calibrated as designed for. (for an under voltage of 150V and an over voltage of 270V).

A valuable output transformer was connected to the mains input. Switching was observed at the specified voltages. The generator input was replaced by a stabilizer output. The load output was connected to a 40 watt bulb.

The indicator meters gave precise indication of the AC levels on both power inputs (Local Supply of Generator). Snap-action oscillation free switching was observed, due to the implementation of hysterisis in the control/switching stage.

4.2.2 PROBLEMS ENCOUNTERED

Relays of high contact current ratings were very difficult to acquire, necessitating the use of a 10V – current 5A, 220V AC relay.

Some components were difficult to work with as they constantly failed during testing after soldering.

A valuable AC power supply was not easily available, so a dismantled stabilizer's auto-transformer was used to effect variable AC generation.

4.3 TESTING AND RESULT

When all the soldering had been completed on the vero board the hole circuit was traced to ensure no short or open circuit.

The output of the power supply unit which power the relay was tested by making the relays to change over immediately the power is supply.

In the absence of a generator, the project was tested using two PHCN sources; one represents a generator and the other representing PHCN source. Two LEDs and one electrical bulb were used for testing. The first red coloured LED standing as PHCN ON/OFF indicator, the second yellow coloured LED standing as Generator ON/OFF indicator and the load is constant irrespective of the source either PHCN or Generator is supplying the LOAD. However, the supply of the load was observed to be constant (continuous) either the supply is from PHCN or Generator (it was observed that both PHCN and Generator were not supplying at the same time).

The automatic starting and shutting down of generator was tested using the ignition activated circuit constructed to start and shut down the ignition of a motor car (in good order). Since generator and automobiles uses the same ignition and shutting principle.

4.4 PROJECT CASING

Any equipment needs a container to protect it and make it safe for use. The casing of the project constructed is made of wood of rectangular shape box having the dimension 21cm x 10cm x 11cm.the woods were jointed together by nails and painted with silver paint. Necessary drilling were made on the casing one side view for PHCN input, generator input, the kick starter (ignition) of the generator and shorting down of the generator. The opposite side is for the generator side is for the generator indicator, PHCN indicator and the load.

4.4.1 PROBLEM ENCOUNTERED

Unavailability of the component required for the project at the immediate environment was the first problem encountered.

Also, the voltage across the regulator was initially not up to the required 12V when measured until the circuit was trouble shorted. When powered for the first time and some relay coils got bunt which could not change contacts. This is as a result of some points or paths along the vero board not properly isolated to prevent short circuiting. This was later corrected and the circuit attains normal. Also the connector initially used was a bit bigger and could not hold the flexible wires used for the ignition. This was later change to smaller one which gives desire result.

4.5 PREVENTIVE MEASURES TAKEN

1. The entire individual components were independently tested before use to ensure that they are all in good working order.
2. Polarities of the components (where applicable) were considered before connecting them to prevent components damage and ensure proper sequence of operation.

3. The normally open and normally close of the relay were identified with the aid of a digital meter to avoid wrong connection of the relay contacts.

4. Necessary portions of the electronic board (vero board) were isolated to avoid continuity which may result in short circuit.

5. Badly soldered joints were avoided by applying a little solder into the joints.

6. Water and moisture were prevented from coming in contact with the unit constructed.

CHAPTER FIVE

5.0 CONCLUSION AN DRECOMMENDATION

5.1 CONCLUSION

The objective of this project, an automatic change over switch has been achieved to a very satisfactory extent. It has the aim of providing a constant power supply to equipments mostly during operation in hospitals and other areas sensitive to power supply. The loss associated with an electrical service interruption due to power failure is of great concern.. This project hence avoids a disorderly shut down which can be both hazardous and costly.

Relays which are mainly the heart of this project provides protection to electrical devices which enables circuit switching equipment to respond to abnormal or dangerous system conditions.

The institute of Electrical Engineering (IEE) regulation for the electrical equipment of building, stipulates that for safe utilization of electrical energy, the fluctuation of normal supply voltage at any time must not exceed ± 60%.

The normal domestic supply phase voltage is known to be 220V interpreting the above regulation means that 202 - 233.2V. From this regulation, it is deduced that the project is safe to be applied to sensitive domestic and industrial establishments.

5.2 RECOMMENDATION

For this design, the ideal situation of an automatic change over switch can be used for three phase or single phase and the alternative means of supply can be a generator, solar energy and other means. And this case depends on the rate of the capacity of the appliance.

For further improvement high current ground fault time alarm should also be considered and a long relay time alarm.

The project has clearly given us the fore knowledge and proper understanding of the change over switch and how to improve on it. Due to the fact that the success of any power supply is to avoid interruption of main source i.e. constant power supply.

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